NASA TM-83242

NASA Technical Memorandum 83242

NASA-TM-83242 19820025950

NECAP 4.1 - NASA'S ENERGY-COST ANALYSIS PROGRAM ENGINEERING FLOW CHARTS

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May 1982

National Aeronautics and
Space Administration

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Hampton, Virginia 23665

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Section 1

INTRODUCTION

This manual is one in a set of NECAP manuals referenced below that describes the computer program NECAP - NASA's Energy Cost Analysis Program. The program is a versatile building design and energy analysis tool which has embodied within it, state-of-the-art techniques for performing thermal load calculations and energy use predictions. With the program, comparisons of building designs and operational alternatives for new or existing buildings can be made.

The major feature of the program is the "response factor" technique for calculating the heat transfer through the building surfaces which accounts for the building's mass. The program expands the response factor technique into a "space response factor" to account for internal building temperature swings; this is extremely important in determining true building loads and energy consumption when internal temperatures are allowed to swing.

The algorithms for the thermal loads portion of NECAP comes from the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., (ASHRAE) manual, Procedure for Determining Heating and Cooling Loads for Computerized Energy Calculation. The original NECAP was published in 1975 and was supported by two manuals entitled NECAP - NASA's Energy Cost Analysis Program, NASA CR-2590 Part I User's Manual and NASA CR-2590 Part II Engineering Manual. Since that time, NASA has used NECAP for building heating and cooling design loads and energy analysis. The program has been used as a reference for the development of several other computerized programs.

This version of NECAP, called NECAP-4.1, contains the following modifications and improvements:

- A NECAP input data processor (NIPP) module was developed which greatly simplifies and reduces the user input task. The original fixed format data field suitable for punching onto computer cards has been eliminated in favor of a free format data field suitable for use with computer terminals.

- Provide built in default values for most input data.

- The Response Factor module was made an integral part of the Thermal Load Analysis and System modules.

- The Variable Temperature module and System and Equipment Simulation module were brought together into one module to allow dynamic simulation and interaction (feedback) between the space, its distribution system, and the heating and cooling plant equipment. In the previous version of NECAP, the hourly space temperatures and system heating/cooling loads were calculated using given heating/cooling capacities. Because of varying plant equipment capacity due to ambient conditions, scheduling, distribution system control options, etc., "loads-not-met" resulted in the old program. "Loads-not-met" were not accounted for in space temperature drift above or below the allowed temperature range.

- Modify the thermostat and ventilation schedule input.
- Improve fan on/off code.
- Addition of process loads.
- Modify the weather tape system.
- Use system component part load performance curves.
- Default CFM, chiller size, and boiler size data.
- Provide an executive summary for energy.
- Print out a temperature frequency chart.
- Add more flexibility to print out.
- Change the glass shade coefficient.
- Correct air infiltration coefficients, fan efficiencies, and floor panel heating algorithms.

The new program is documented in the following manuals:

TM 83238, Users Manual - Describes examples and output forms.

TM 83239, Input Manual - Details the input requirements.

TM 83240, Engineering Manual - Provides the algorithms for the program.

TM 83241, Fast Input Manual and Example - Gives a fast method of input.

TM 83242, Engineering Flow Charts - Provides flow charts that supplements the Engineering Manual.

CR- 165802, Operations Manual - Gives the specific operating instruction for Langley Research Center's computer system operation.

Program modifications were directed specifically at program improvements and not at a complete rework of the program structure. We wish to acknowledge the contributions made by the project's contractor, GARD, Inc. of Niles, IL, for the various changes and documentation in the program performed under contract NASW-3307. The program's maintenance contractor, Computer Science Corporation, of Hampton, Virginia also assisted in program updates and documentation.

The program is run on NASA, Langley Research Center's large computer system. Users should be cautioned that program implementation can be time consuming and costly. Although computer run costs are much lower than the original response factor programs, they are still a magnitude greater that the simple "bin method" type energy calculation. With this in mind, judgment should be exercised to assure that needs are compatible with the investment. Operational assistance in running the program cannot be provided by NASA.

There are limited means to update the material. Comments on the program are welcomed, although the Government accepts no obligation even if the suggestions are used. Send comments to:

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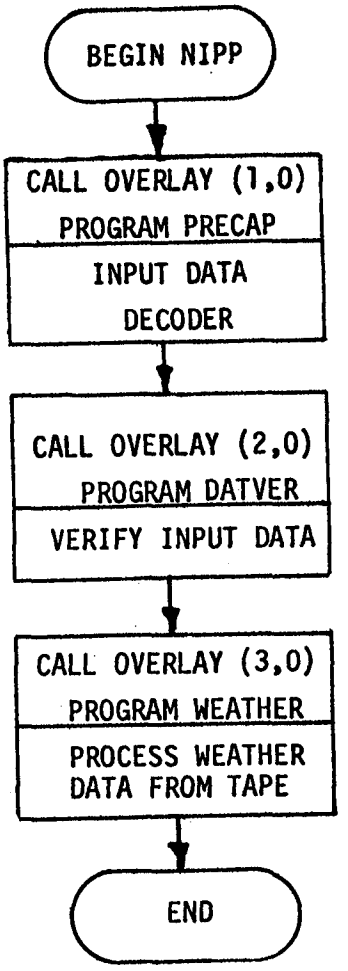
Hampton, VA 23665

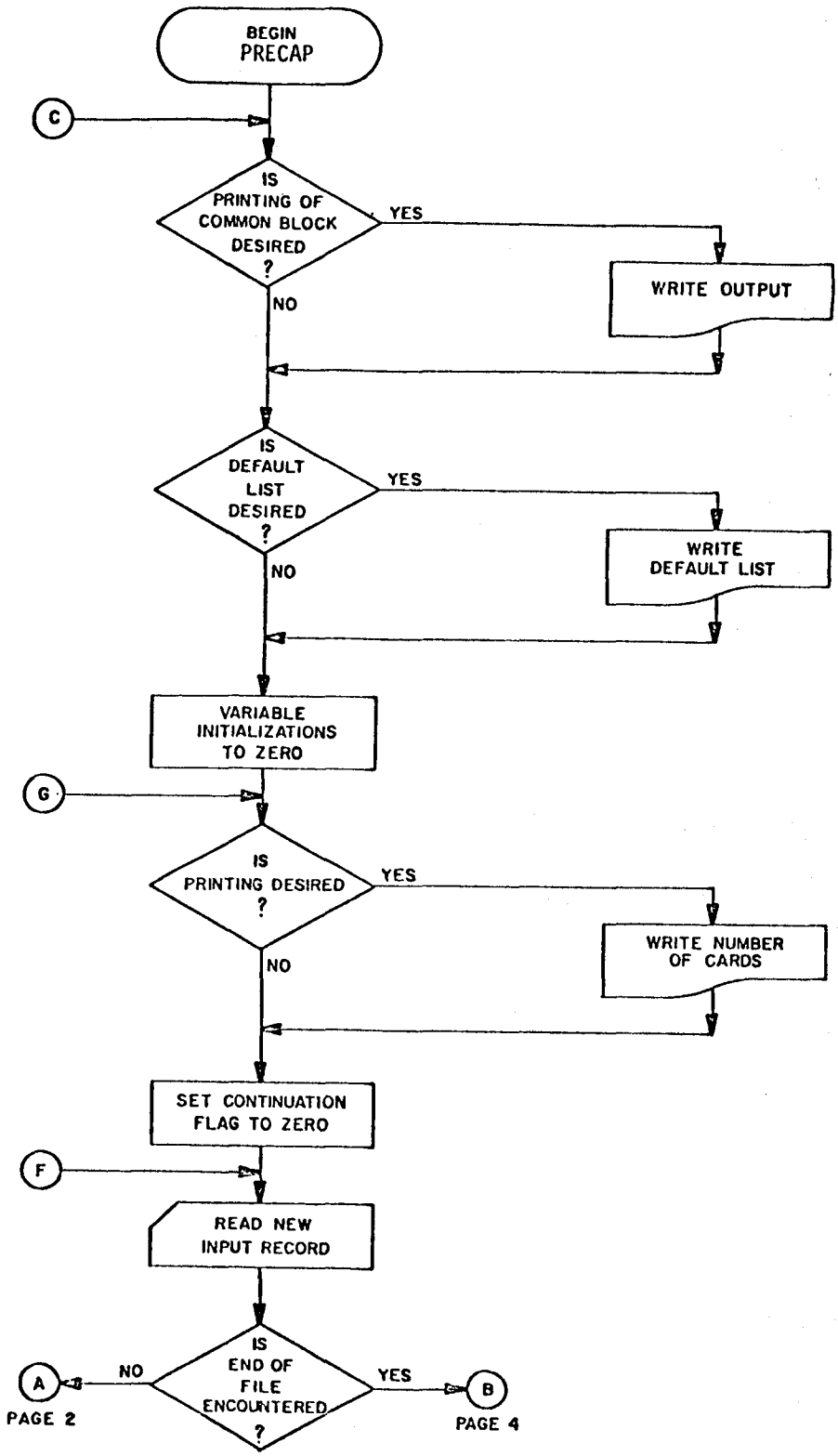
NECAP-4.1 is made up of the following program modules:

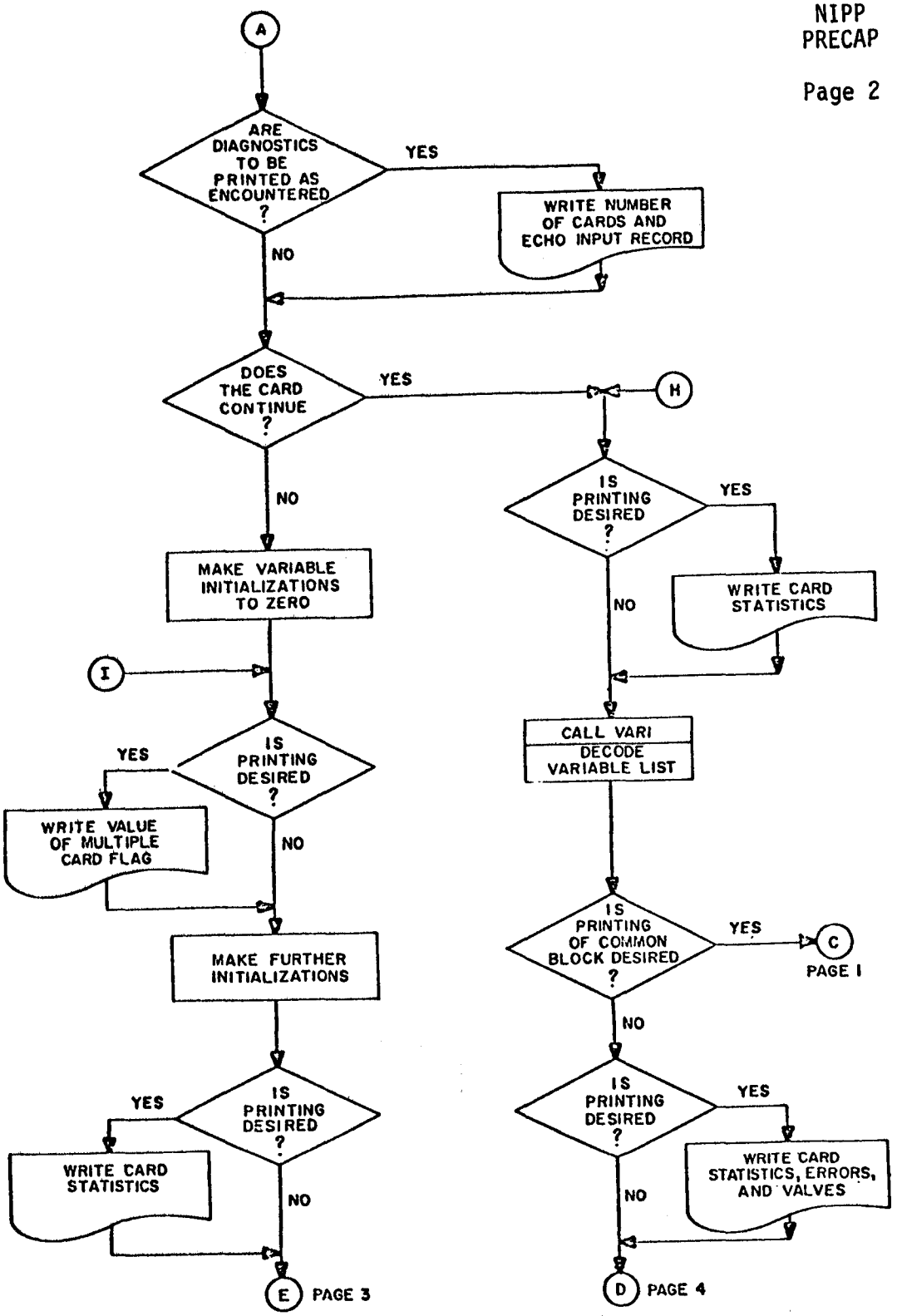
NECAP Input Processor (NIPP)
Thermal Load Analysis (TLAP)
Systems Energy Simulation (SESP)
Owning and Operating Cost (ESCON)

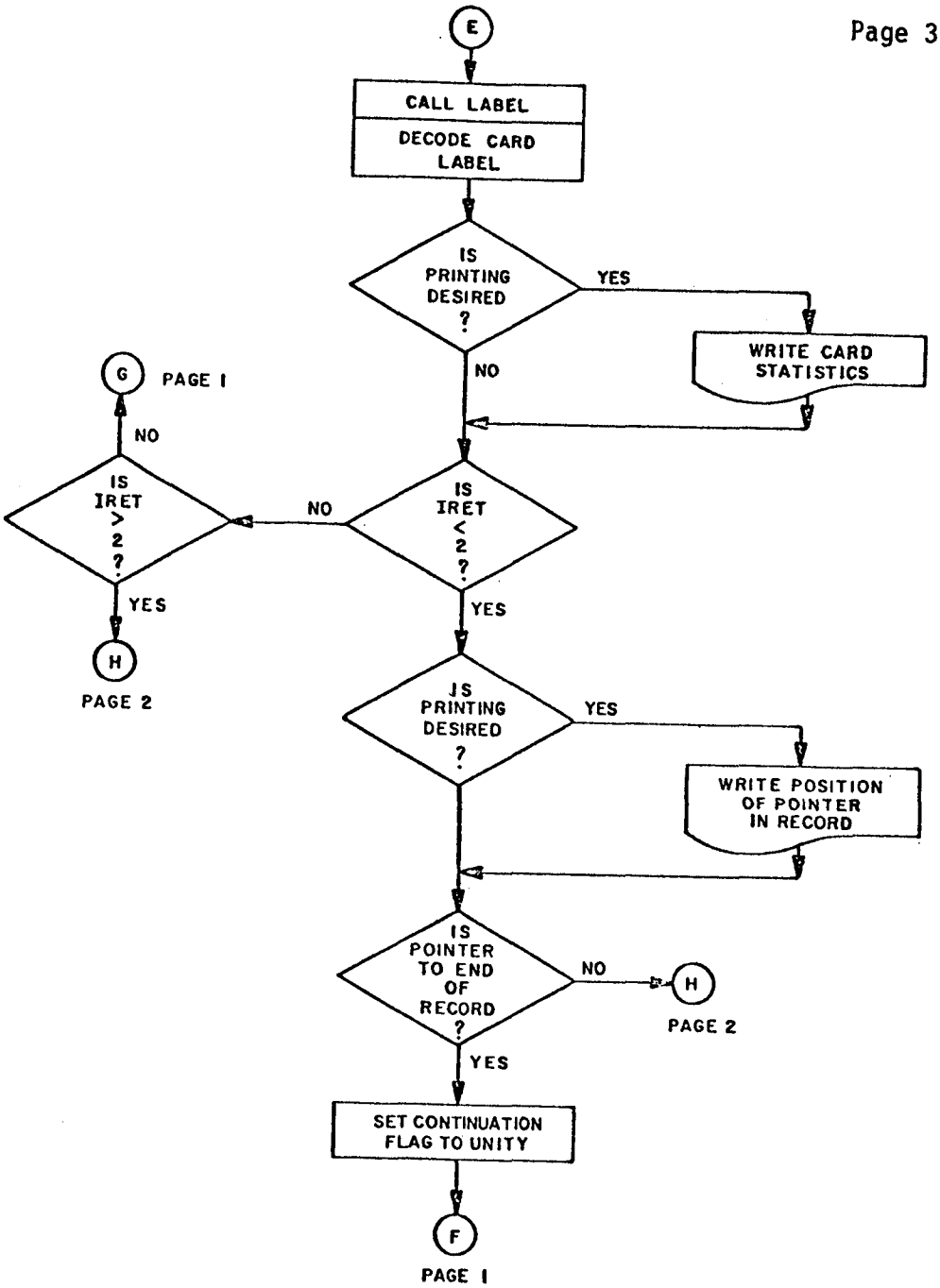
Section 2

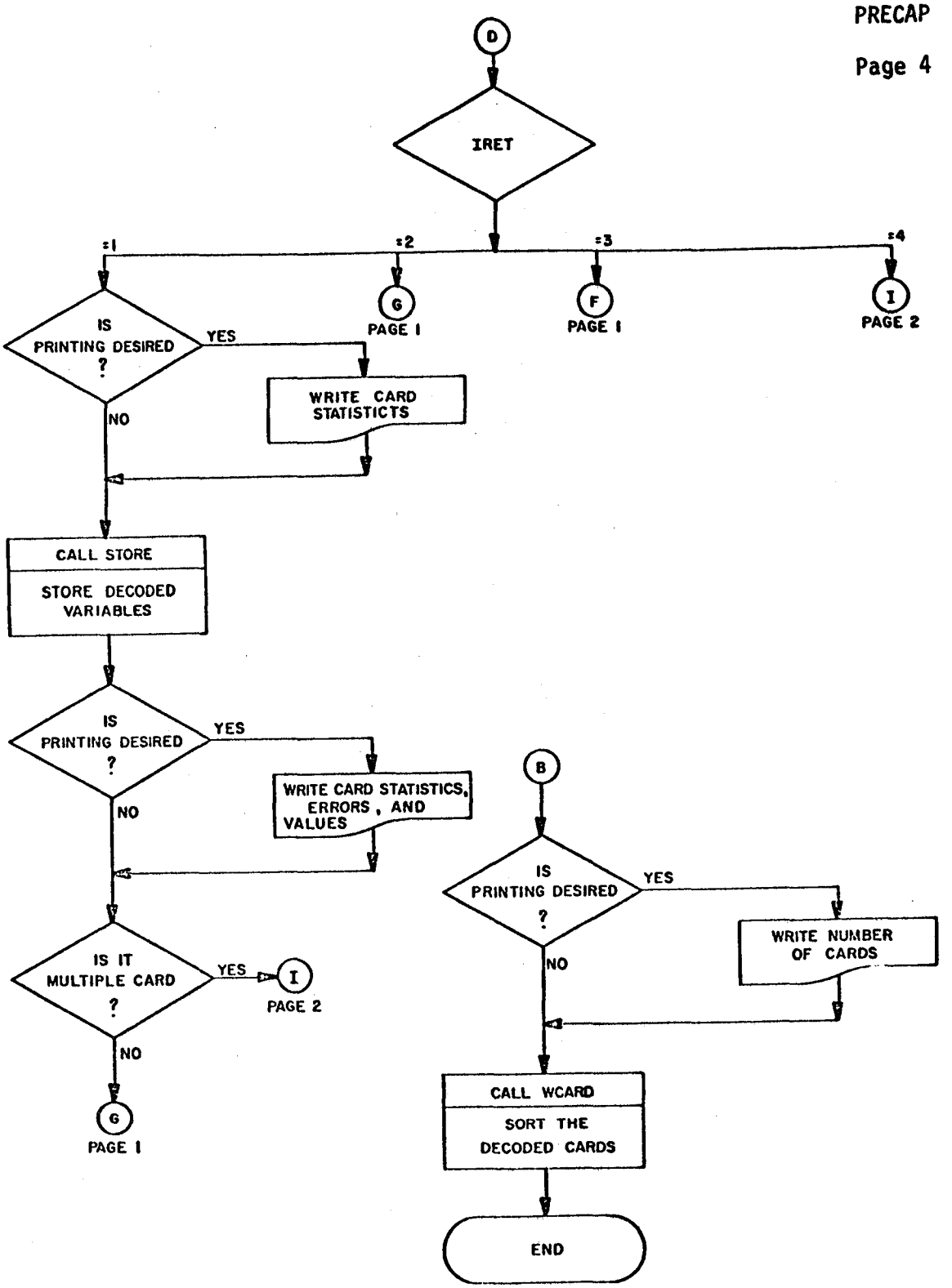
NECAP INPUT PROCESSOR PROGRAM

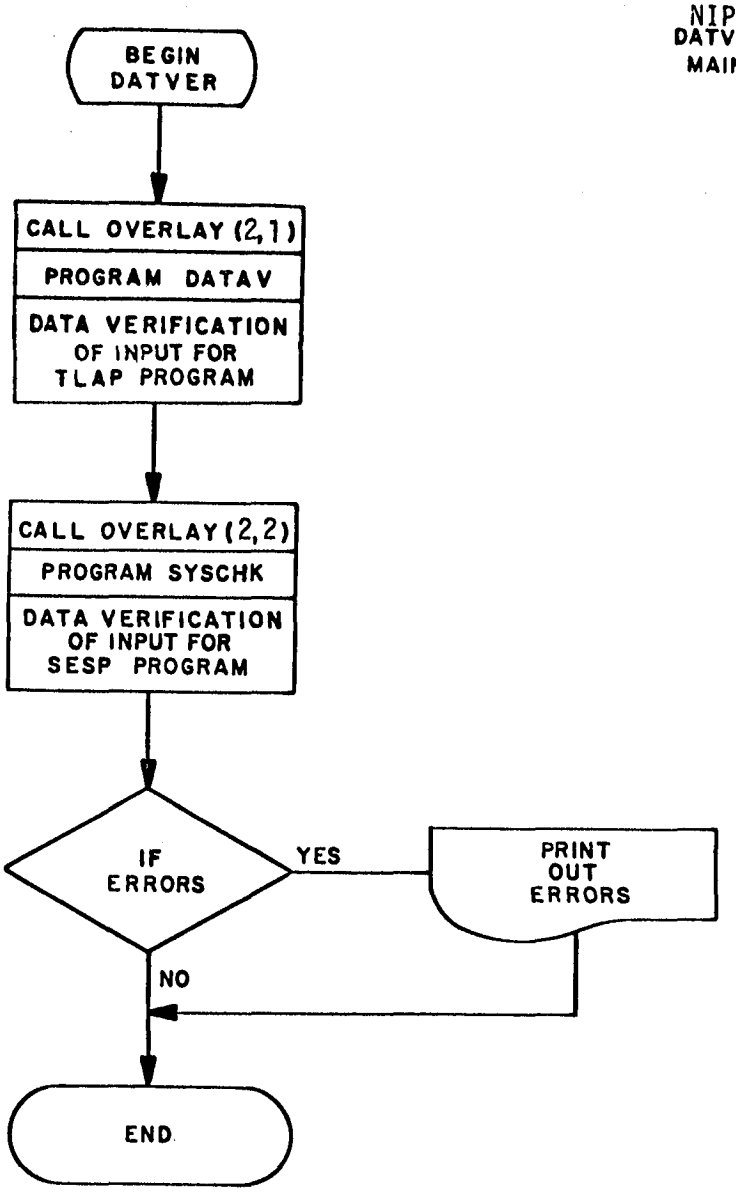

BEGIN NIPP
CALL OVERLAY (1,0)
PROGRAM PRECAP
INPUT DATA
DECODER
CALL OVERLAY (2,0)
PROGRAM DATVER
VERIFY INPUT DATA
CALL OVERLAY (3,0)
PROGRAM WEATHER
PROCESS WEATHER
DATA FROM TAPE
END

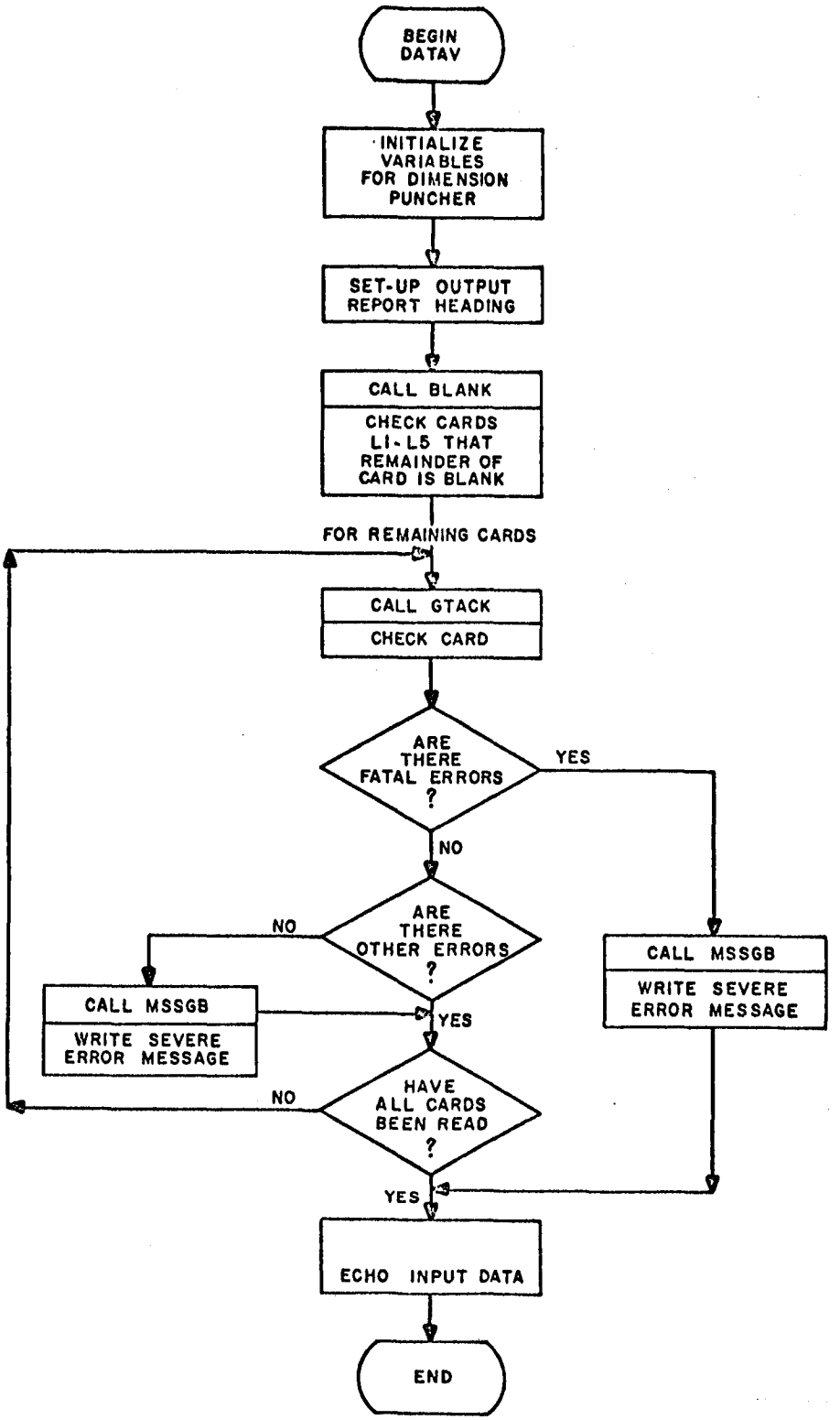

BEGIN
PRECAP
C
IS
PRINTING OF
COMMON BLOCK
DESIRED
?
YES
WRITE OUTPUT
NO
IS
DEFAULT
LIST
DESIRED
?
YES
WRITE
DEFAULT LIST
NO
VARIABLE
INITIALIZATIONS
TO ZERO
G
IS
PRINTING DESIRED
?
YES
WRITE NUMBER
OF CARDS
NO
SET CONTINUATION
FLAG TO ZERO
F
READ NEW
INPUT RECORD
IS
END OF
FILE
ENCOUNTERED
?
NO
A
PAGE 2
YES
B
PAGE 4

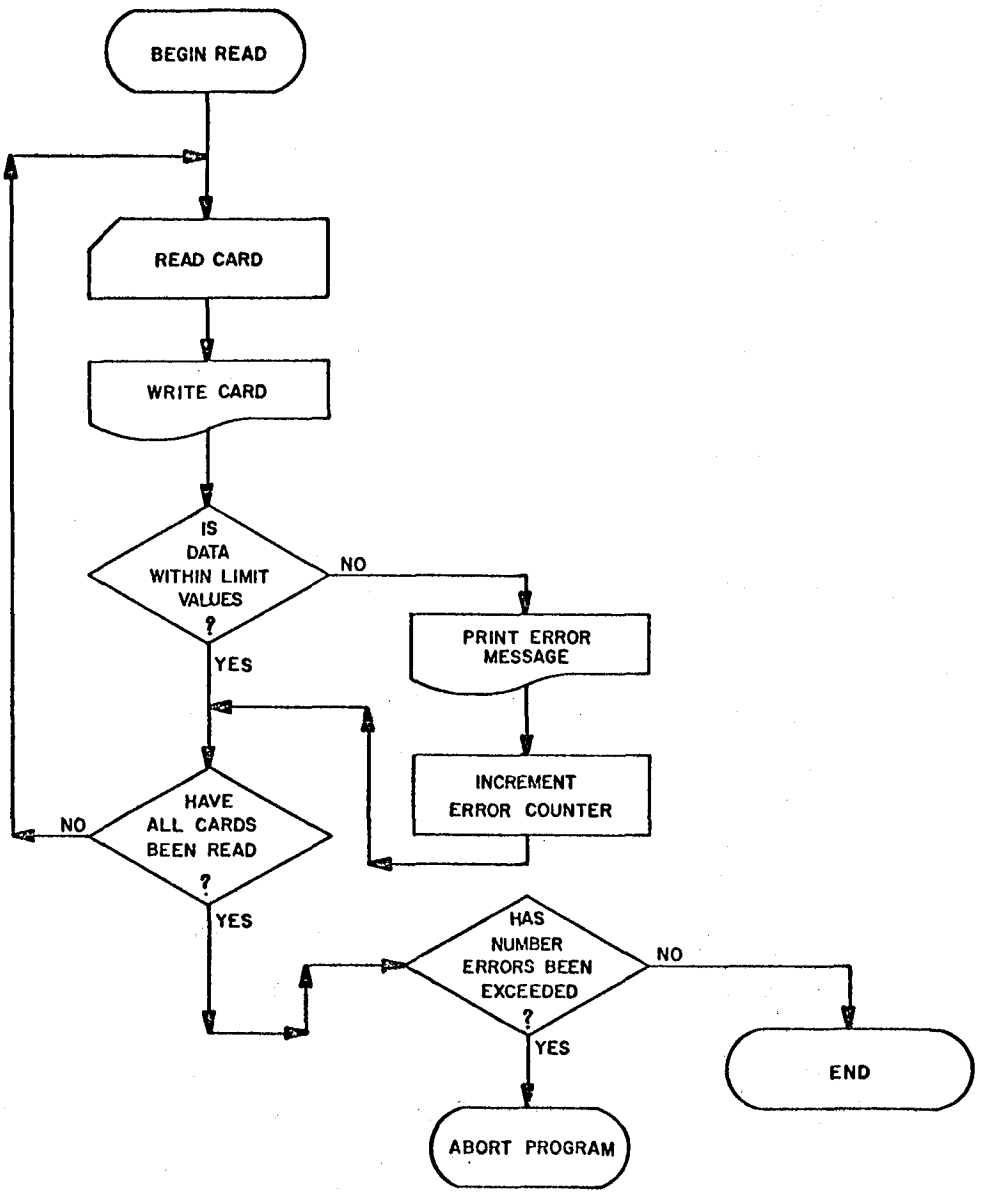

A
ARE DIAGNOSTICS TO BE PRINTED AS ENCOUNTERED ?
YES
WRITE NUMBER OF CARDS AND ECHO INPUT RECORD
NO
DOES THE CARD CONTINUE ?
YES
H
NO
IS PRINTING DESIRED ?
YES
WRITE CARD STATISTICS
NO
MAKE VARIABLE INITIALIZATIONS TO ZERO
I
IS PRINTING DESIRED ?
YES
WRITE VALUE OF MULTIPLE CARD FLAG
NO
CALL VARI
DECODE VARIABLE LIST
MAKE FURTHER INITIALIZATIONS
IS PRINTING OF COMMON BLOCK DESIRED ?
YES
C
PAGE 1
NO
IS PRINTING DESIRED ?
YES
WRITE CARD STATISTICS
NO
E
PAGE 3
IS PRINTING DESIRED ?
YES
WRITE CARD STATISTICS, ERRORS, AND VALVES
NO
D
PAGE 4

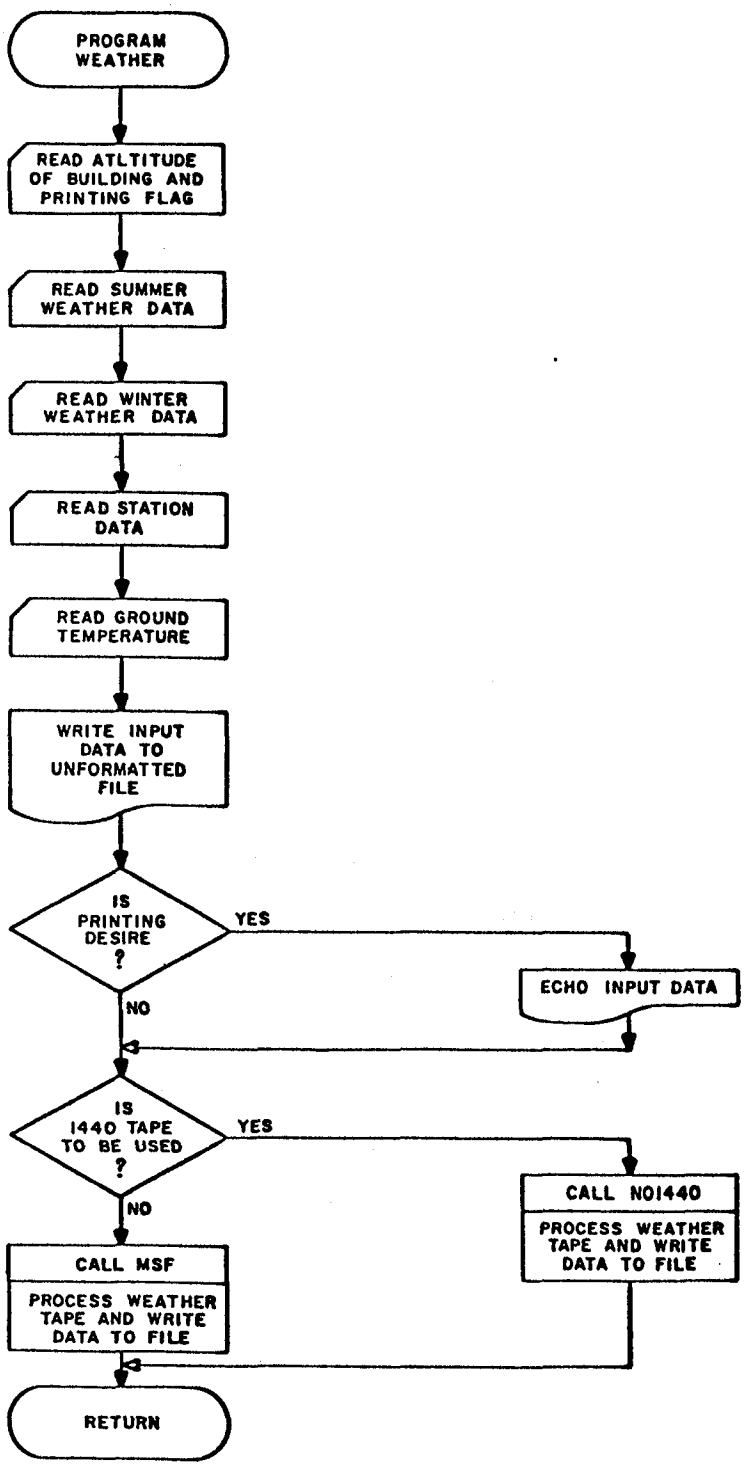

E
CALL LABEL
DECODE CARD LABEL
IS PRINTING DESIRED ?
YES
WRITE CARD STATISTICS
NO
G
PAGE 1
NO
IS IRET > 2 ?
NO
IS IRET < 2 ?
YES
H
PAGE 2
YES
IS PRINTING DESIRED ?
YES
WRITE POSITION OF POINTER IN RECORD
IS POINTER TO END OF RECORD ?
NO
H
PAGE 2
YES
SET CONTINUATION FLAG TO UNITY
F
PAGE 1


D
IRET
=1
=2
=3
=4
G
PAGE 1
F
PAGE 1
I
PAGE 2
IS PRINTING DESIRED ?
YES
NO
WRITE CARD STATISTICTS
CALL STORE
STORE DECODED VARIABLES
IS PRINTING DESIRED ?
YES
NO
WRITE CARD STATISTICS, ERRORS, AND VALUES
IS IT MULTIPLE CARD ?
YES
I
PAGE 2
NO
G
PAGE 1
B
IS PRINTING DESIRED ?
YES
NO
WRITE NUMBER OF CARDS
CALL WCARD
SORT THE DECODED CARDS
END


BEGIN
DATVER
CALL OVERLAY (2,1)
PROGRAM DATAV
DATA VERIFICATION
OF INPUT FOR
TLAP PROGRAM
CALL OVERLAY (2,2)
PROGRAM SYSCHK
DATA VERIFICATION
OF INPUT FOR
SESP PROGRAM
IF
ERRORS
YES
PRINT
OUT
ERRORS
NO
END

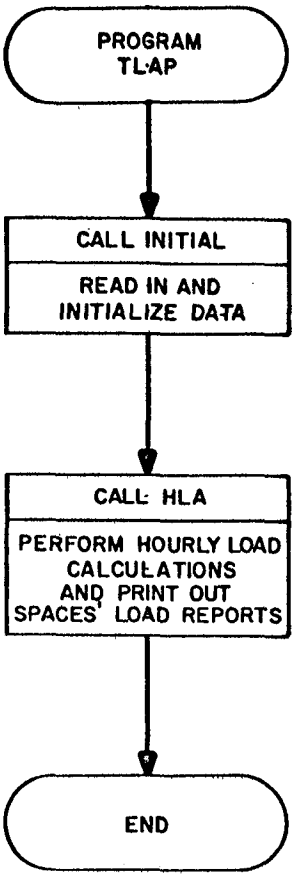

BEGIN DATAV
INITIALIZE VARIABLES FOR DIMENSION PUNCHER
SET-UP OUTPUT REPORT HEADING
CALL BLANK
CHECK CARDS L1-L5 THAT REMAINDER OF CARD IS BLANK
FOR REMAINING CARDS
CALL GTACK
CHECK CARD
ARE THERE FATAL ERRORS ?
YES
NO
ARE THERE OTHER ERRORS ?
NO
CALL MSSGB
WRITE SEVERE ERROR MESSAGE
YES
CALL MSSGB
WRITE SEVERE ERROR MESSAGE
HAVE ALL CARDS BEEN READ ?
NO
YES
ECHO INPUT DATA
END

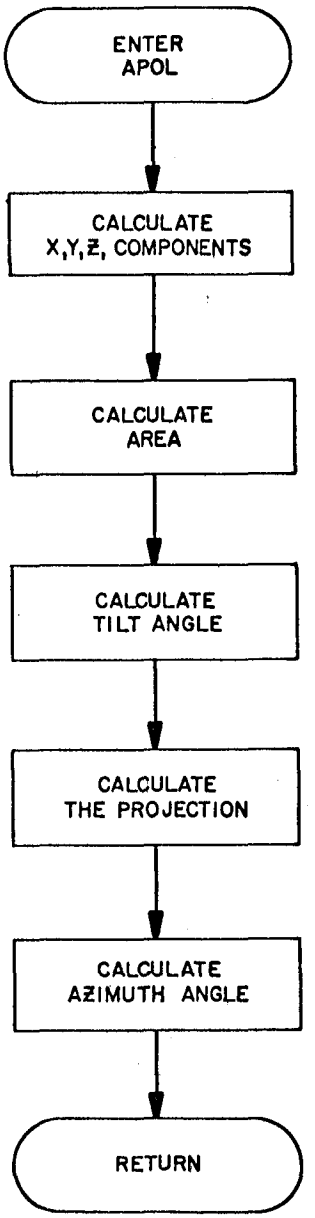

BEGIN READ
READ CARD
WRITE CARD
IS DATA WITHIN LIMIT VALUES ?
NO
YES
PRINT ERROR MESSAGE
INCREMENT ERROR COUNTER
HAVE ALL CARDS BEEN READ ?
NO
YES
HAS NUMBER ERRORS BEEN EXCEEDED ?
NO
YES
END
ABORT PROGRAM

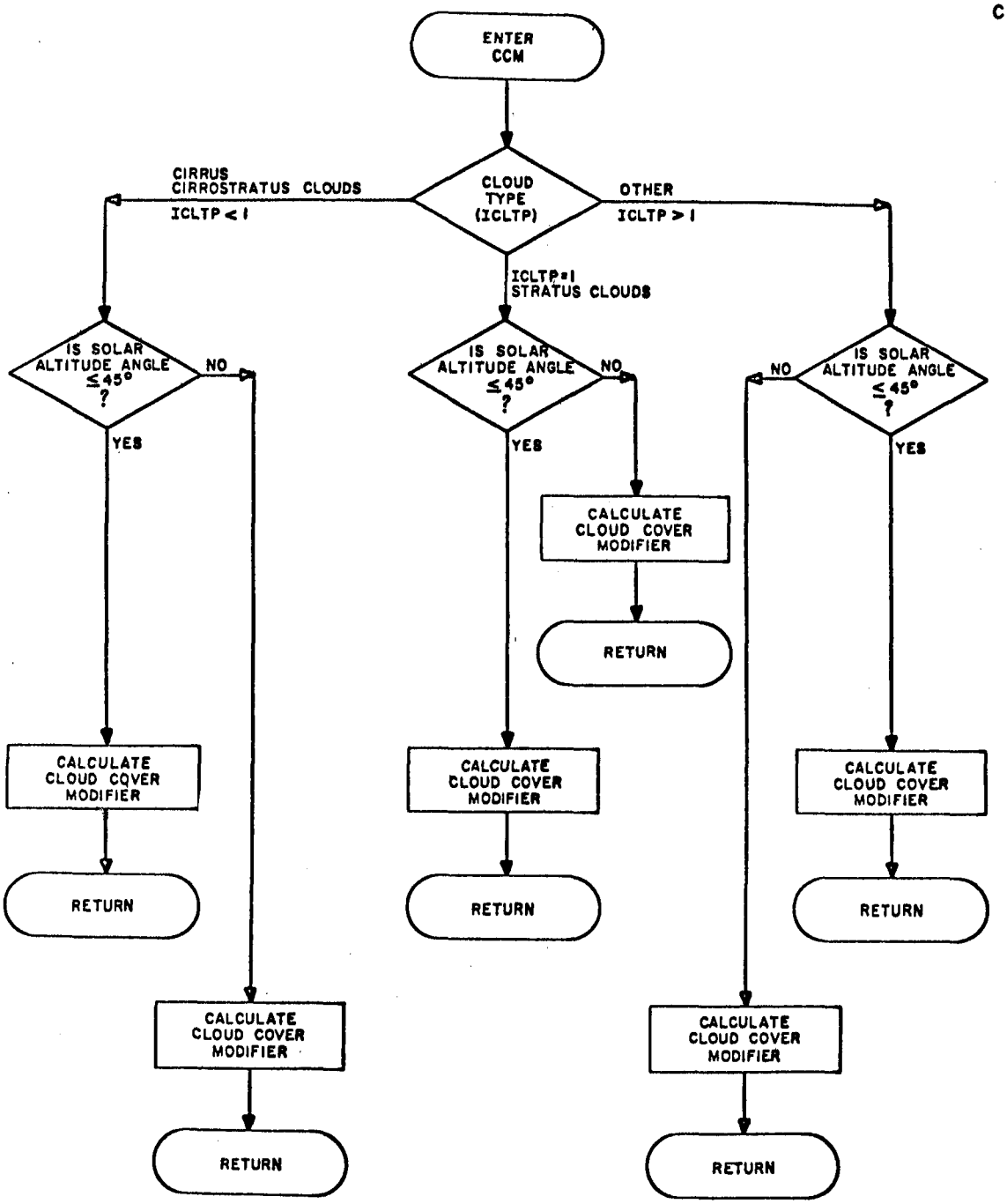

PROGRAM WEATHER
READ ATLTITUDE OF BUILDING AND PRINTING FLAG
READ SUMMER WEATHER DATA
READ WINTER WEATHER DATA
READ STATION DATA
READ GROUND TEMPERATURE
WRITE INPUT DATA TO UNFORMATTED FILE
IS PRINTING DESIRE ?
YES
ECHO INPUT DATA
NO
IS 1440 TAPE TO BE USED ?
YES
CALL NO1440
PROCESS WEATHER TAPE AND WRITE DATA TO FILE
NO
CALL MSF
PROCESS WEATHER TAPE AND WRITE DATA TO FILE
RETURN

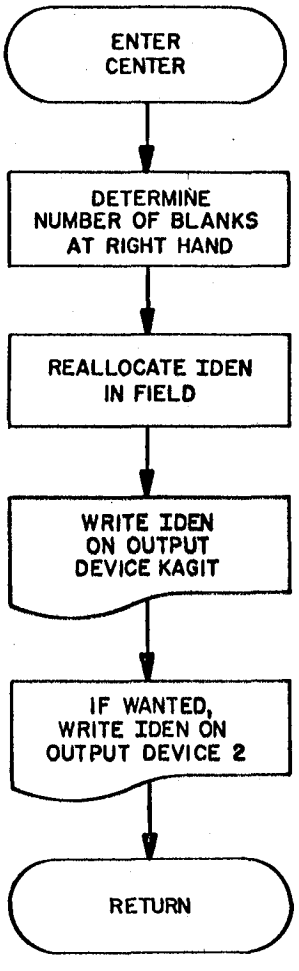
Section 3

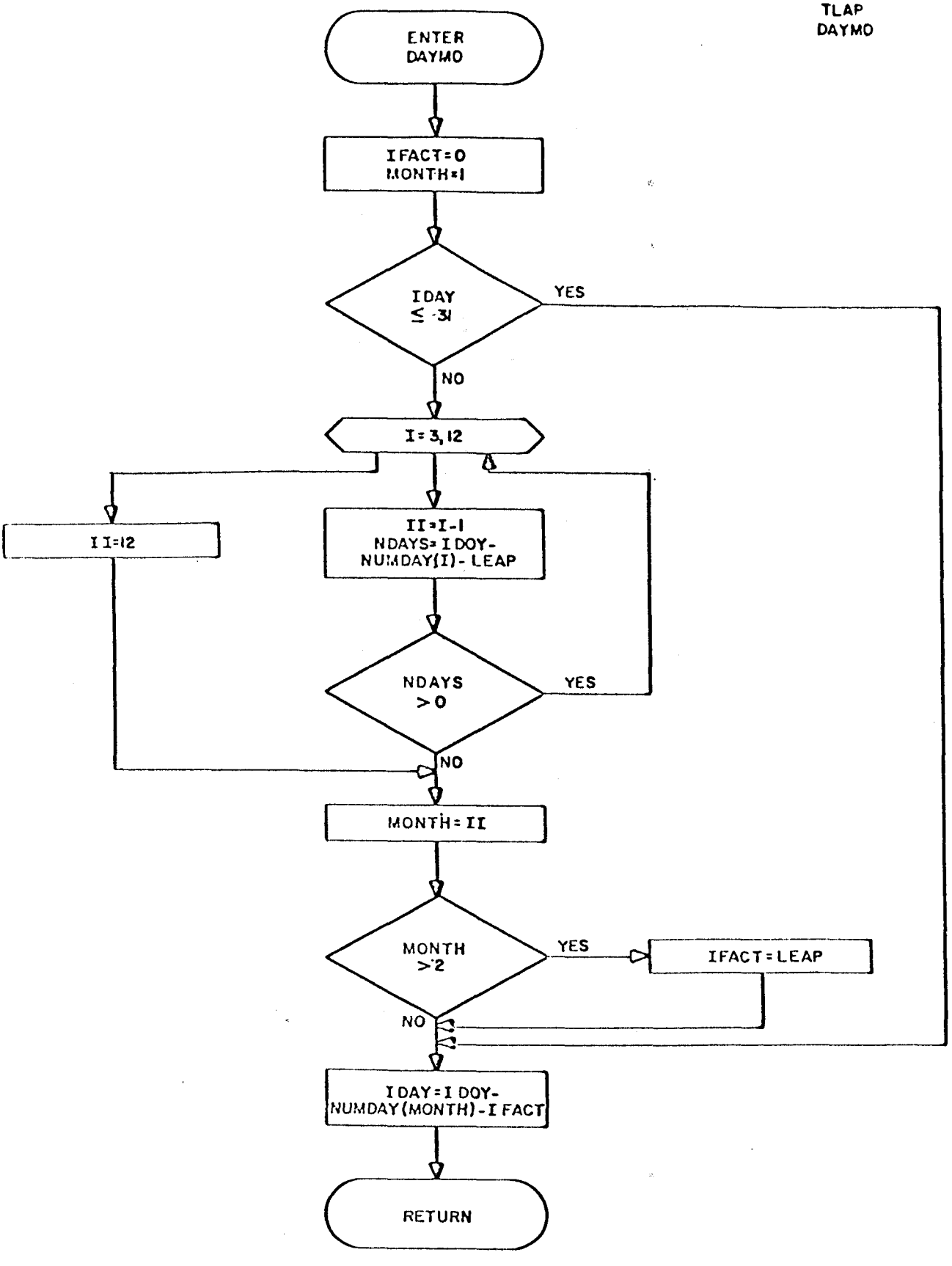
THERMAL LOADS ANALYSIS PROGRAM

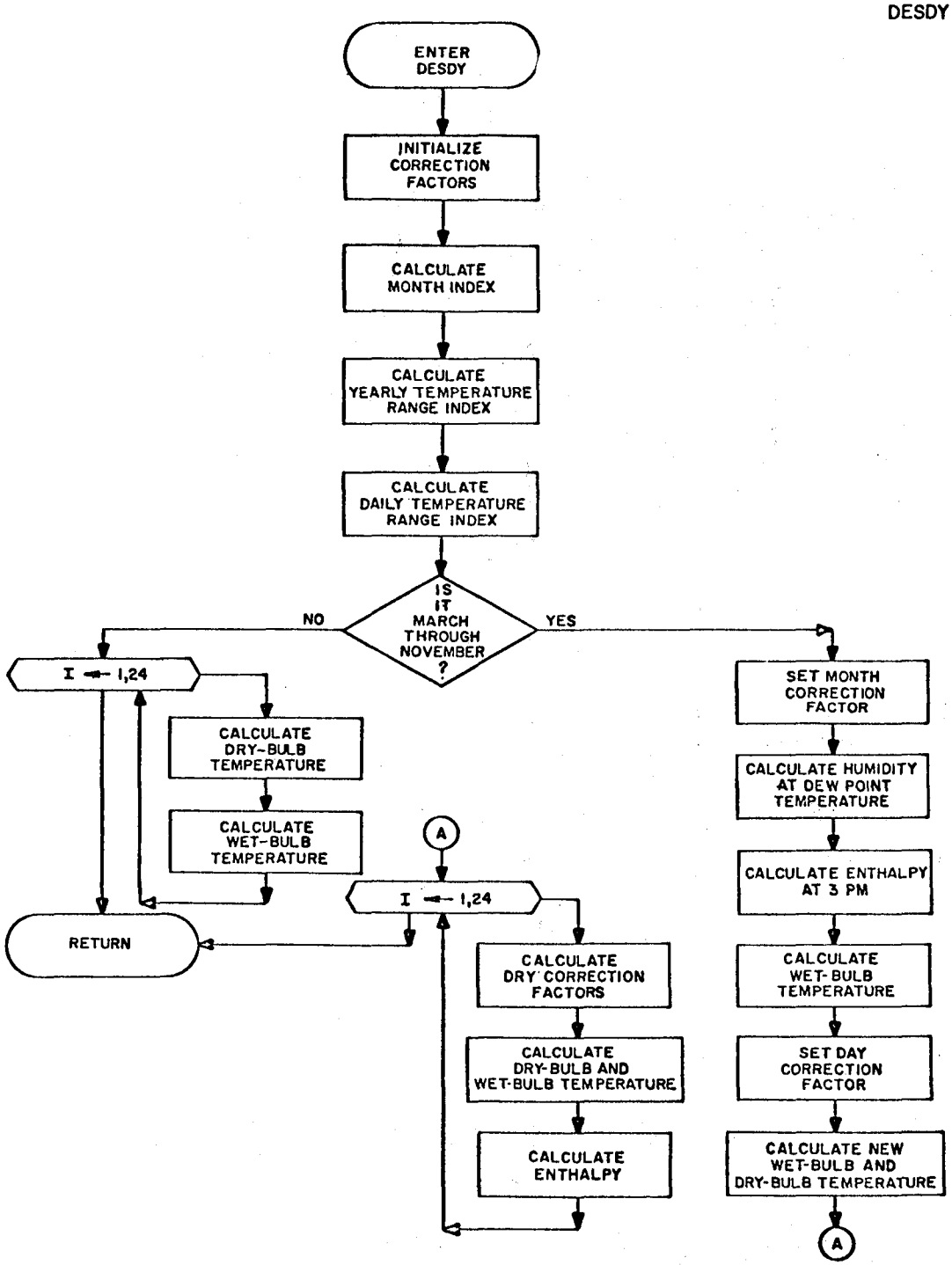

PROGRAM
TLAP
CALL INITIAL
READ IN AND
INITIALIZE DATA
CALL HLA
PERFORM HOURLY LOAD
CALCULATIONS
AND PRINT OUT
SPACES' LOAD REPORTS
END

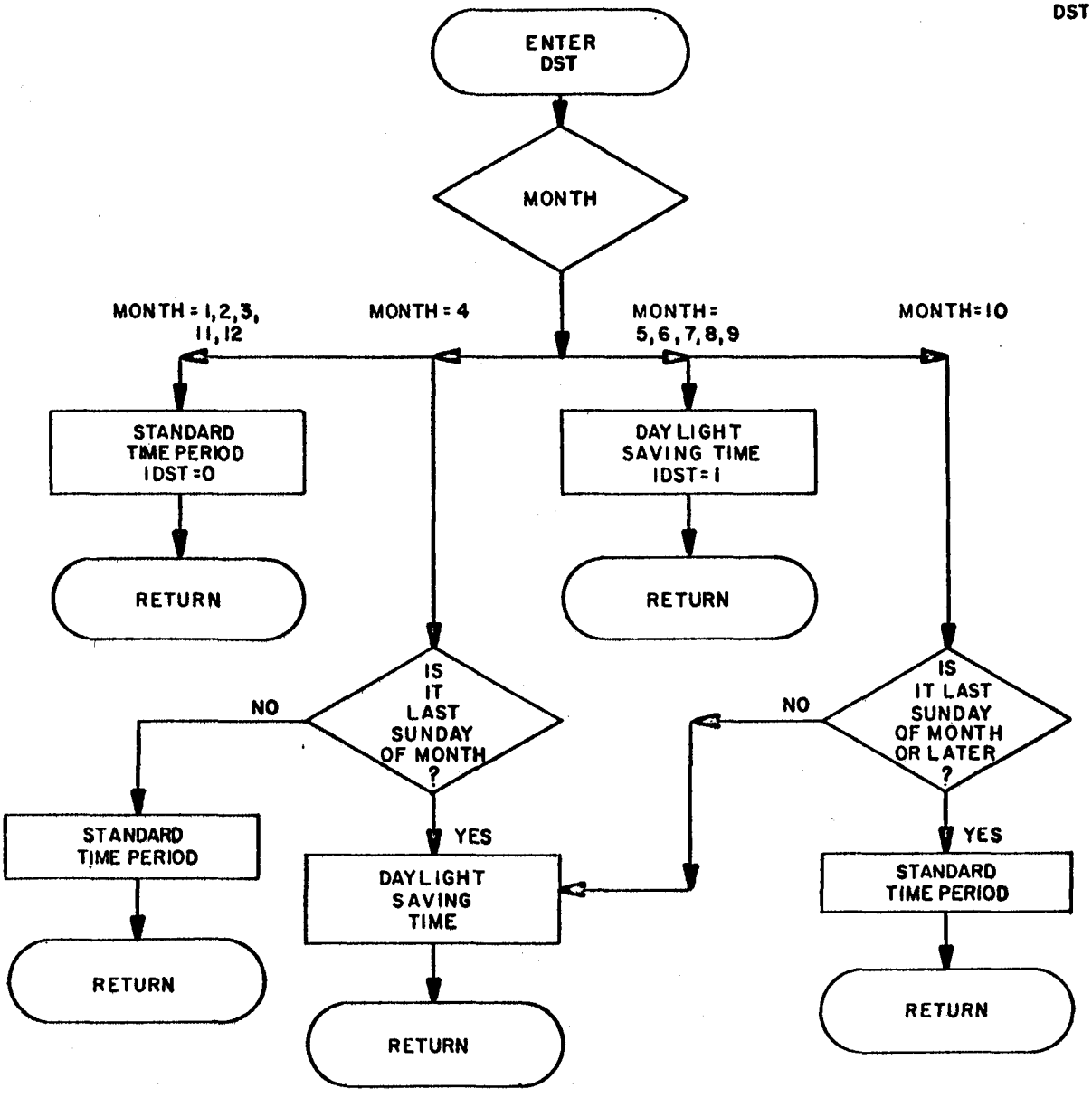

ENTER
APOL
CALCULATE
X,Y,Z, COMPONENTS
CALCULATE
AREA
CALCULATE
TILT ANGLE
CALCULATE
THE PROJECTION
CALCULATE
AZIMUTH ANGLE
RETURN

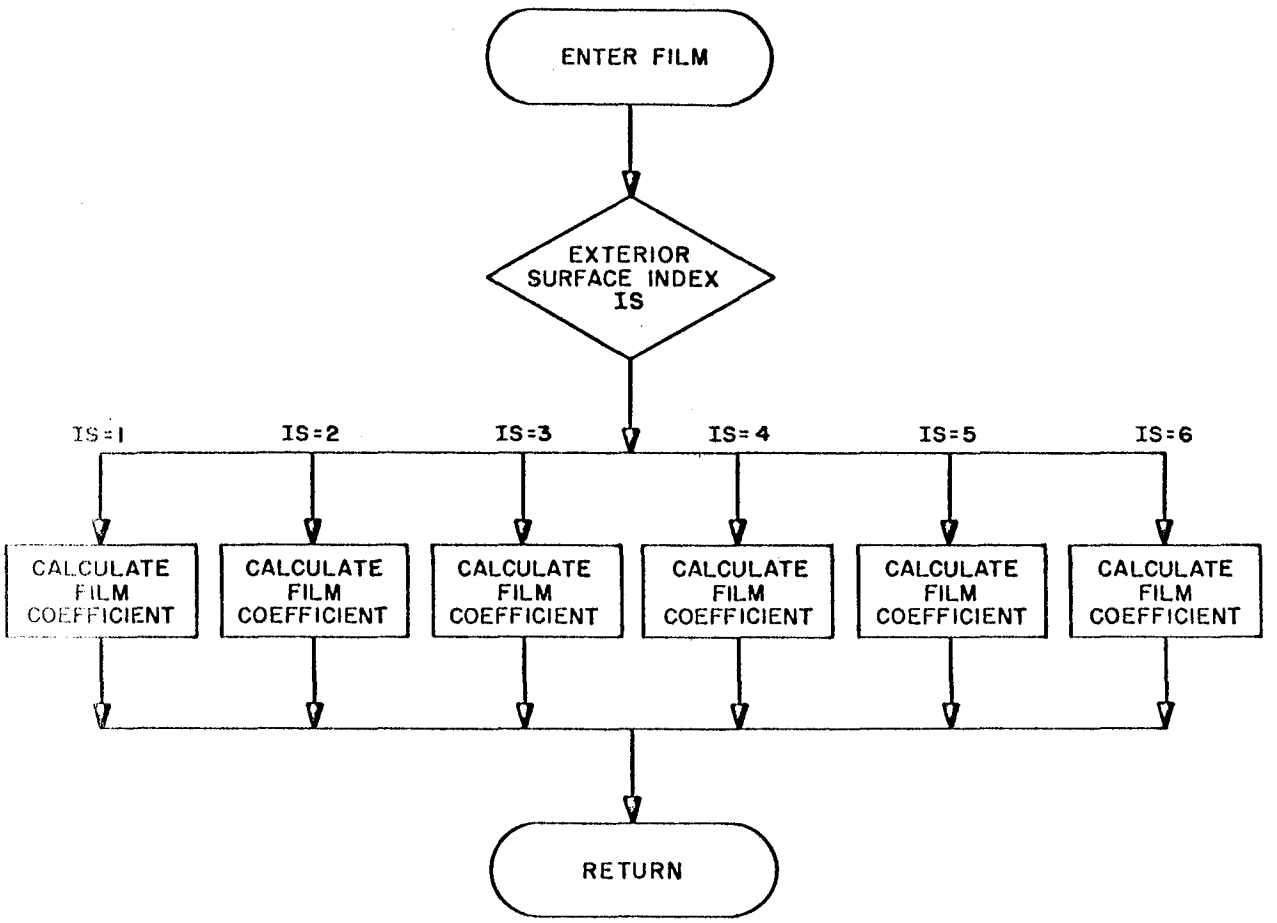

ENTER
CCM
CLOUD
TYPE
(ICLTP)
CIRRUS
CIRROSTRATUS CLOUDS
ICLTP < 1
OTHER
ICLTP > 1
ICLTP = 1
STRATUS CLOUDS
IS SOLAR
ALTITUDE ANGLE
≤ 45°
?
NO
YES
CALCULATE
CLOUD COVER
MODIFIER
RETURN

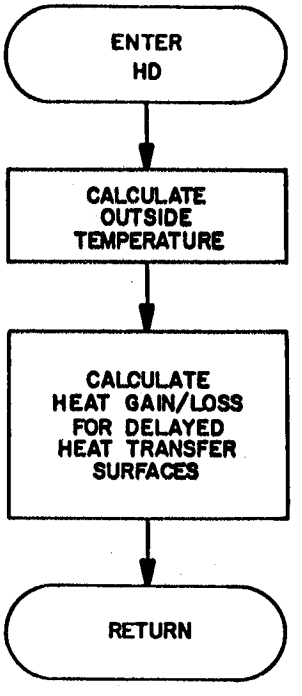

ENTER
CENTER
DETERMINE
NUMBER OF BLANKS
AT RIGHT HAND
REALLOCATE IDEN
IN FIELD
WRITE IDEN
ON OUTPUT
DEVICE KAGIT
IF WANTED,
WRITE IDEN ON
OUTPUT DEVICE 2
RETURN

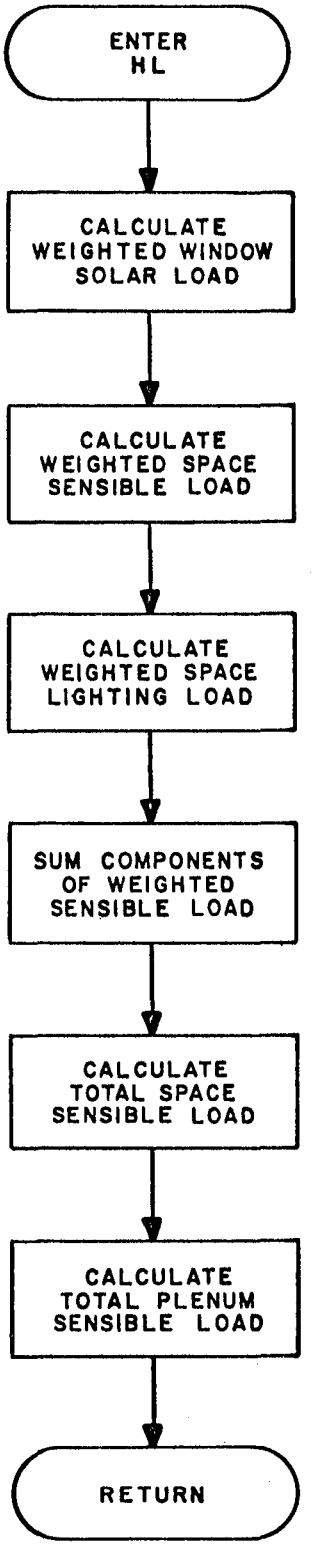

ENTER
DAYMO
IFACT=0
MONTH=1
IDAY
≤ 31
YES
NO
I=3,12
II=12
II=I-1
NDAYS=IDOY-
NUMDAY(I)-LEAP
NDAYS
>0
YES
NO
MONTH=II
MONTH
>2
YES
IFACT=LEAP
NO
IDAY=IDOY-
NUMDAY(MONTH)-IFACT
RETURN

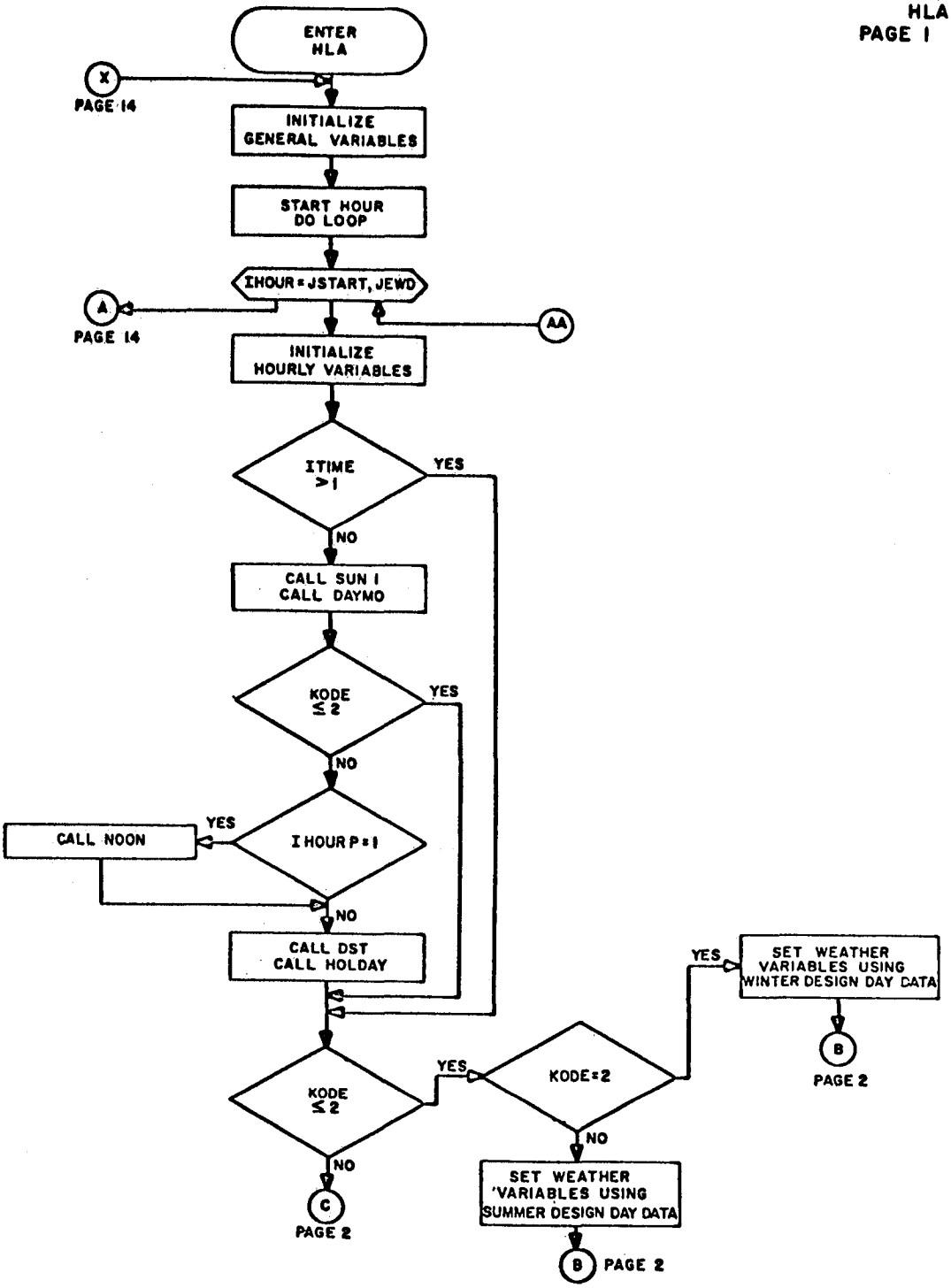

ENTER DESDY
INITIALIZE CORRECTION FACTORS
CALCULATE MONTH INDEX
CALCULATE YEARLY TEMPERATURE RANGE INDEX
CALCULATE DAILY TEMPERATURE RANGE INDEX
IS IT MARCH THROUGH NOVEMBER ?
NO
YES
I ← 1,24
CALCULATE DRY-BULB TEMPERATURE
CALCULATE WET-BULB TEMPERATURE
RETURN
A
I ← 1,24
CALCULATE DRY CORRECTION FACTORS
CALCULATE DRY-BULB AND WET-BULB TEMPERATURE
CALCULATE ENTHALPY
SET MONTH CORRECTION FACTOR
CALCULATE HUMIDITY AT DEW POINT TEMPERATURE
CALCULATE ENTHALPY AT 3 PM
CALCULATE WET-BULB TEMPERATURE
SET DAY CORRECTION FACTOR
CALCULATE NEW WET-BULB AND DRY-BULB TEMPERATURE
A

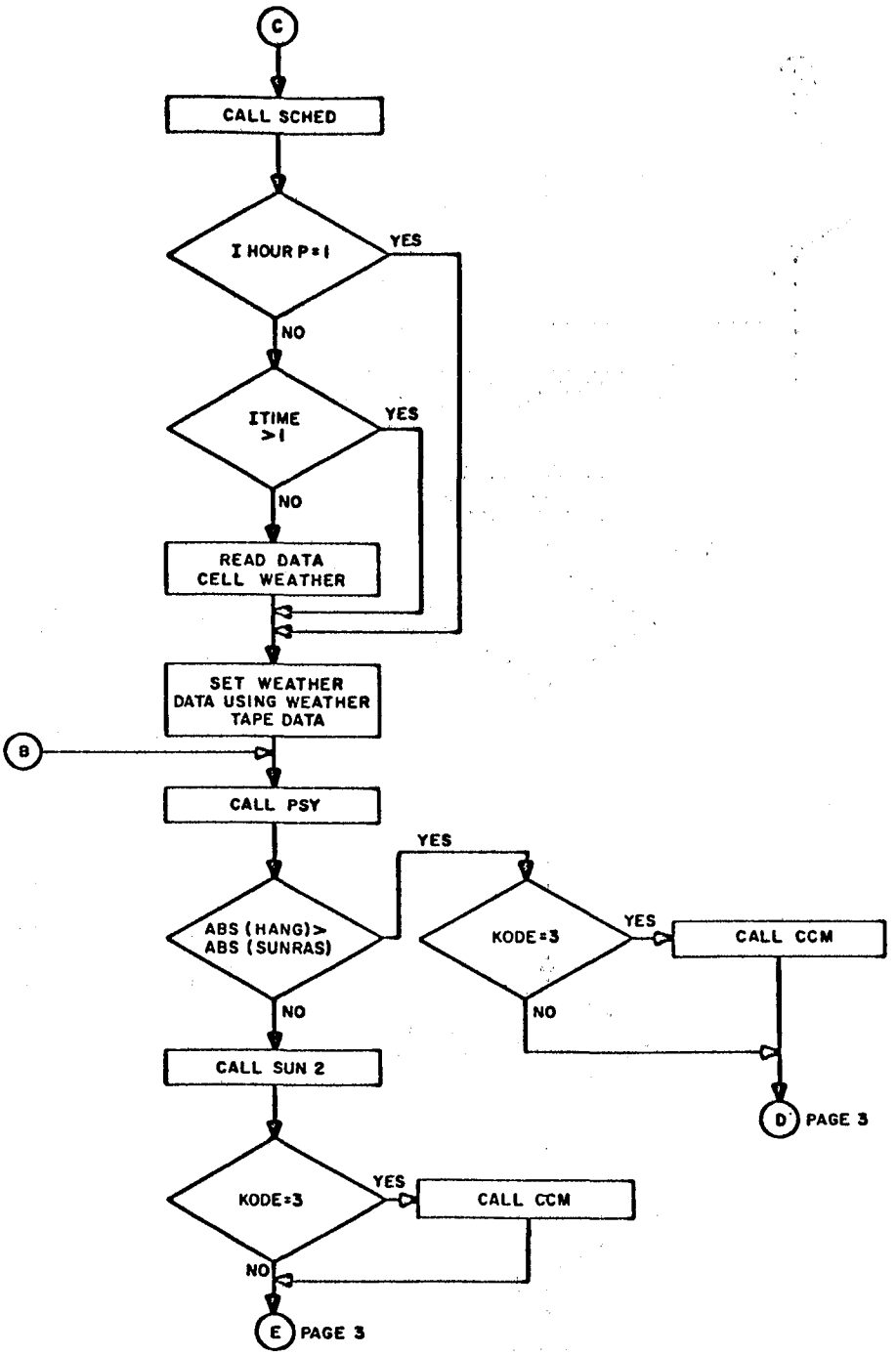

ENTER
DST
MONTH
MONTH = 1,2,3,
11,12
MONTH = 4
MONTH =
5,6,7,8,9
MONTH=10
STANDARD
TIME PERIOD
IDST=0
DAYLIGHT
SAVING TIME
IDST=1
RETURN
RETURN
IS
IT
LAST
SUNDAY
OF MONTH
?
NO
YES
IS
IT LAST
SUNDAY
OF MONTH
OR LATER
?
NO
YES
STANDARD
TIME PERIOD
DAYLIGHT
SAVING
TIME
STANDARD
TIME PERIOD
RETURN
RETURN
RETURN

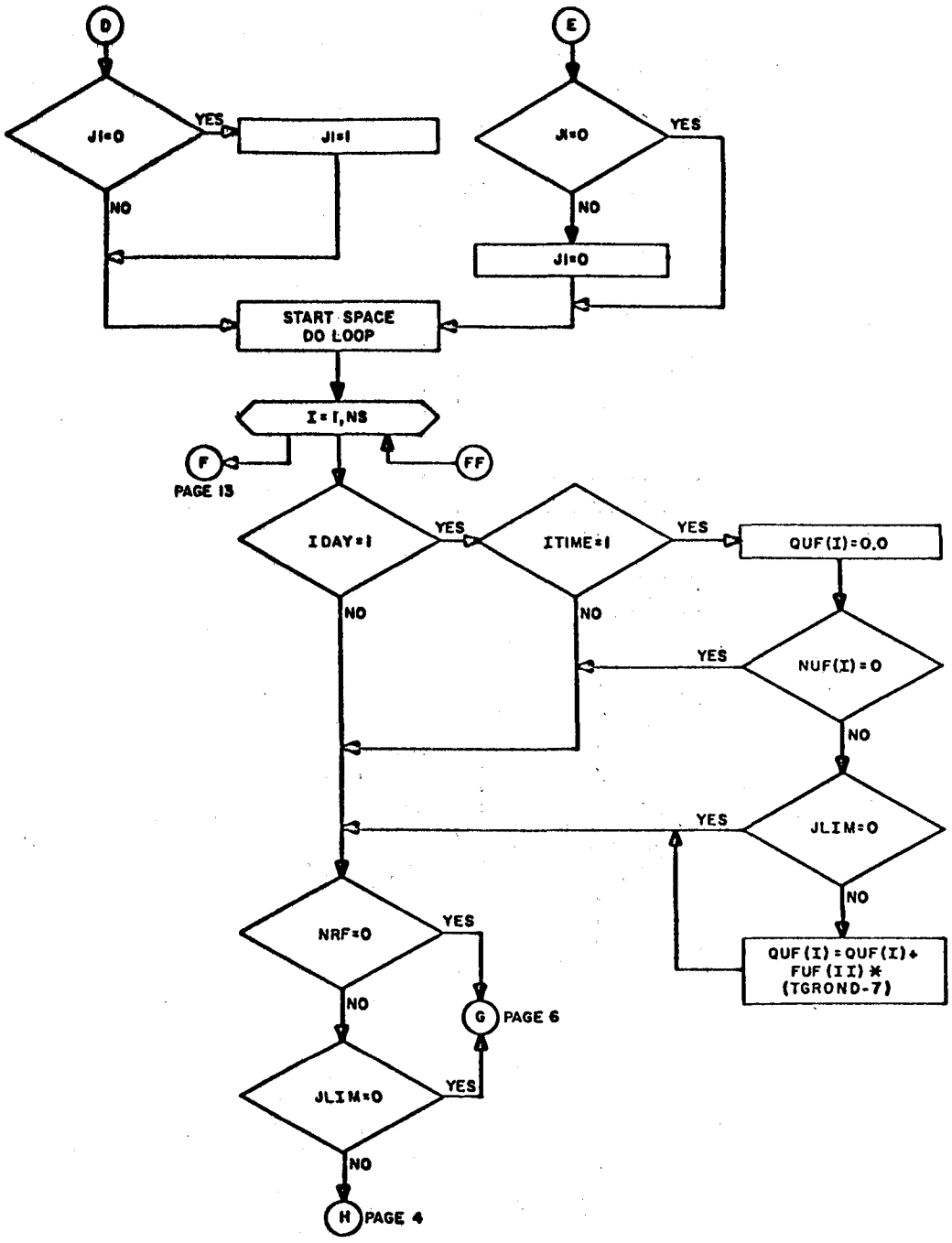

ENTER FILM
EXTERIOR SURFACE INDEX IS
IS=1
IS=2
IS=3
IS=4
IS=5
IS=6
CALCULATE FILM COEFFICIENT
CALCULATE FILM COEFFICIENT
CALCULATE FILM COEFFICIENT
CALCULATE FILM COEFFICIENT
CALCULATE FILM COEFFICIENT
CALCULATE FILM COEFFICIENT
RETURN

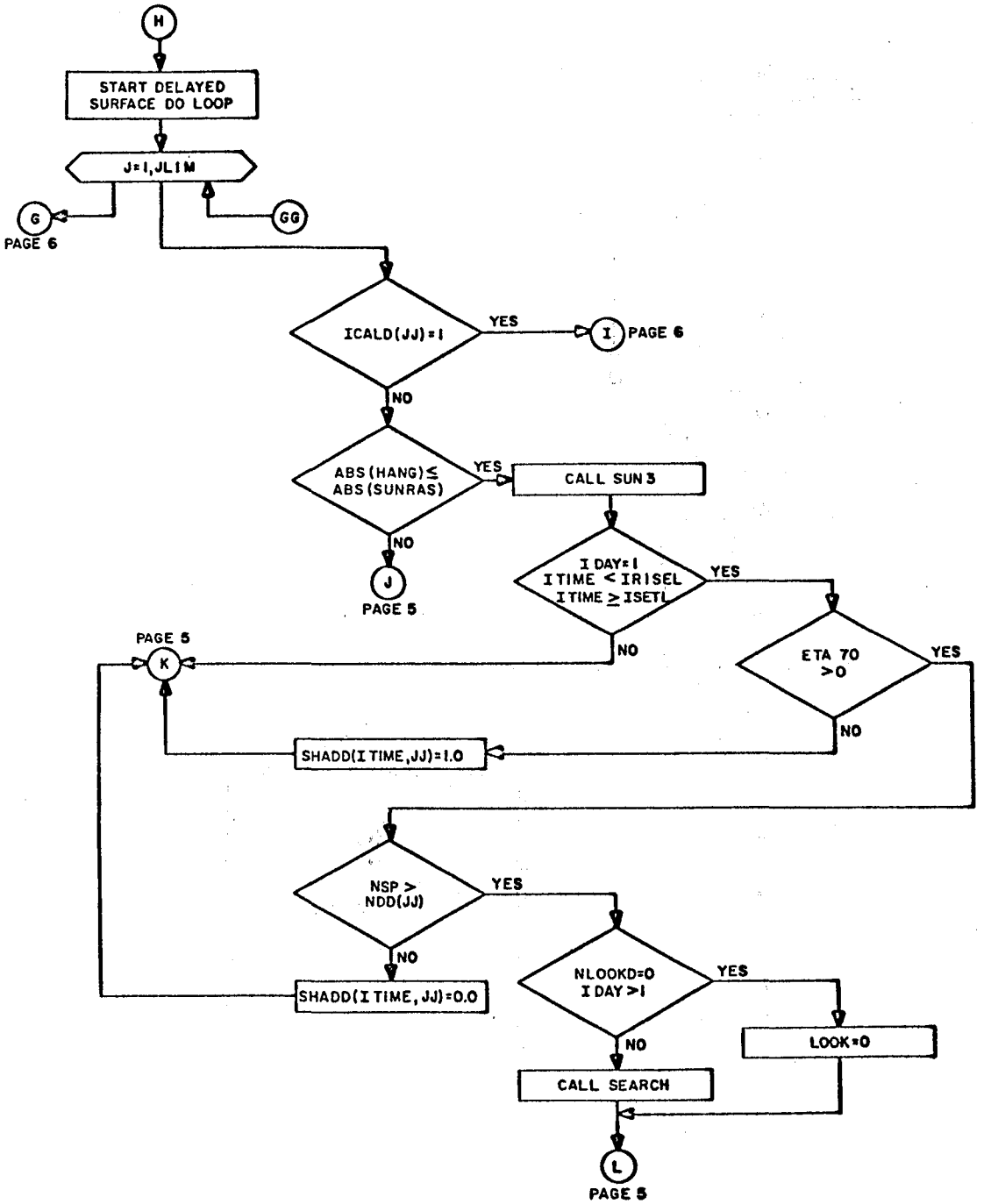

ENTER
HD
CALCULATE
OUTSIDE
TEMPERATURE
CALCULATE
HEAT GAIN/LOSS
FOR DELAYED
HEAT TRANSFER
SURFACES
RETURN

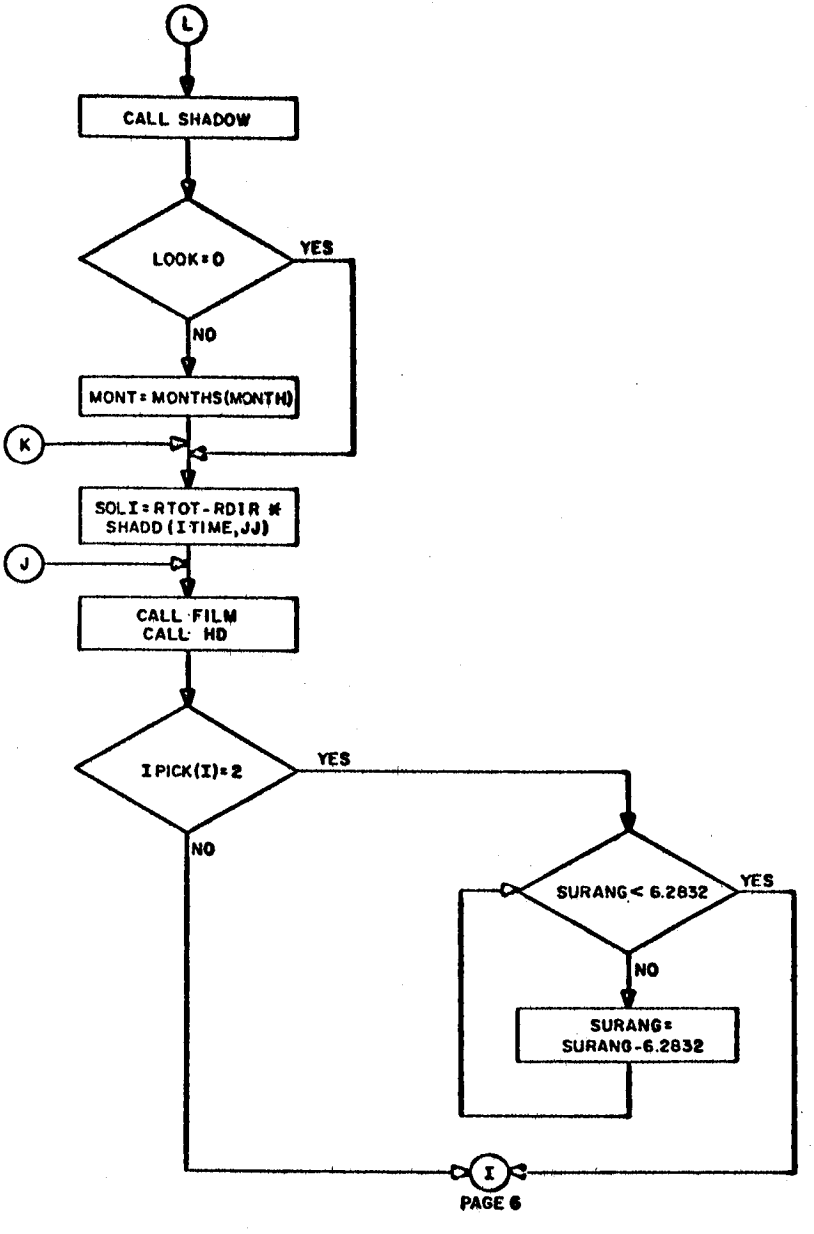

ENTER
HL
CALCULATE
WEIGHTED WINDOW
SOLAR LOAD
CALCULATE
WEIGHTED SPACE
SENSIBLE LOAD
CALCULATE
WEIGHTED SPACE
LIGHTING LOAD
SUM COMPONENTS
OF WEIGHTED
SENSIBLE LOAD
CALCULATE
TOTAL SPACE
SENSIBLE LOAD
CALCULATE
TOTAL PLENUM
SENSIBLE LOAD
RETURN

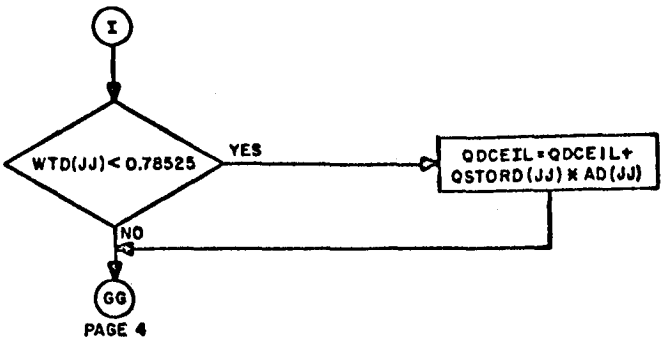

ENTER HLA
X
PAGE 14
INITIALIZE GENERAL VARIABLES
START HOUR DO LOOP
IHOUR = JSTART, JEWD
A
PAGE 14
AA
INITIALIZE HOURLY VARIABLES
ITIME >1
YES
NO
CALL SUN I
CALL DAYMO
KODE ≤ 2
YES
NO
CALL NOON
YES
I HOUR P = 1
NO
CALL DST
CALL HOLDAY
KODE ≤ 2
YES
KODE = 2
YES
SET WEATHER VARIABLES USING WINTER DESIGN DAY DATA
B
PAGE 2
NO
NO
C
PAGE 2
SET WEATHER VARIABLES USING SUMMER DESIGN DAY DATA
B
PAGE 2

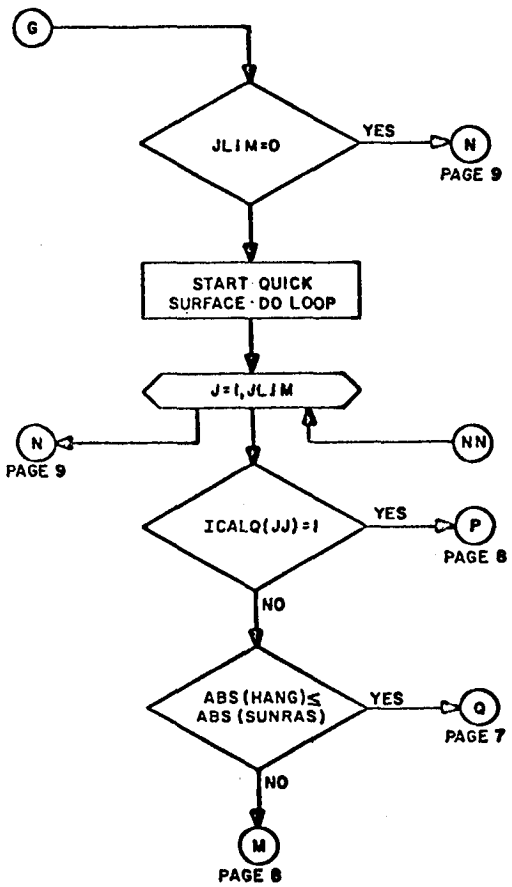

C
CALL SCHED
I HOUR P=1
YES
NO
ITIME >1
YES
NO
READ DATA CELL WEATHER
SET WEATHER DATA USING WEATHER TAPE DATA
B
CALL PSY
YES
ABS (HANG)> ABS (SUNRAS)
KODE=3
YES
CALL CCM
NO
NO
CALL SUN 2
D PAGE 3
KODE=3
YES
CALL CCM
NO
E PAGE 3

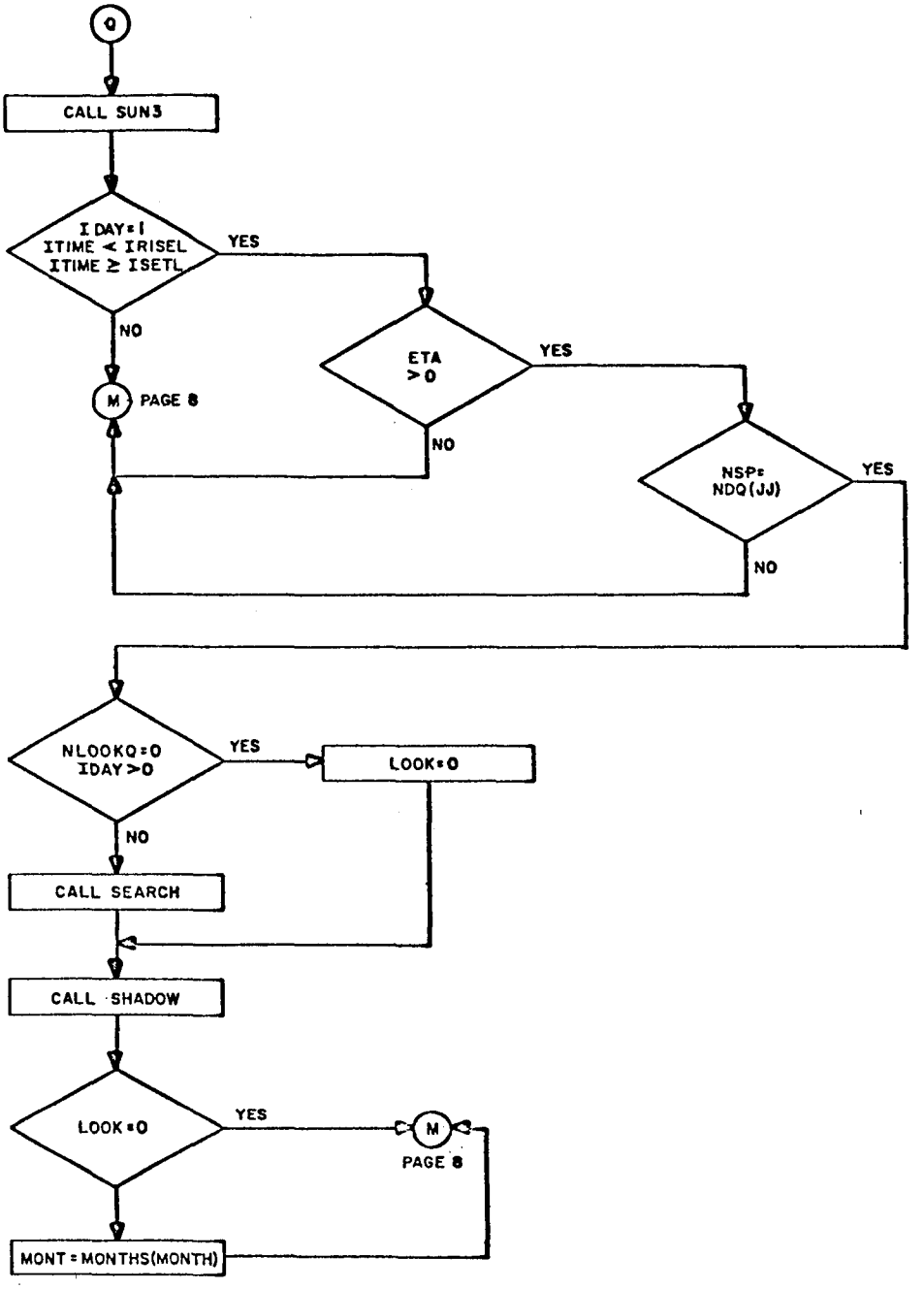

D
JI=0
YES
JI=1
NO
E
JI=0
YES
NO
JI=0
START SPACE
DO LOOP
I=1,NS
F
PAGE 13
FF
IDAY=1
YES
ITIME=1
YES
QUF(I)=0.0
NO
NO
YES
NUF(I)=0
NO
YES
JLIM=0
NO
QUF(I)=QUF(I)+
FUF(II)*
(TGROND-7)
NRF=0
YES
NO
G
PAGE 6
JLIM=0
YES
NO
H
PAGE 4

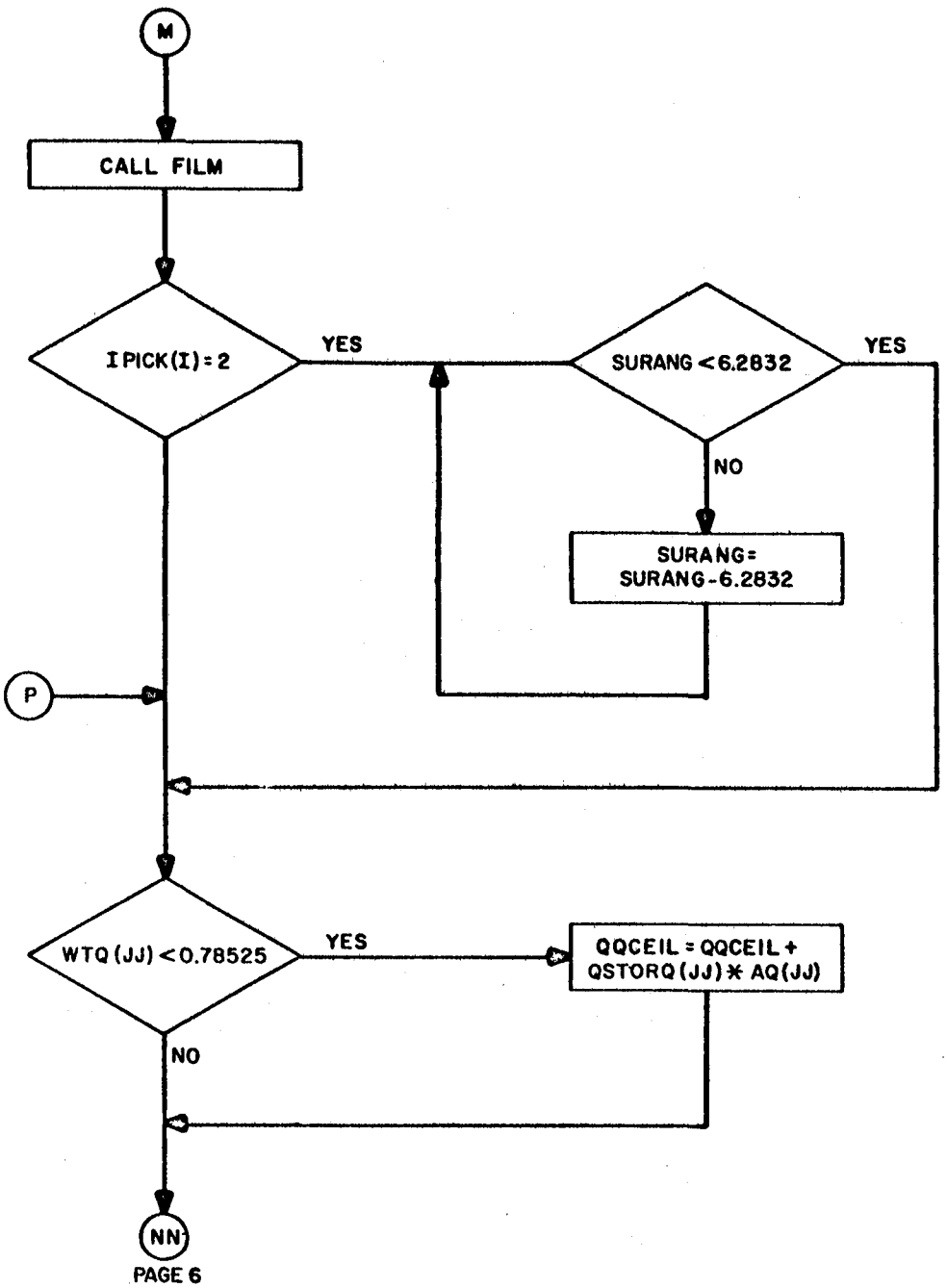

H
START DELAYED SURFACE DO LOOP
J=1,JLIM
G
PAGE 6
GG
ICALD(JJ)=1
YES
I
PAGE 6
NO
ABS(HANG)≤ ABS(SUNRAS)
YES
CALL SUN3
NO
J
PAGE 5
I DAY=1
I TIME < IRISEL
I TIME ≥ ISETL
YES
NO
PAGE 5
K
ETA 70 >0
YES
NO
SHADD(I TIME,JJ)=1.0
NSP > NDD(JJ)
YES
NO
SHADD(I TIME, JJ)=0.0
NLOOKD=0
I DAY>1
YES
NO
LOOK=0
CALL SEARCH
L
PAGE 5

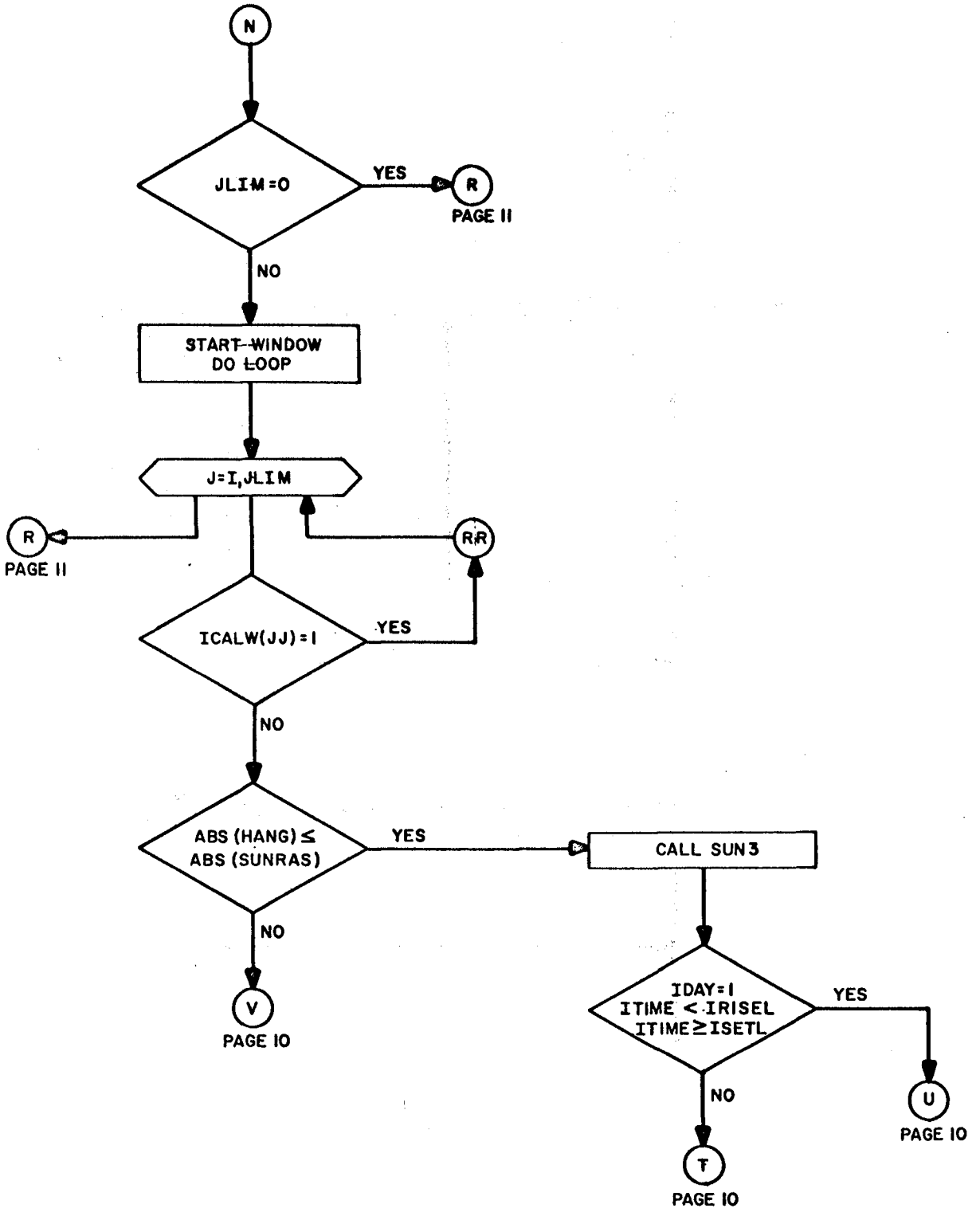

L
CALL SHADOW
LOOK=0
YES
NO
MONT=MONTHS(MONTH)
K
SOLI=RTOT-RDIR *
SHADD(ITIME,JJ)
J
CALL FILM
CALL HD
IPICK(I)=2
YES
NO
SURANG< 6.2832
YES
NO
SURANG=
SURANG-6.2832
I
PAGE 6

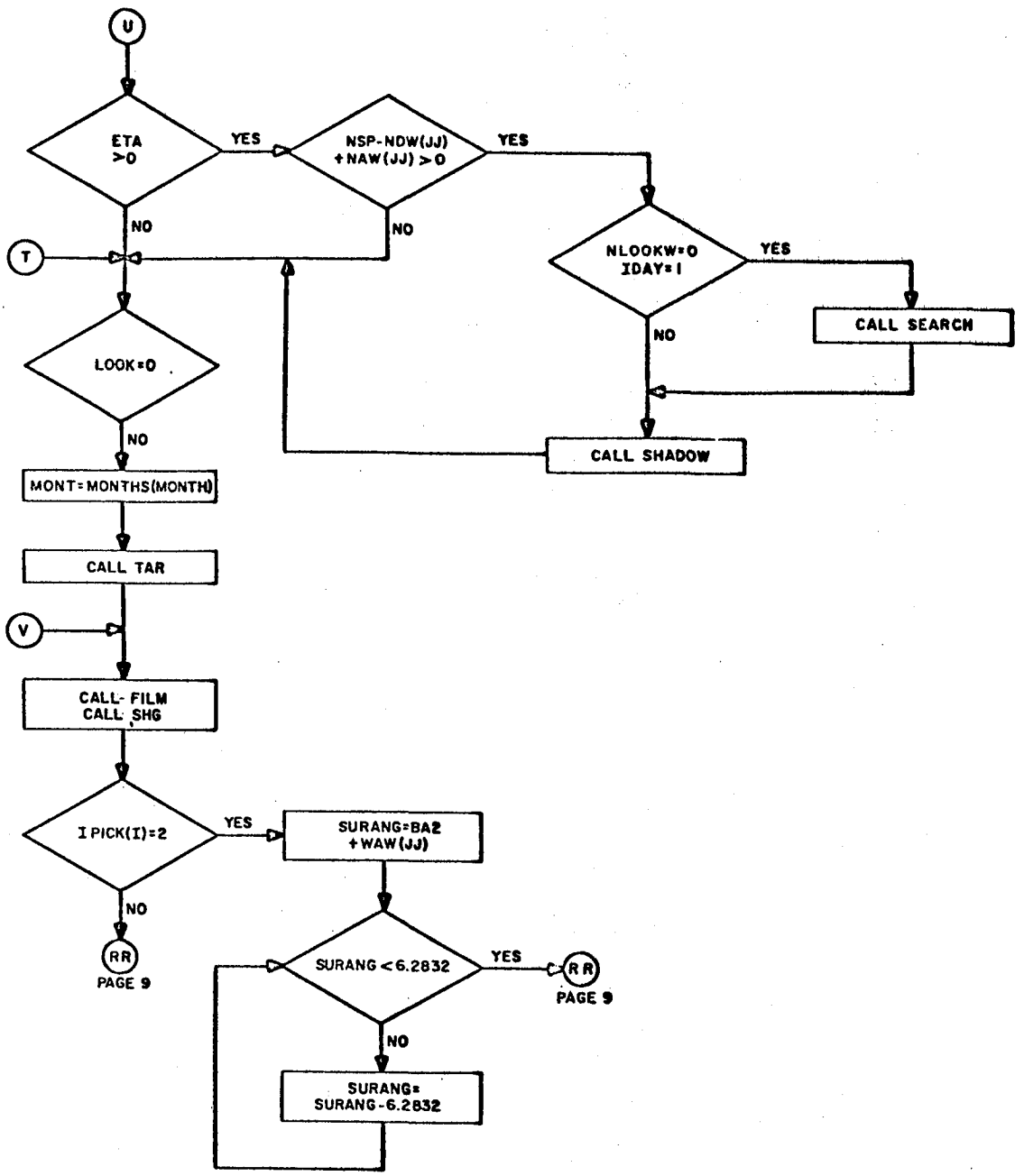

I
WTD(JJ) < 0.78525
YES
QDCEIL = QDCEIL +
QSTORD(JJ) * AD(JJ)
NO
GG
PAGE 4

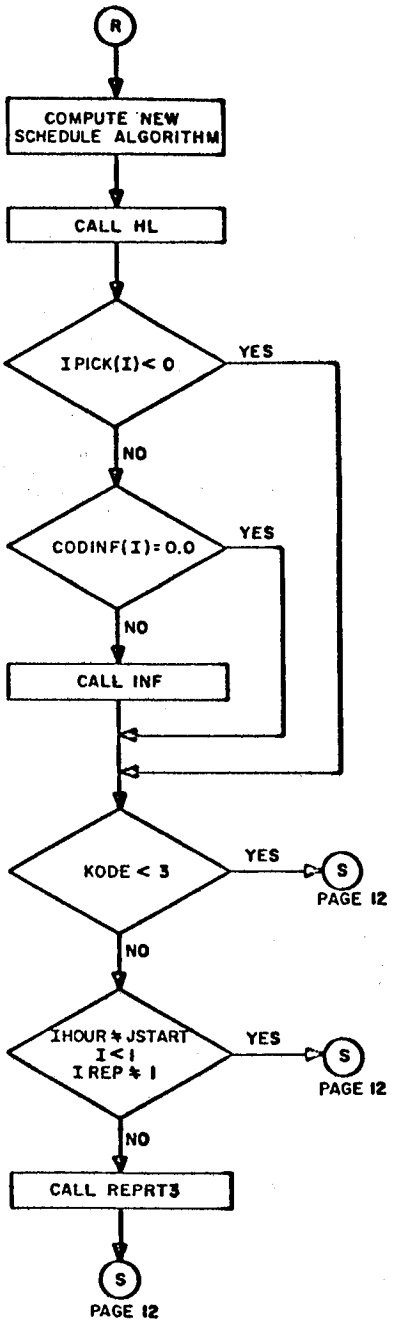

G
JLIM=0
YES
N
PAGE 9
START QUICK
SURFACE DO LOOP
J=1,JLIM
N
PAGE 9
NN
ICALQ(JJ)=1
YES
P
PAGE 8
NO
ABS(HANG)≤
ABS(SUNRAS)
YES
Q
PAGE 7
NO
M
PAGE 8

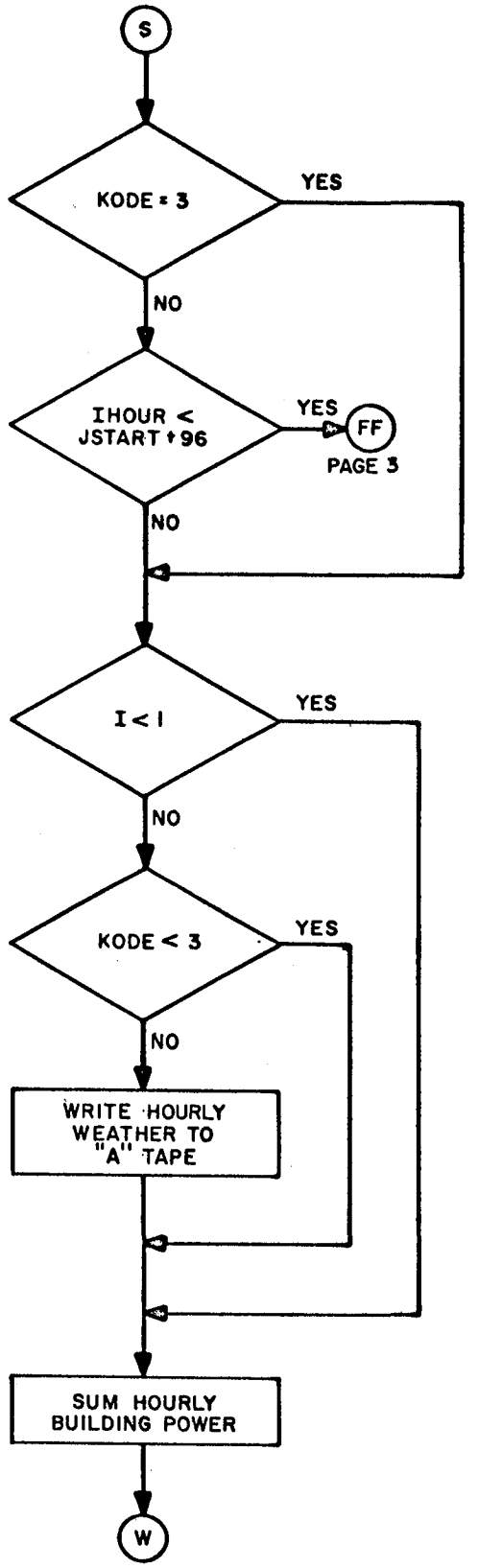

Q
CALL SUN3
I DAY=1
ITIME < IRISEL
ITIME ≥ ISETL
YES
NO
M
PAGE 8
ETA
>0
YES
NO
NSP=
NDQ(JJ)
YES
NO
NLOOKQ=0
IDAY>0
YES
LOOK=0
NO
CALL SEARCH
CALL SHADOW
LOOK=0
YES
M
PAGE 8
MONT=MONTHS(MONTH)

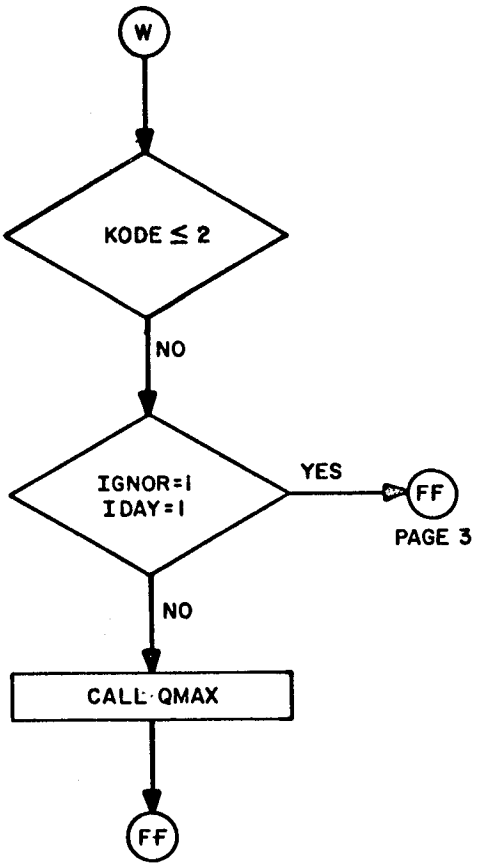

M
CALL FILM
IPICK(I) = 2
YES
SURANG < 6.2832
YES
NO
SURANG=
SURANG-6.2832
P
WTQ (JJ) < 0.78525
YES
QQCEIL = QQCEIL +
QSTORQ (JJ) * AQ(JJ)
NO
NN
PAGE 6

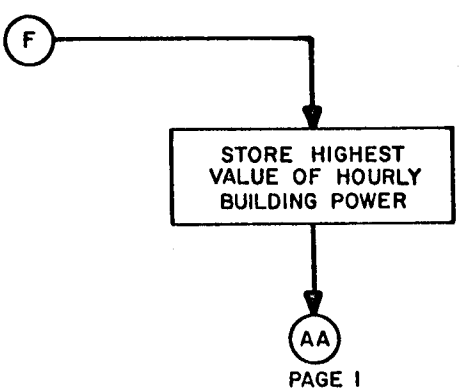

N
JLIM=0
YES
R
PAGE 11
NO
START WINDOW
DO LOOP
J=I,JLIM
R
PAGE 11
RR
ICALW(JJ)=1
YES
NO
ABS (HANG) ≤
ABS (SUNRAS)
YES
CALL SUN3
NO
V
PAGE 10
IDAY=1
ITIME < IRISEL
ITIME ≥ ISETL
YES
U
PAGE 10
NO
T
PAGE 10

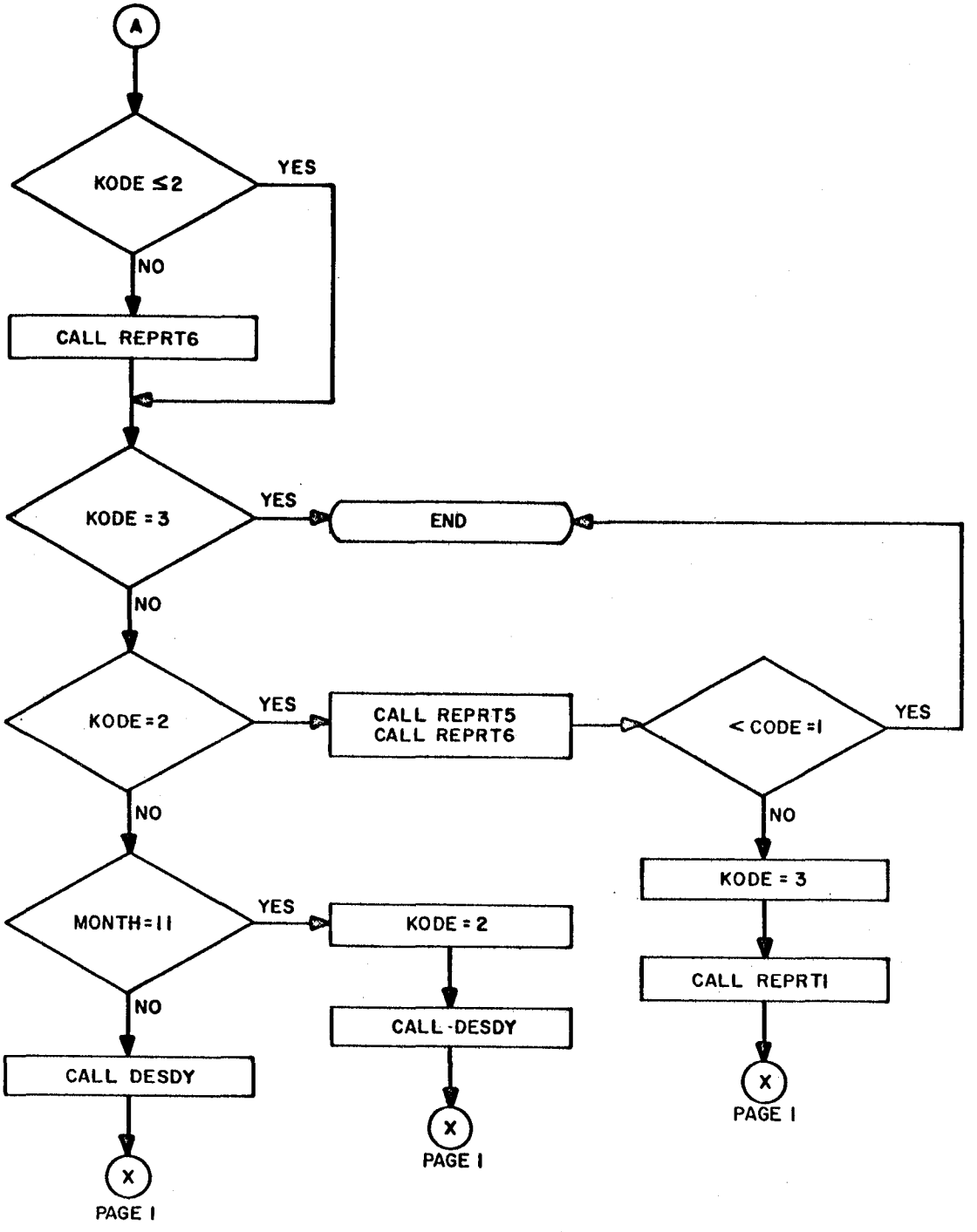

U
ETA >0
YES
NSP-NDW(JJ) +NAW(JJ) >0
YES
NO
NO
T
NLOOKW=0 IDAY=1
YES
CALL SEARCH
NO
LOOK=0
NO
CALL SHADOW
MONT=MONTHS(MONTH)
CALL TAR
V
CALL- FILM
CALL SHG
I PICK(I)=2
YES
SURANG=BA2 +WAW(JJ)
NO
RR
PAGE 9
SURANG <6.2832
YES
RR
PAGE 9
NO
SURANG= SURANG-6.2832

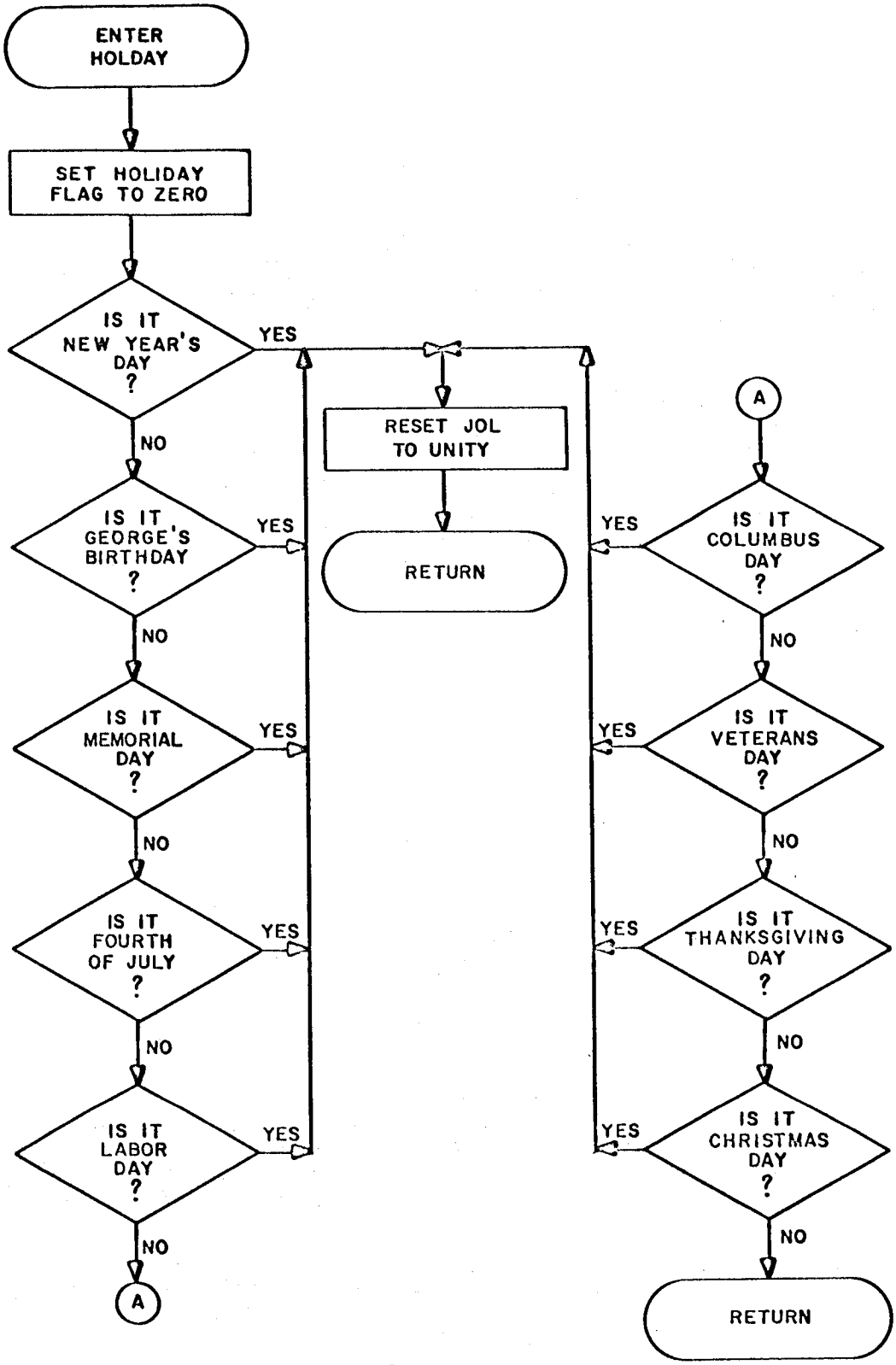

R
COMPUTE NEW SCHEDULE ALGORITHM
CALL HL
IPICK(I) < 0
YES
NO
CODINF(I) = 0.0
YES
NO
CALL INF
KODE < 3
YES
S
PAGE 12
NO
IHOUR ≠ JSTART
I < 1
I REP ≠ 1
YES
S
PAGE 12
NO
CALL REPRT3
S
PAGE 12

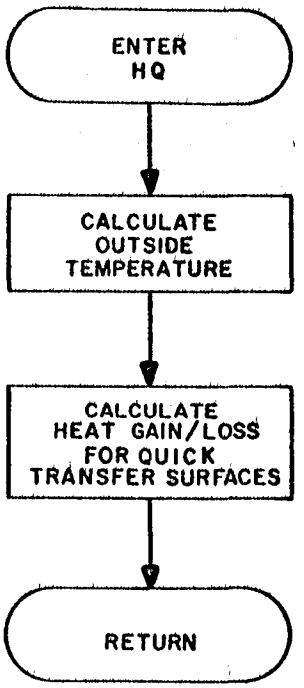

S
KODE = 3
YES
NO
IHOUR <
JSTART + 96
YES
FF
PAGE 3
NO
I < 1
YES
NO
KODE < 3
YES
NO
WRITE HOURLY
WEATHER TO
"A" TAPE
SUM HOURLY
BUILDING POWER
W
PAGE 13

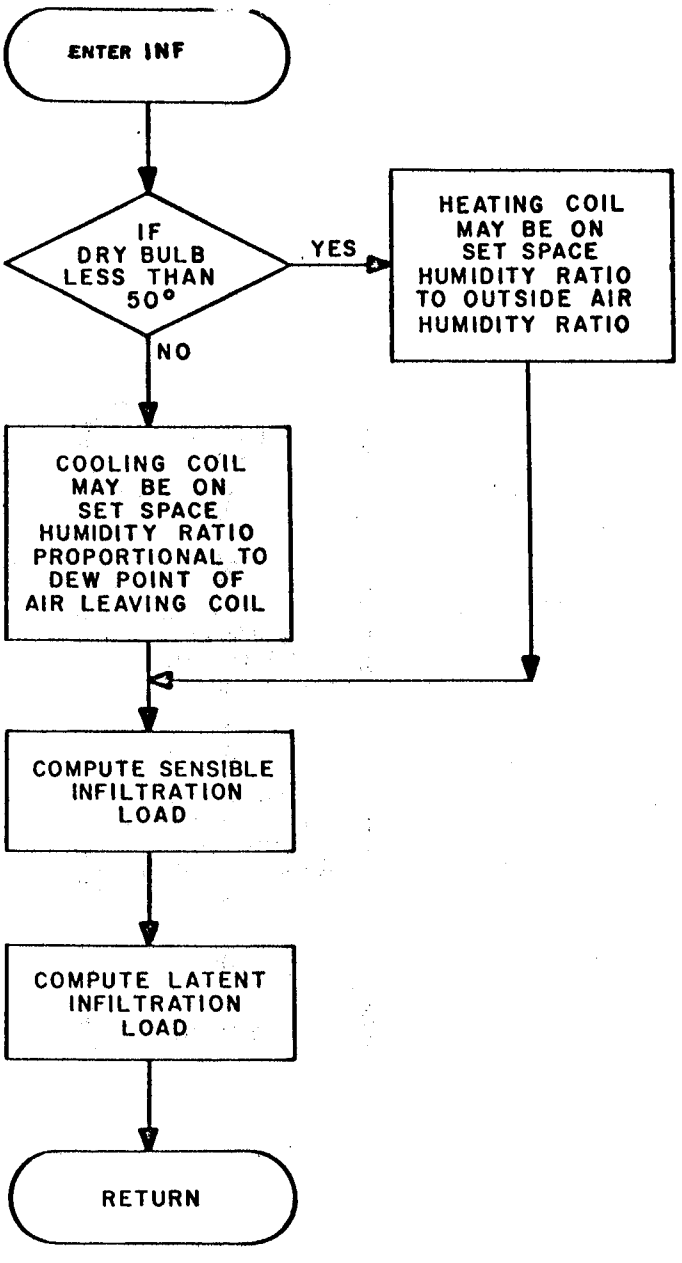

W
KODE ≤ 2
NO
IGNOR=1
IDAY=1
YES
FF
PAGE 3
NO
CALL QMAX
FF

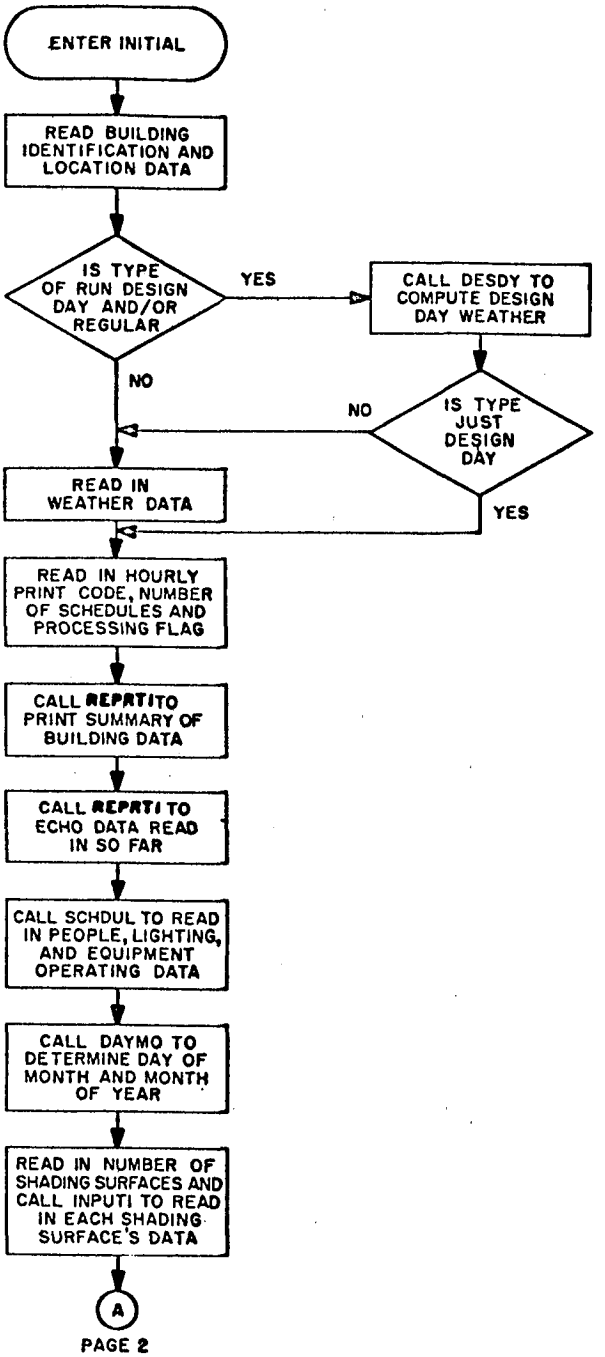

F
STORE HIGHEST
VALUE OF HOURLY
BUILDING POWER
AA
PAGE 1

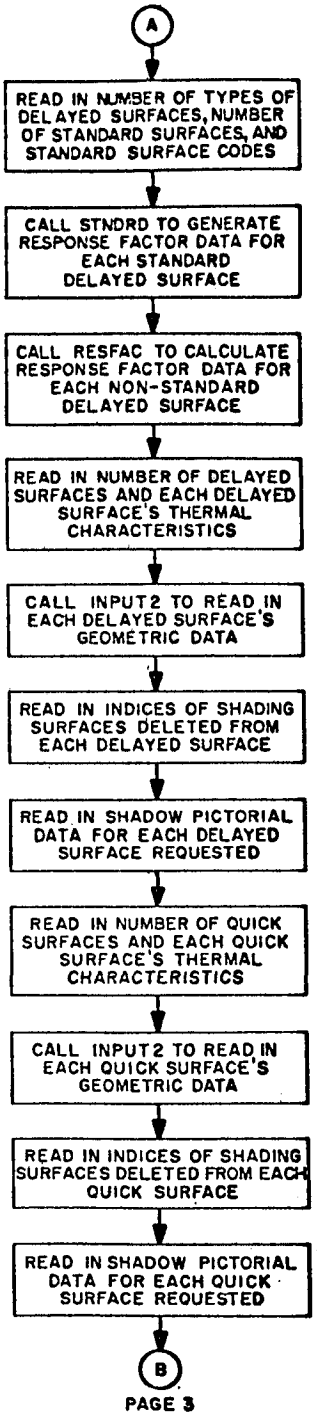

A
KODE ≤2
YES
NO
CALL REPRT6
KODE = 3
YES
END
NO
KODE = 2
YES
CALL REPRT5
CALL REPRT6
< CODE = 1
YES
NO
KODE = 3
CALL REPRT1
X
PAGE 1
NO
MONTH = 11
YES
KODE = 2
CALL DESDY
X
PAGE 1
NO
CALL DESDY
X
PAGE 1

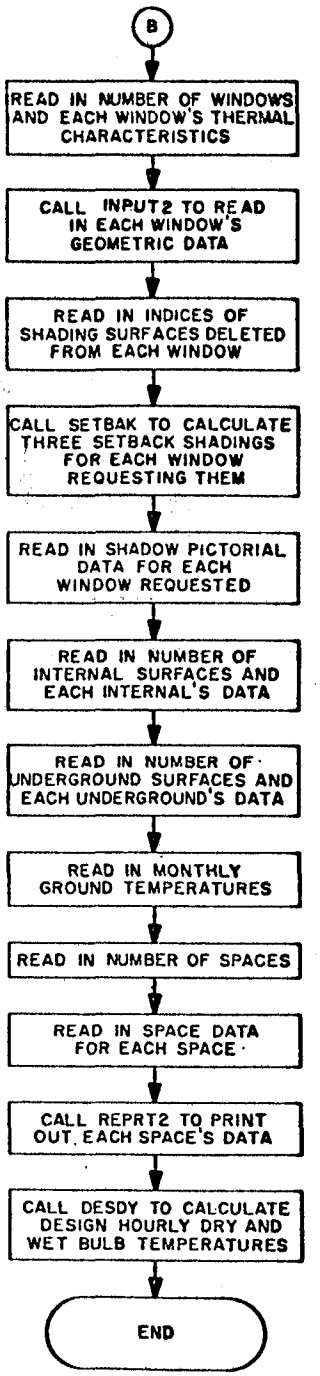

ENTER HOLDAY
SET HOLIDAY FLAG TO ZERO
IS IT NEW YEAR'S DAY ?
YES
NO
IS IT GEORGE'S BIRTHDAY ?
YES
NO
IS IT MEMORIAL DAY ?
YES
NO
IS IT FOURTH OF JULY ?
YES
NO
IS IT LABOR DAY ?
YES
NO
A
RESET JOL TO UNITY
RETURN
A
IS IT COLUMBUS DAY ?
YES
NO
IS IT VETERANS DAY ?
YES
NO
IS IT THANKSGIVING DAY ?
YES
NO
IS IT CHRISTMAS DAY ?
YES
NO
RETURN

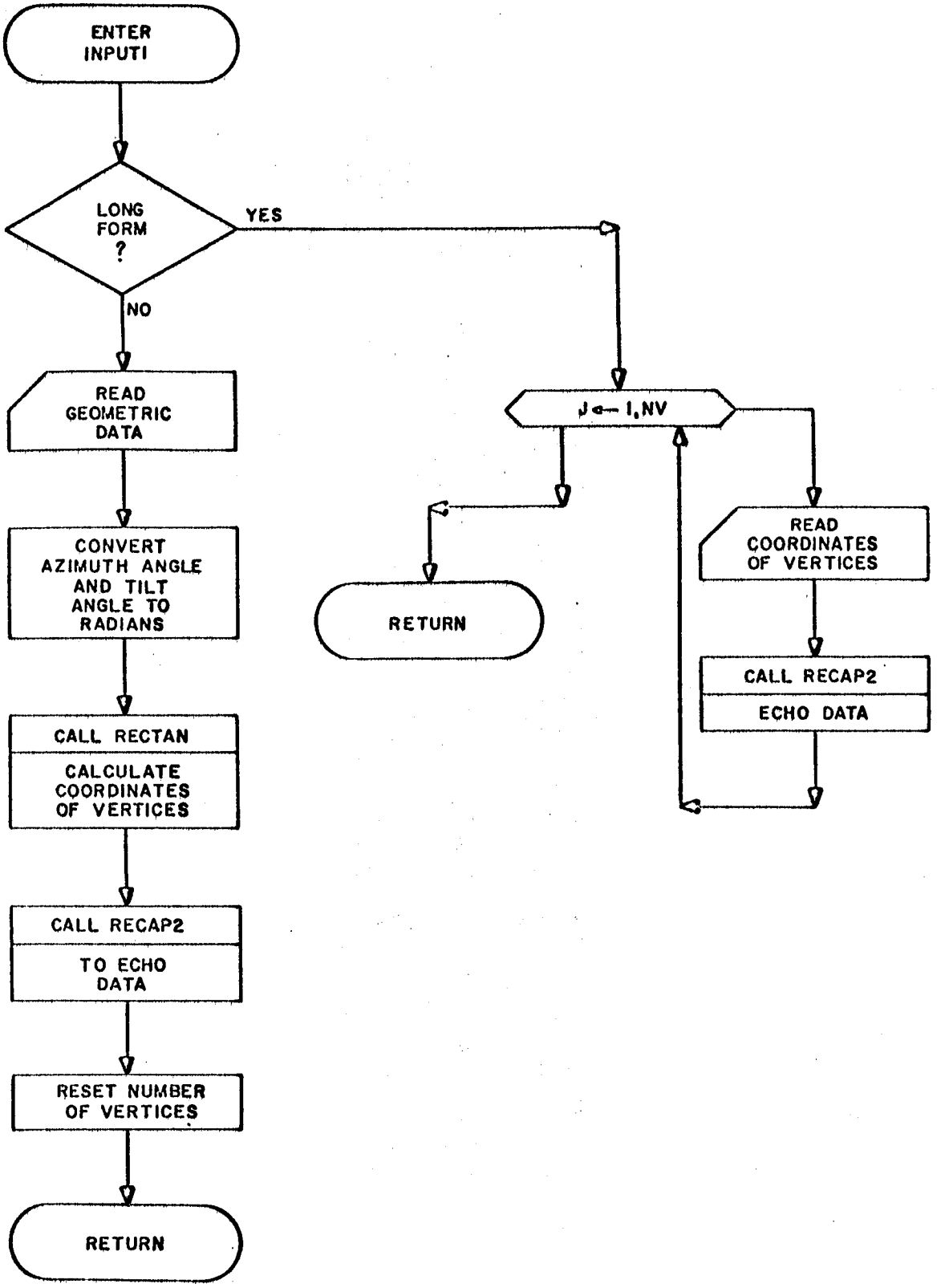

ENTER
HQ
CALCULATE
OUTSIDE
TEMPERATURE
CALCULATE
HEAT GAIN/LOSS
FOR QUICK
TRANSFER SURFACES
RETURN

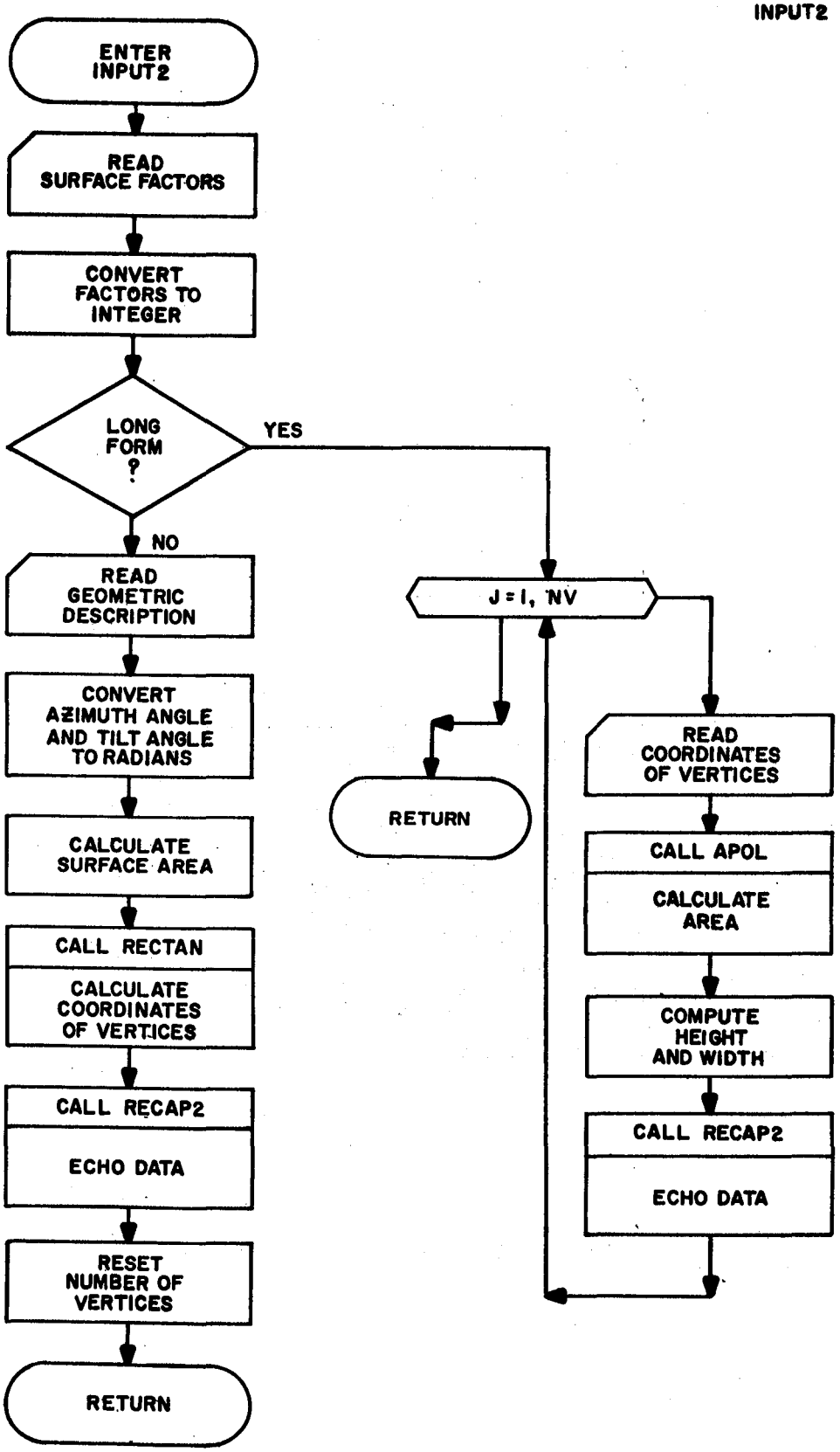

ENTER INF
IF DRY BULB LESS THAN 50°
YES
HEATING COIL MAY BE ON SET SPACE HUMIDITY RATIO TO OUTSIDE AIR HUMIDITY RATIO
NO
COOLING COIL MAY BE ON SET SPACE HUMIDITY RATIO PROPORTIONAL TO DEW POINT OF AIR LEAVING COIL
COMPUTE SENSIBLE INFILTRATION LOAD
COMPUTE LATENT INFILTRATION LOAD
RETURN

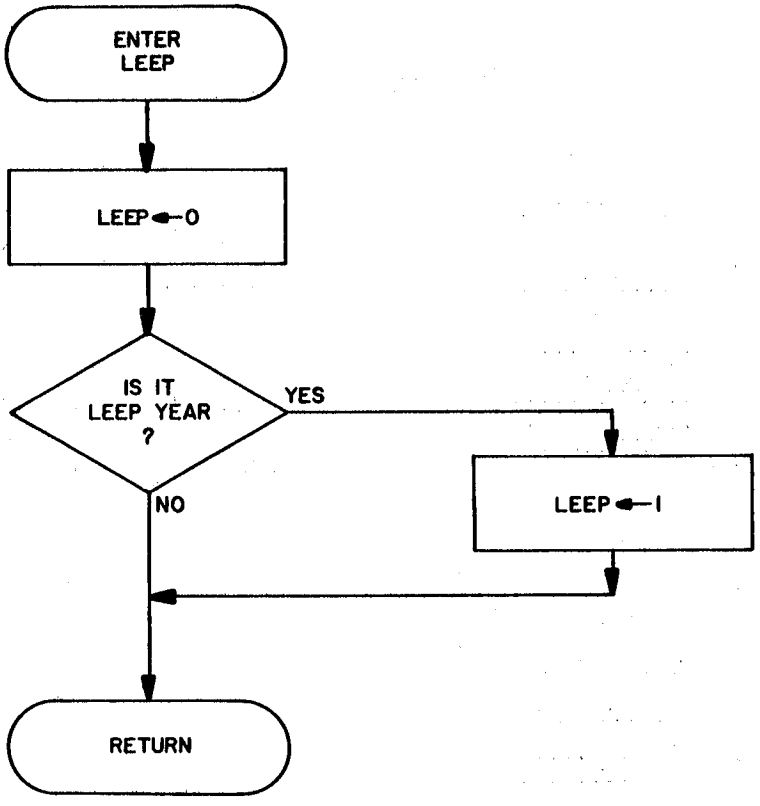

ENTER INITIAL
READ BUILDING IDENTIFICATION AND LOCATION DATA
IS TYPE OF RUN DESIGN DAY AND/OR REGULAR
YES
CALL DESDY TO COMPUTE DESIGN DAY WEATHER
NO
IS TYPE JUST DESIGN DAY
NO
YES
READ IN WEATHER DATA
READ IN HOURLY PRINT CODE, NUMBER OF SCHEDULES AND PROCESSING FLAG
CALL REPRTI TO PRINT SUMMARY OF BUILDING DATA
CALL REPRTI TO ECHO DATA READ IN SO FAR
CALL SCHDUL TO READ IN PEOPLE, LIGHTING, AND EQUIPMENT OPERATING DATA
CALL DAYMO TO DETERMINE DAY OF MONTH AND MONTH OF YEAR
READ IN NUMBER OF SHADING SURFACES AND CALL INPUTI TO READ IN EACH SHADING SURFACE'S DATA
A
PAGE 2

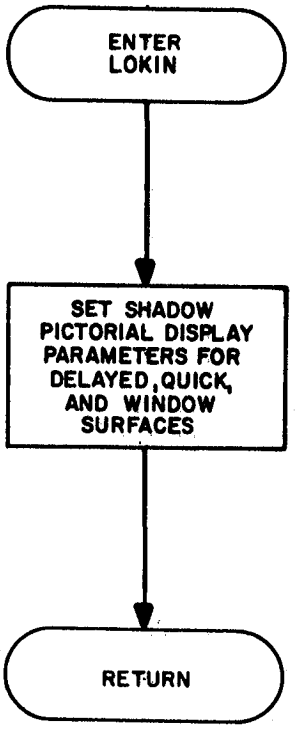

A
READ IN NUMBER OF TYPES OF DELAYED SURFACES, NUMBER OF STANDARD SURFACES, AND STANDARD SURFACE CODES
CALL STNDRD TO GENERATE RESPONSE FACTOR DATA FOR EACH STANDARD DELAYED SURFACE
CALL RESFAC TO CALCULATE RESPONSE FACTOR DATA FOR EACH NON-STANDARD DELAYED SURFACE
READ IN NUMBER OF DELAYED SURFACES AND EACH DELAYED SURFACE'S THERMAL CHARACTERISTICS
CALL INPUT2 TO READ IN EACH DELAYED SURFACE'S GEOMETRIC DATA
READ IN INDICES OF SHADING SURFACES DELETED FROM EACH DELAYED SURFACE
READ IN SHADOW PICTORIAL DATA FOR EACH DELAYED SURFACE REQUESTED
READ IN NUMBER OF QUICK SURFACES AND EACH QUICK SURFACE'S THERMAL CHARACTERISTICS
CALL INPUT2 TO READ IN EACH QUICK SURFACE'S GEOMETRIC DATA
READ IN INDICES OF SHADING SURFACES DELETED FROM EACH QUICK SURFACE
READ IN SHADOW PICTORIAL DATA FOR EACH QUICK SURFACE REQUESTED
B
PAGE 3

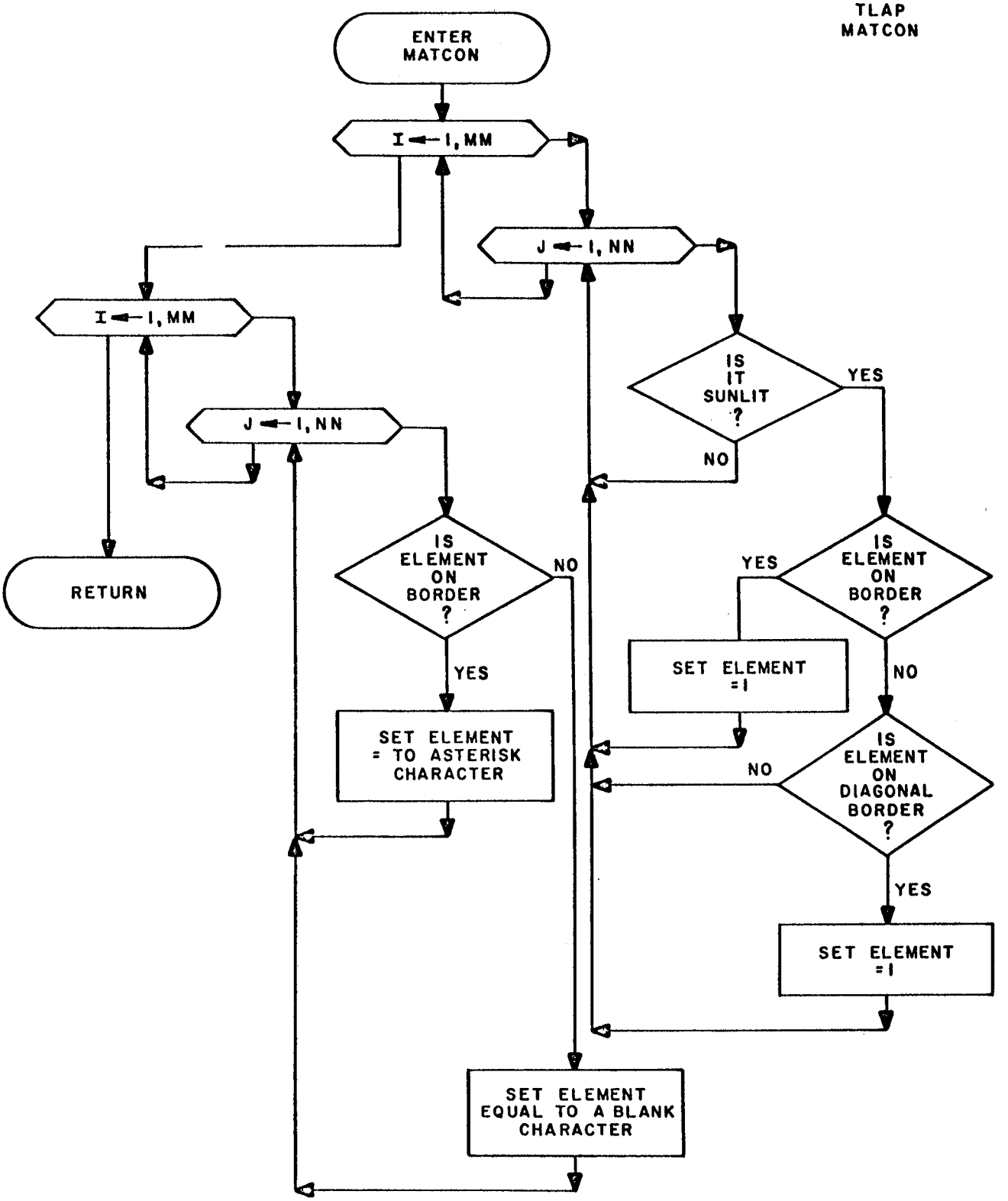

B
READ IN NUMBER OF WINDOWS AND EACH WINDOW'S THERMAL CHARACTERISTICS
CALL INPUT2 TO READ IN EACH WINDOW'S GEOMETRIC DATA
READ IN INDICES OF SHADING SURFACES DELETED FROM EACH WINDOW
CALL SETBAK TO CALCULATE THREE SETBACK SHADINGS FOR EACH WINDOW REQUESTING THEM
READ IN SHADOW PICTORIAL DATA FOR EACH WINDOW REQUESTED
READ IN NUMBER OF INTERNAL SURFACES AND EACH INTERNAL'S DATA
READ IN NUMBER OF UNDERGROUND SURFACES AND EACH UNDERGROUND'S DATA
READ IN MONTHLY GROUND TEMPERATURES
READ IN NUMBER OF SPACES
READ IN SPACE DATA FOR EACH SPACE
CALL REPRT2 TO PRINT OUT EACH SPACE'S DATA
CALL DESDY TO CALCULATE DESIGN HOURLY DRY AND WET BULB TEMPERATURES
END

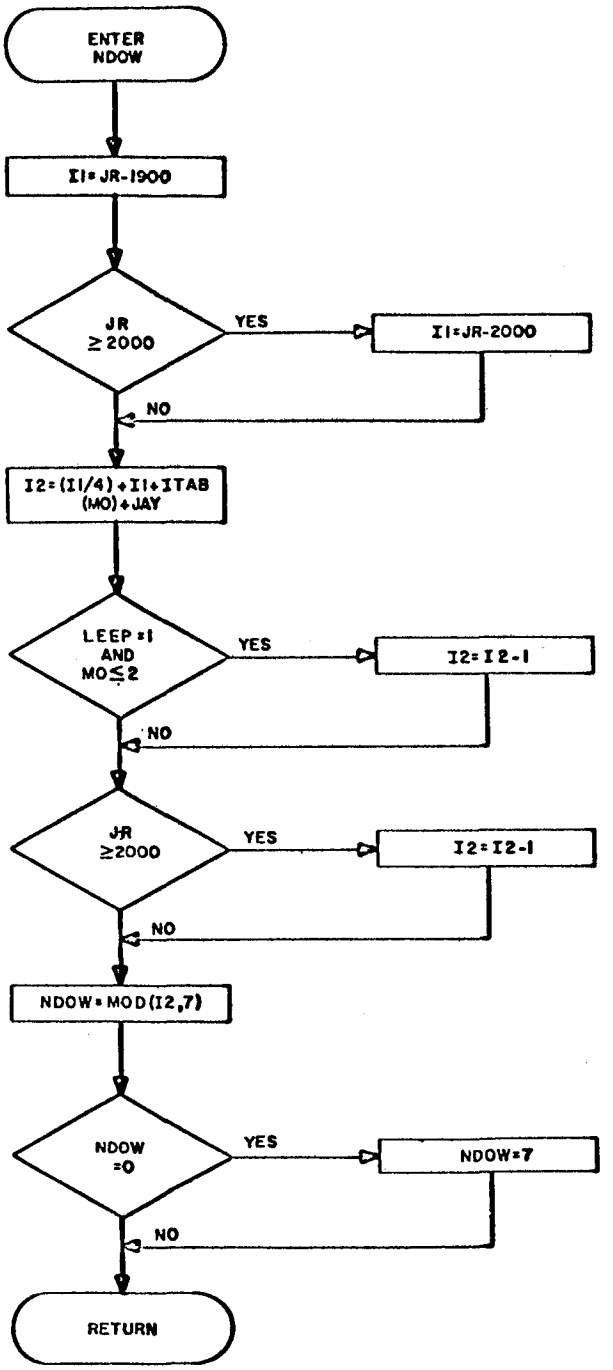

ENTER
INPUTI
LONG
FORM
?
YES
NO
READ
GEOMETRIC
DATA
CONVERT
AZIMUTH ANGLE
AND TILT
ANGLE TO
RADIANS
CALL RECTAN
CALCULATE
COORDINATES
OF VERTICES
CALL RECAP2
TO ECHO
DATA
RESET NUMBER
OF VERTICES
RETURN
J ← 1,NV
RETURN
READ
COORDINATES
OF VERTICES
CALL RECAP2
ECHO DATA

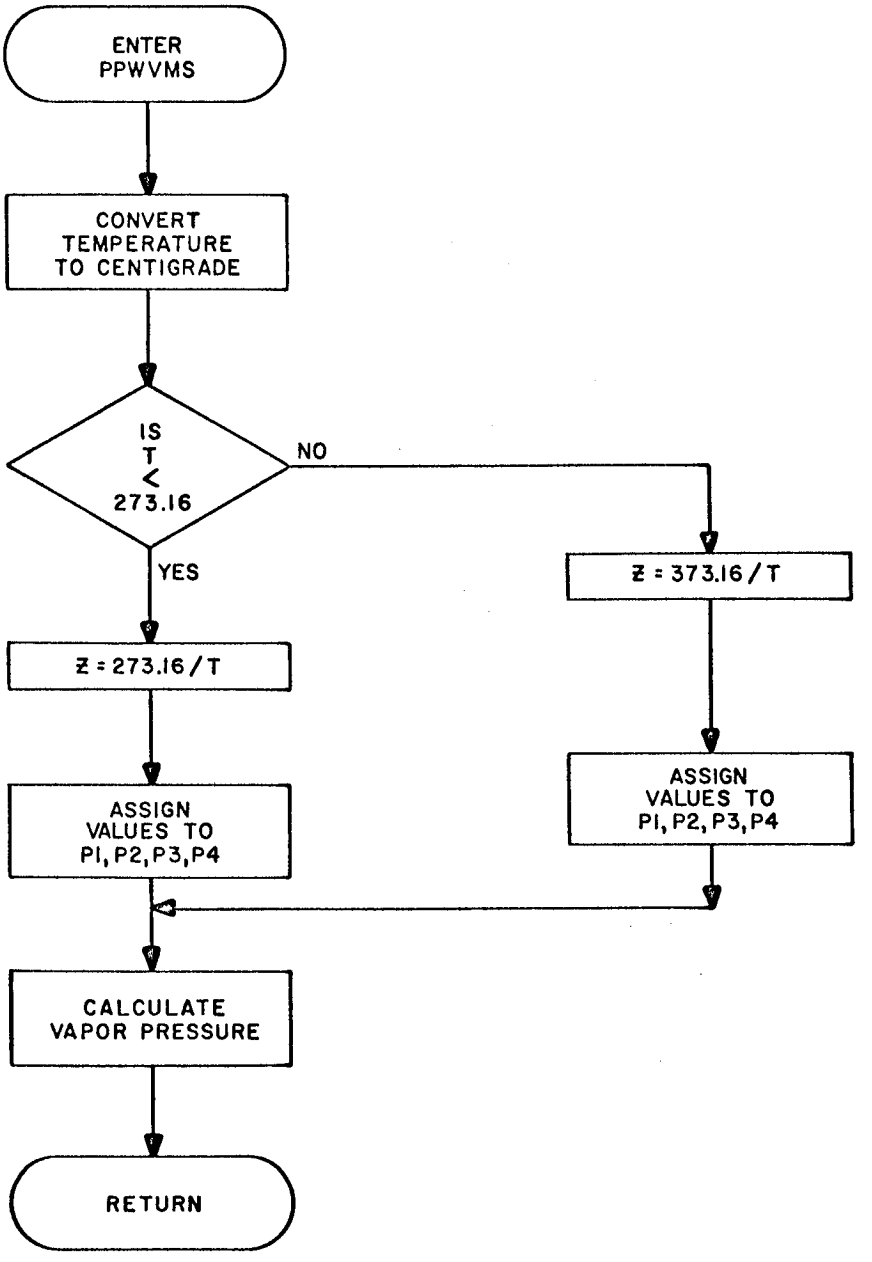

ENTER INPUT2
READ SURFACE FACTORS
CONVERT FACTORS TO INTEGER
LONG FORM ?
YES
NO
READ GEOMETRIC DESCRIPTION
CONVERT AZIMUTH ANGLE AND TILT ANGLE TO RADIANS
CALCULATE SURFACE AREA
CALL RECTAN
CALCULATE COORDINATES OF VERTICES
CALL RECAP2
ECHO DATA
RESET NUMBER OF VERTICES
RETURN
J = I, NV
RETURN
READ COORDINATES OF VERTICES
CALL APOL
CALCULATE AREA
COMPUTE HEIGHT AND WIDTH
CALL RECAP2
ECHO DATA

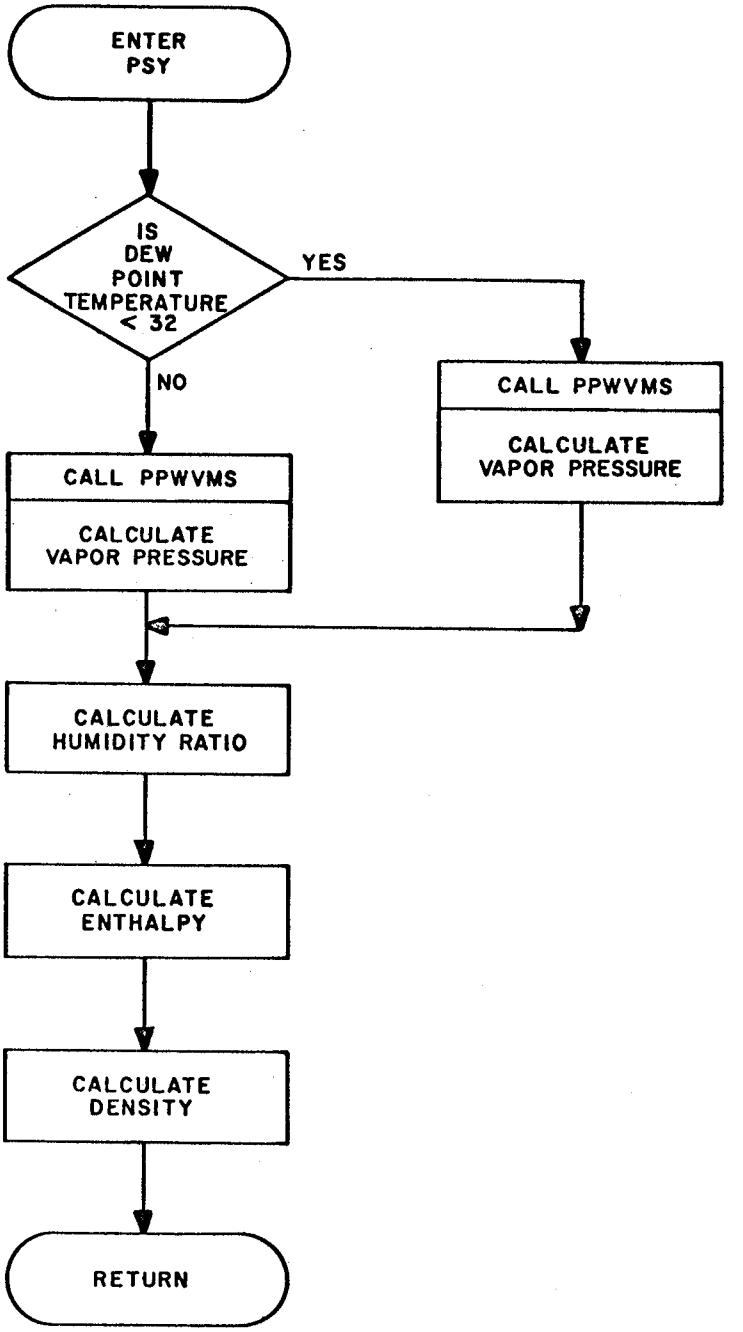

ENTER
LEEP
LEEP ← 0
IS IT
LEEP YEAR
?
YES
NO
LEEP ← 1
RETURN

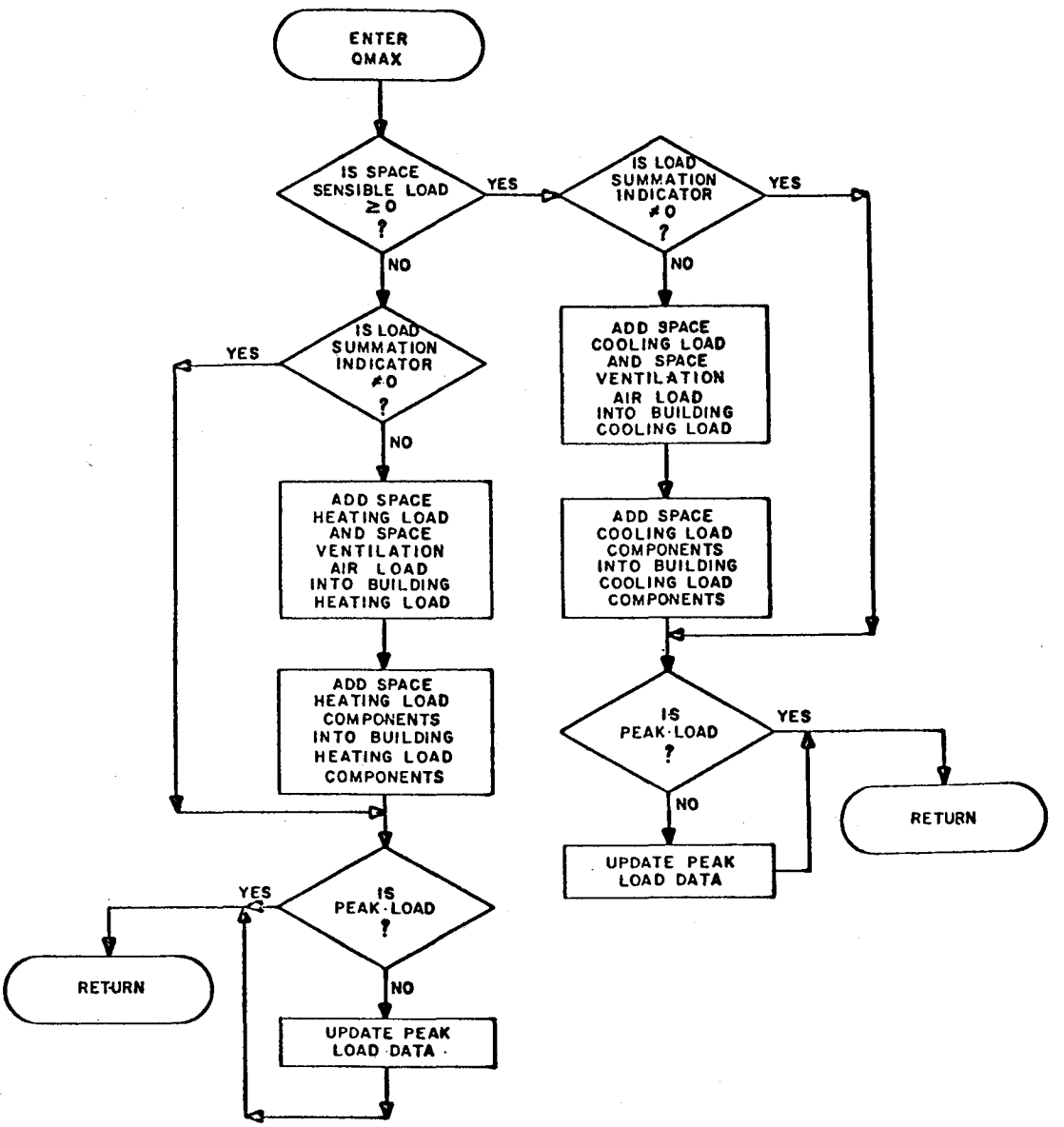

ENTER
LOKIN
SET SHADOW
PICTORIAL DISPLAY
PARAMETERS FOR
DELAYED, QUICK,
AND WINDOW
SURFACES
RETURN

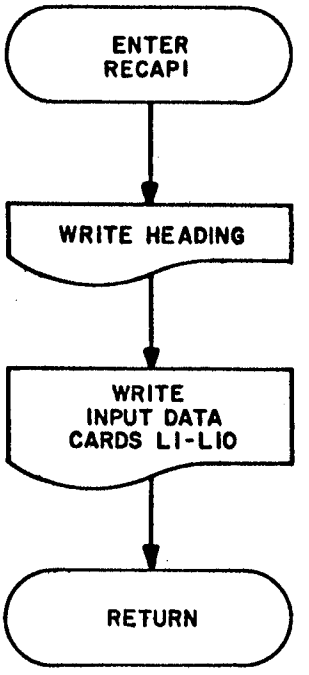

ENTER MATCON
I ← 1, MM
J ← 1, NN
IS IT SUNLIT ?
YES
NO
IS ELEMENT ON BORDER ?
YES
NO
SET ELEMENT = TO ASTERISK CHARACTER
IS ELEMENT ON BORDER ?
YES
NO
SET ELEMENT = 1
IS ELEMENT ON DIAGONAL BORDER ?
NO
YES
SET ELEMENT = 1
SET ELEMENT EQUAL TO A BLANK CHARACTER
I ← 1, MM
J ← 1, NN
RETURN

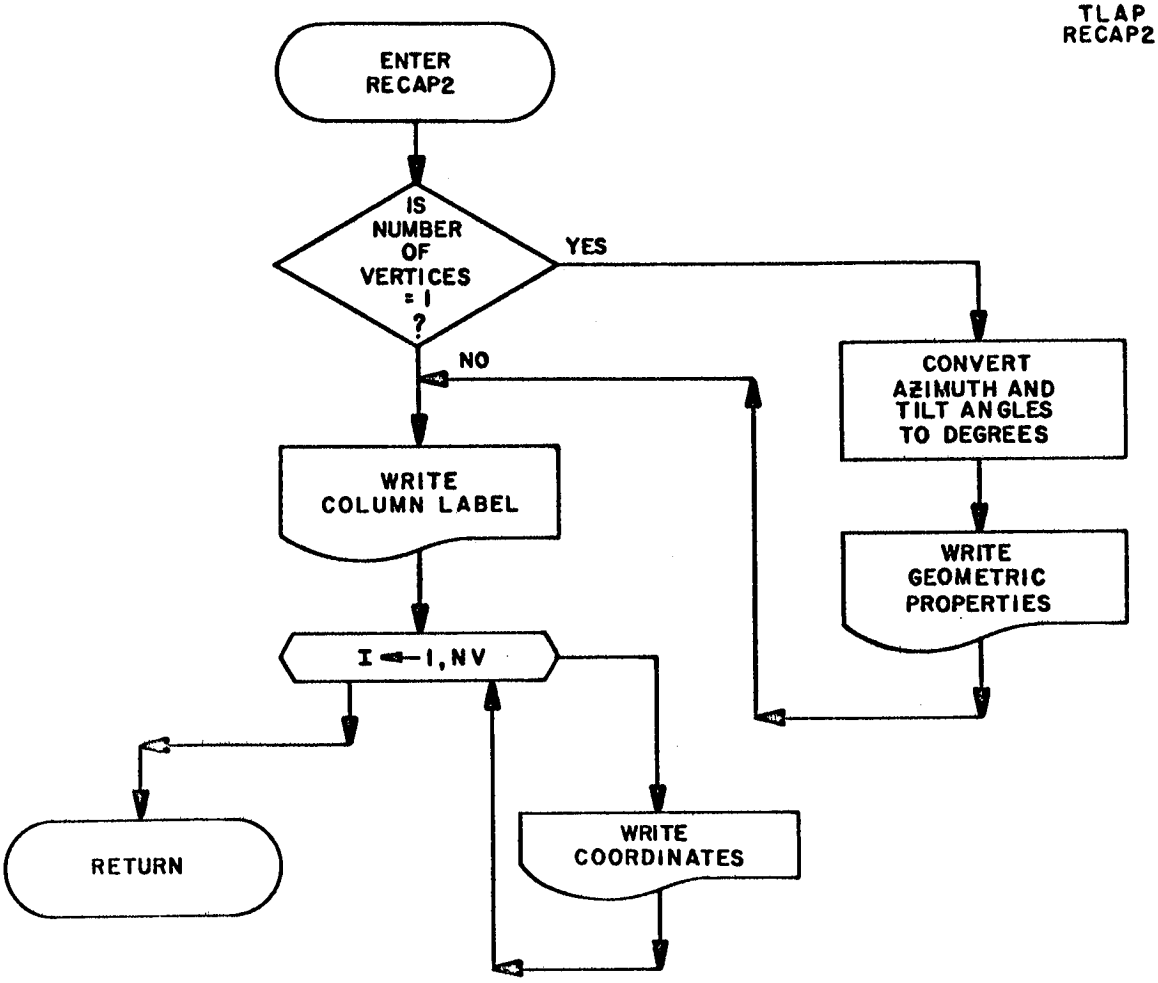

ENTER
NDOW
I1=JR-1900
JR
≥2000
YES
I1=JR-2000
NO
I2=(I1/4)+I1+ITAB
(MO)+JAY
LEEP=1
AND
MO≤2
YES
I2=I2-1
NO
JR
≥2000
YES
I2=I2-1
NO
NDOW=MOD(I2,7)
NDOW
=0
YES
NDOW=7
NO
RETURN

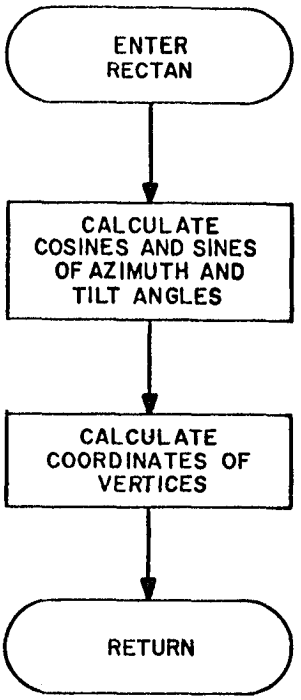

ENTER
PPWVMS
CONVERT
TEMPERATURE
TO CENTIGRADE
IS
T
<
273.16
NO
YES
Z = 373.16 / T
Z = 273.16 / T
ASSIGN
VALUES TO
P1, P2, P3, P4
ASSIGN
VALUES TO
P1, P2, P3, P4
CALCULATE
VAPOR PRESSURE
RETURN

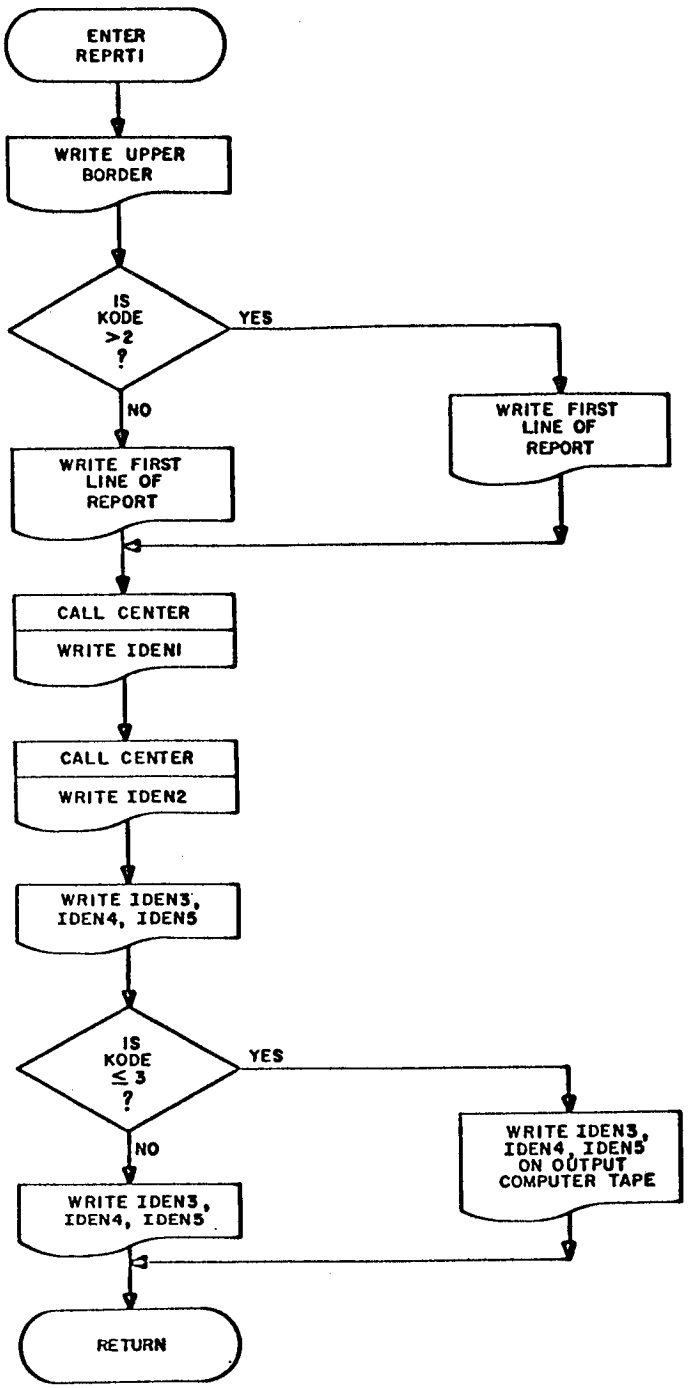

ENTER
PSY
IS
DEW
POINT
TEMPERATURE
< 32
YES
NO
CALL PPWVMS
CALCULATE
VAPOR PRESSURE
CALL PPWVMS
CALCULATE
VAPOR PRESSURE
CALCULATE
HUMIDITY RATIO
CALCULATE
ENTHALPY
CALCULATE
DENSITY
RETURN

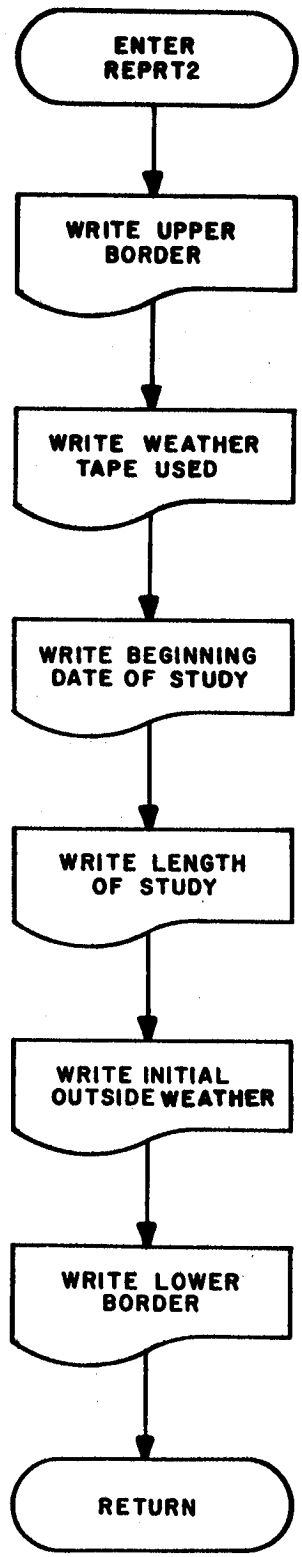

ENTER
QMAX
IS SPACE SENSIBLE LOAD ≥ 0 ?
YES
NO
IS LOAD SUMMATION INDICATOR ≠ 0 ?
YES
NO
IS LOAD SUMMATION INDICATOR ≠ 0 ?
YES
NO
ADD SPACE COOLING LOAD AND SPACE VENTILATION AIR LOAD INTO BUILDING COOLING LOAD
ADD SPACE HEATING LOAD AND SPACE VENTILATION AIR LOAD INTO BUILDING HEATING LOAD
ADD SPACE COOLING LOAD COMPONENTS INTO BUILDING COOLING LOAD COMPONENTS
ADD SPACE HEATING LOAD COMPONENTS INTO BUILDING HEATING LOAD COMPONENTS
IS PEAK LOAD ?
YES
NO
RETURN
UPDATE PEAK LOAD DATA
IS PEAK LOAD ?
YES
NO
RETURN
UPDATE PEAK LOAD DATA

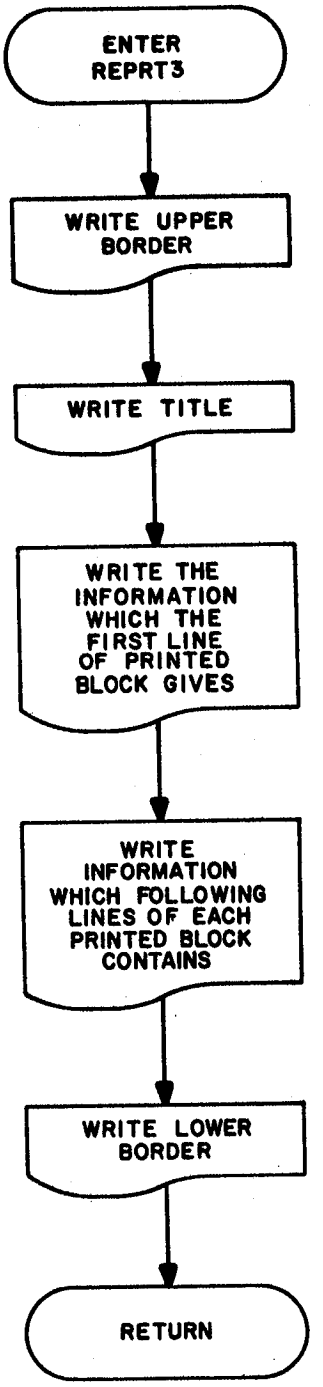

ENTER
RECAPI
WRITE HEADING
WRITE
INPUT DATA
CARDS L1-L10
RETURN

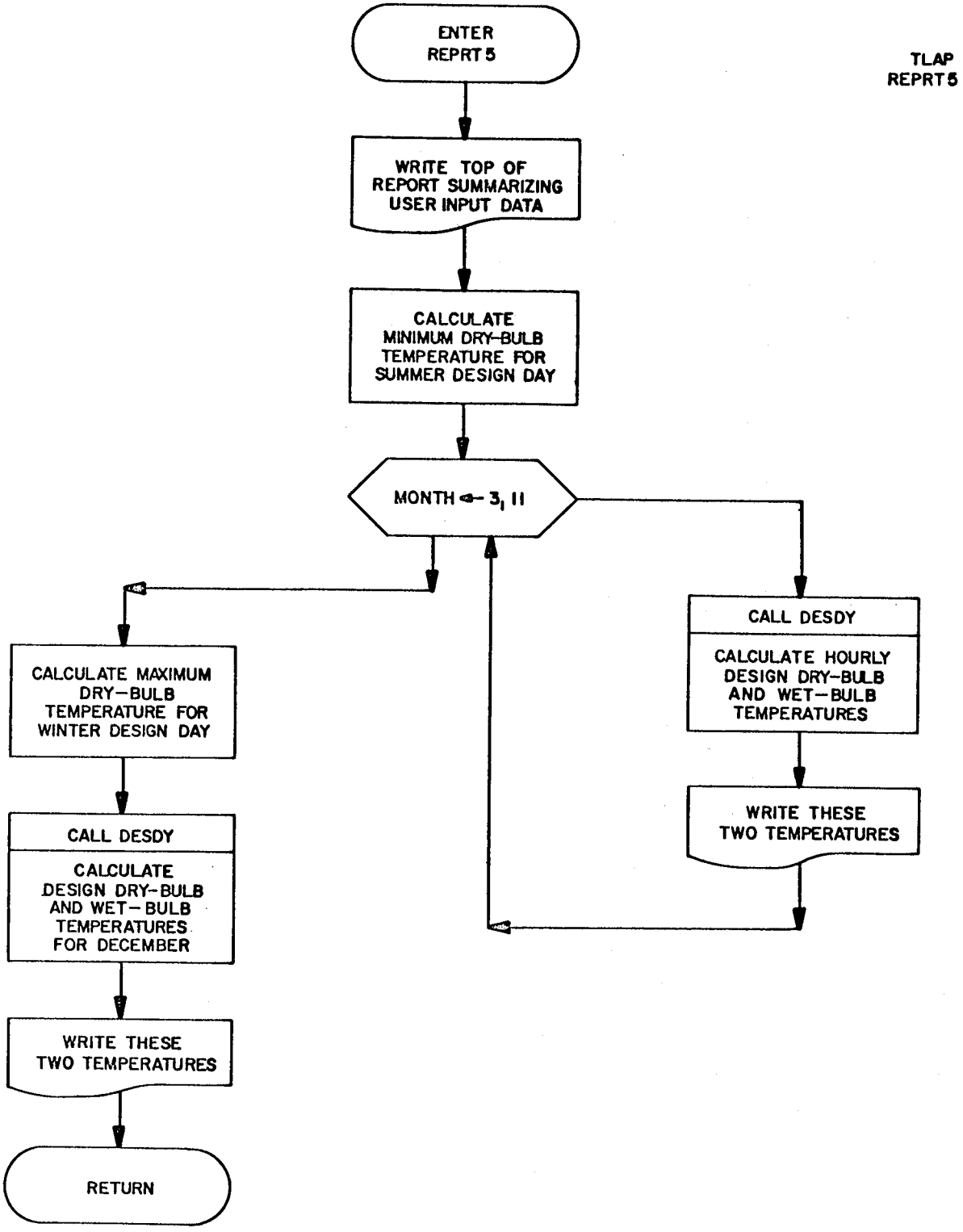

ENTER
RECAP2
IS
NUMBER
OF
VERTICES
= 1
?
YES
NO
CONVERT
AZIMUTH AND
TILT ANGLES
TO DEGREES
WRITE
COLUMN LABEL
WRITE
GEOMETRIC
PROPERTIES
I ← 1, NV
RETURN
WRITE
COORDINATES

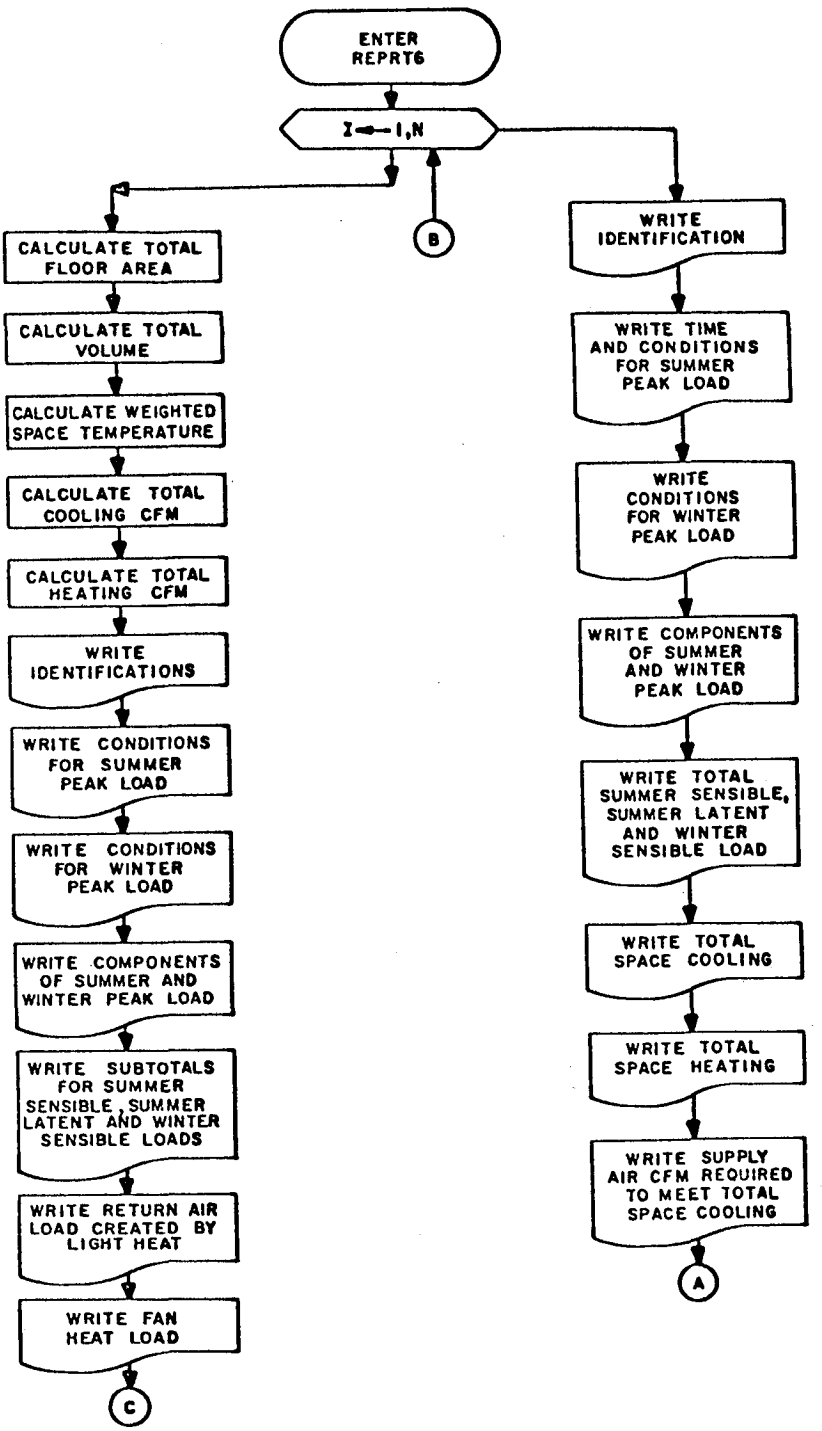

ENTER
RECTAN
CALCULATE
COSINES AND SINES
OF AZIMUTH AND
TILT ANGLES
CALCULATE
COORDINATES OF
VERTICES
RETURN

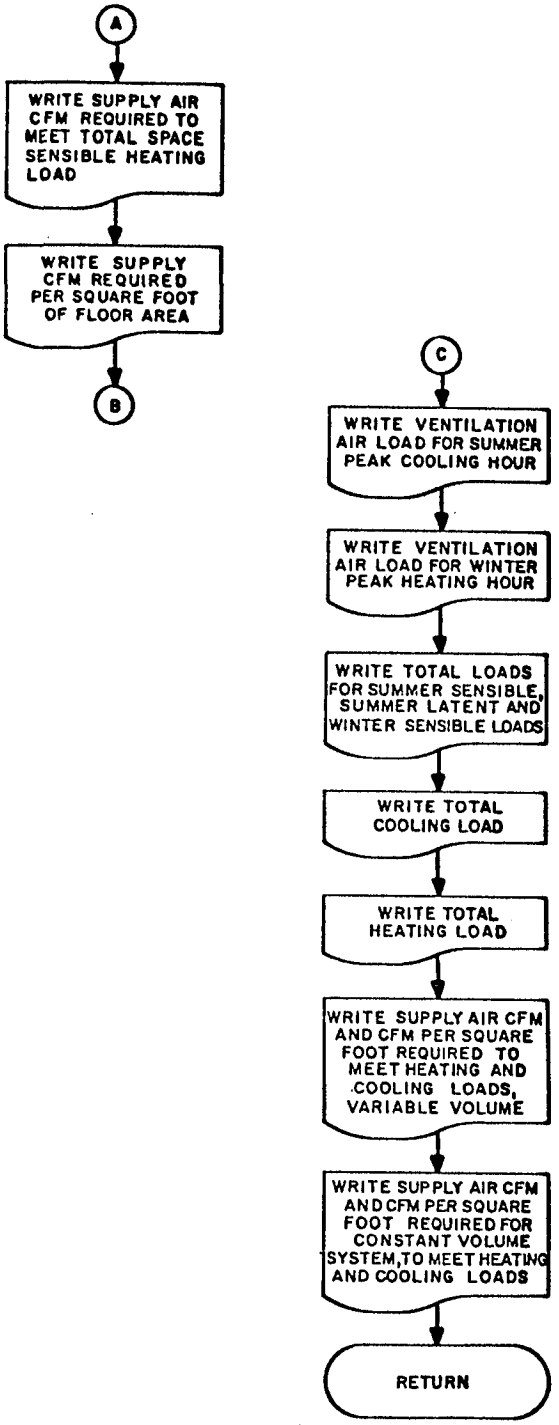

ENTER
REPRTI
WRITE UPPER
BORDER
IS
KODE
>2
?
YES
NO
WRITE FIRST
LINE OF
REPORT
WRITE FIRST
LINE OF
REPORT
CALL CENTER
WRITE IDEN1
CALL CENTER
WRITE IDEN2
WRITE IDEN3,
IDEN4, IDEN5
IS
KODE
≤ 3
?
YES
NO
WRITE IDEN3,
IDEN4, IDEN5
ON OUTPUT
COMPUTER TAPE
WRITE IDEN3,
IDEN4, IDEN5
RETURN

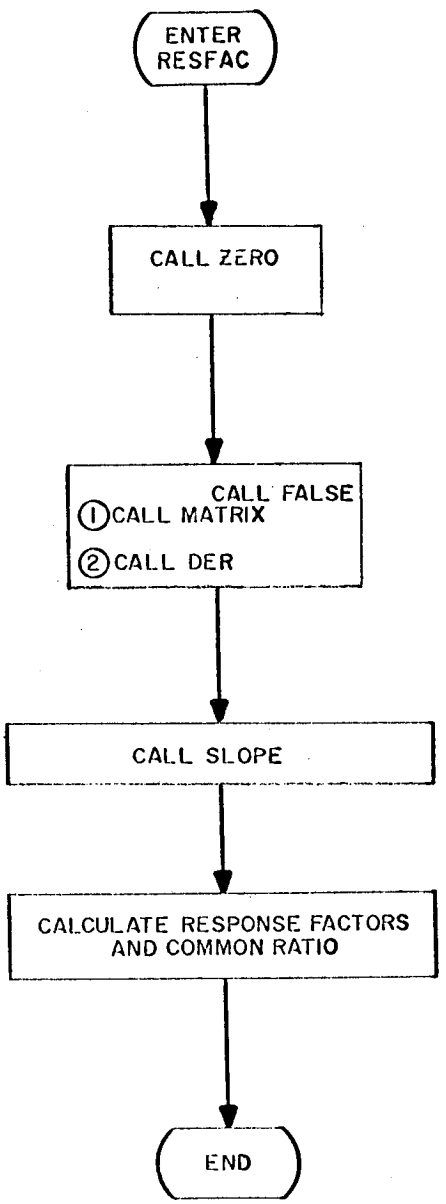

ENTER
REPRT2
WRITE UPPER
BORDER
WRITE WEATHER
TAPE USED
WRITE BEGINNING
DATE OF STUDY
WRITE LENGTH
OF STUDY
WRITE INITIAL
OUTSIDE WEATHER
WRITE LOWER
BORDER
RETURN

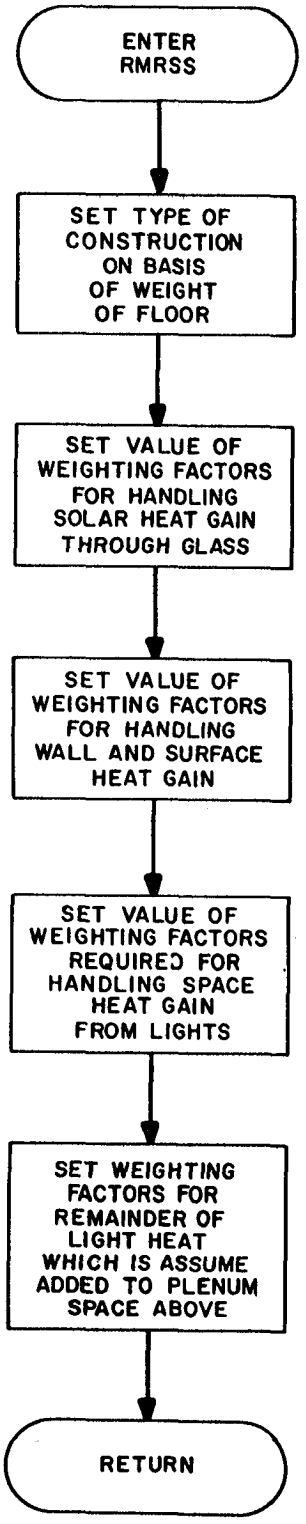

ENTER
REPRT3
WRITE UPPER
BORDER
WRITE TITLE
WRITE THE
INFORMATION
WHICH THE
FIRST LINE
OF PRINTED
BLOCK GIVES
WRITE
INFORMATION
WHICH FOLLOWING
LINES OF EACH
PRINTED BLOCK
CONTAINS
WRITE LOWER
BORDER
RETURN

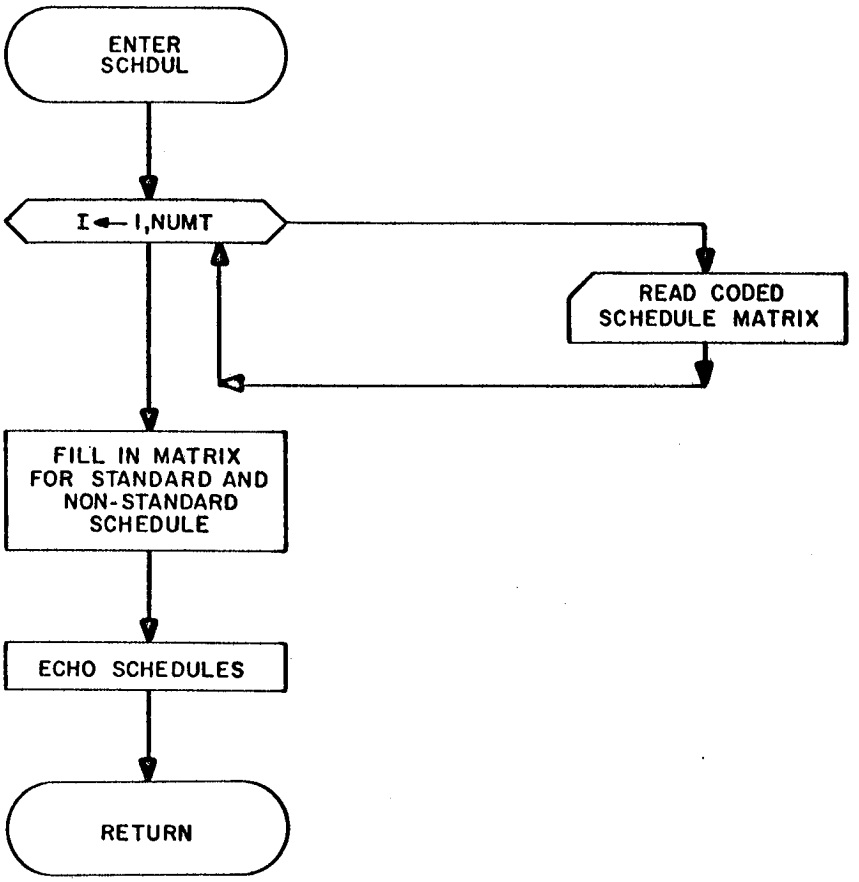

TLAP
REPRT5
ENTER
REPRT5
WRITE TOP OF
REPORT SUMMARIZING
USER INPUT DATA
CALCULATE
MINIMUM DRY-BULB
TEMPERATURE FOR
SUMMER DESIGN DAY
MONTH ← 3, 11
CALCULATE MAXIMUM
DRY-BULB
TEMPERATURE FOR
WINTER DESIGN DAY
CALL DESDY
CALCULATE
DESIGN DRY-BULB
AND WET-BULB
TEMPERATURES
FOR DECEMBER
WRITE THESE
TWO TEMPERATURES
RETURN
CALL DESDY
CALCULATE HOURLY
DESIGN DRY-BULB
AND WET-BULB
TEMPERATURES
WRITE THESE
TWO TEMPERATURES

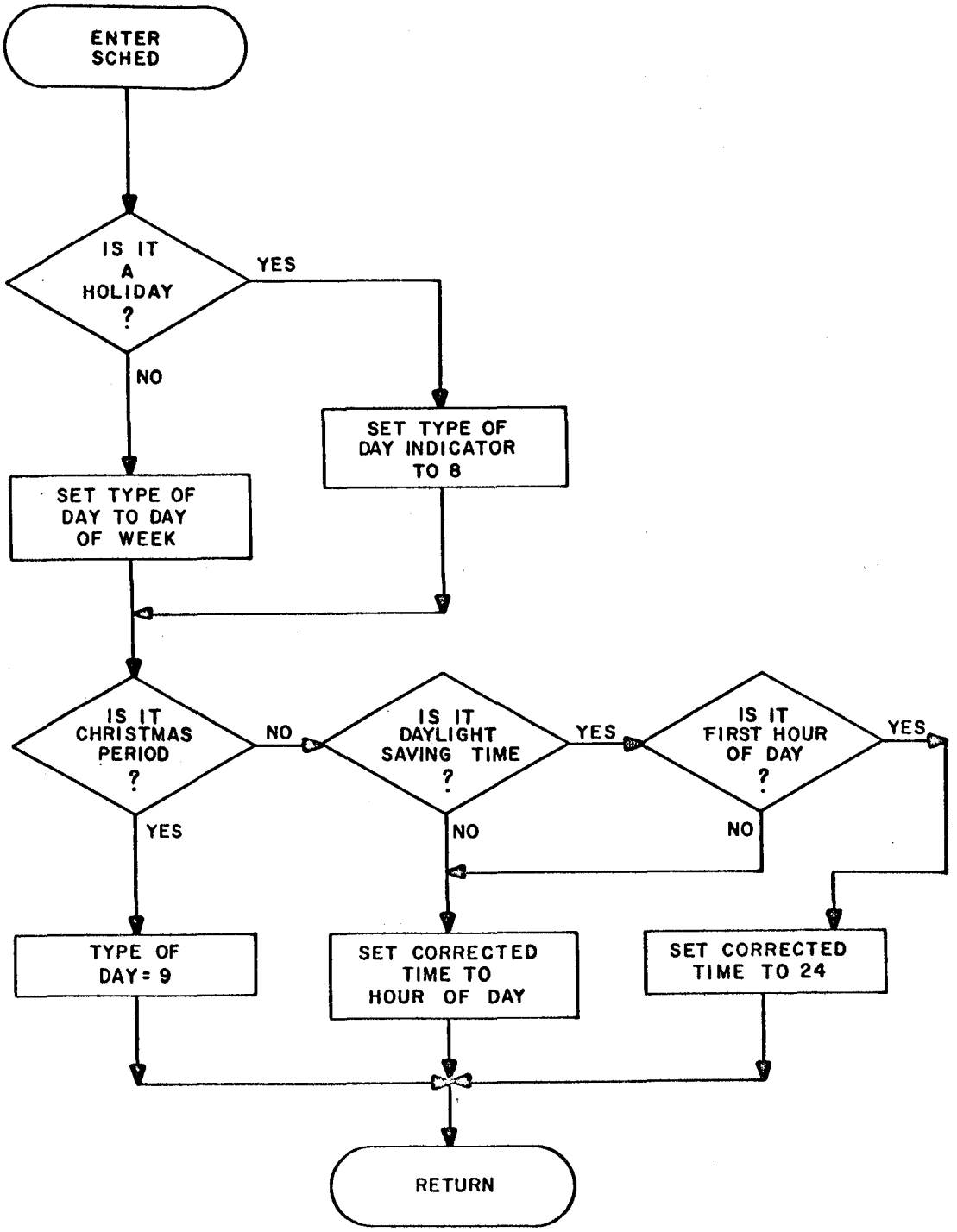

ENTER REPRT6
I←1,N
B
CALCULATE TOTAL FLOOR AREA
CALCULATE TOTAL VOLUME
CALCULATE WEIGHTED SPACE TEMPERATURE
CALCULATE TOTAL COOLING CFM
CALCULATE TOTAL HEATING CFM
WRITE IDENTIFICATIONS
WRITE CONDITIONS FOR SUMMER PEAK LOAD
WRITE CONDITIONS FOR WINTER PEAK LOAD
WRITE COMPONENTS OF SUMMER AND WINTER PEAK LOAD
WRITE SUBTOTALS FOR SUMMER SENSIBLE, SUMMER LATENT AND WINTER SENSIBLE LOADS
WRITE RETURN AIR LOAD CREATED BY LIGHT HEAT
WRITE FAN HEAT LOAD
C
WRITE IDENTIFICATION
WRITE TIME AND CONDITIONS FOR SUMMER PEAK LOAD
WRITE CONDITIONS FOR WINTER PEAK LOAD
WRITE COMPONENTS OF SUMMER AND WINTER PEAK LOAD
WRITE TOTAL SUMMER SENSIBLE, SUMMER LATENT AND WINTER SENSIBLE LOAD
WRITE TOTAL SPACE COOLING
WRITE TOTAL SPACE HEATING
WRITE SUPPLY AIR CFM REQUIRED TO MEET TOTAL SPACE COOLING
A

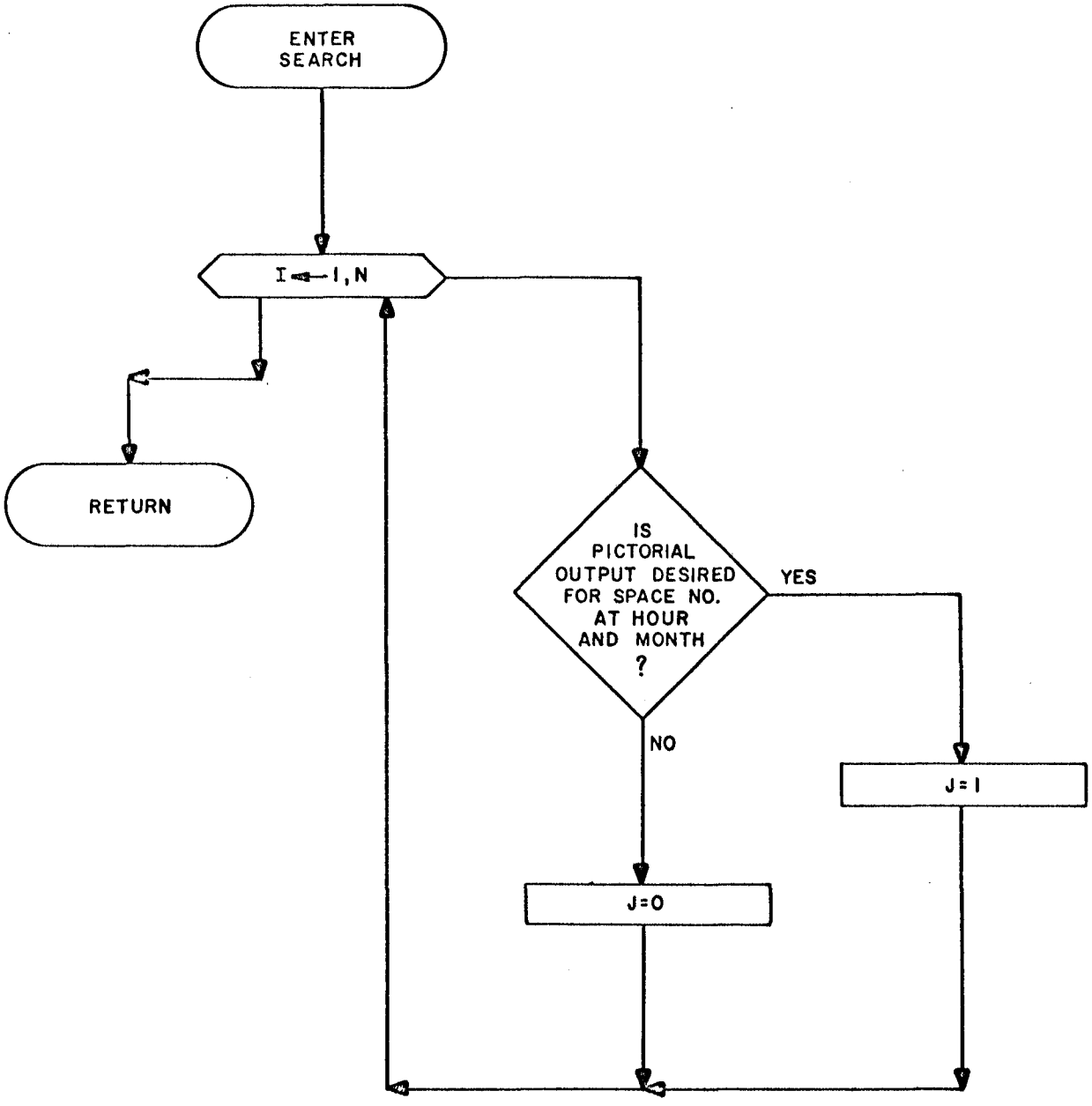

A
WRITE SUPPLY AIR CFM REQUIRED TO MEET TOTAL SPACE SENSIBLE HEATING LOAD
WRITE SUPPLY CFM REQUIRED PER SQUARE FOOT OF FLOOR AREA
B
C
WRITE VENTILATION AIR LOAD FOR SUMMER PEAK COOLING HOUR
WRITE VENTILATION AIR LOAD FOR WINTER PEAK HEATING HOUR
WRITE TOTAL LOADS FOR SUMMER SENSIBLE, SUMMER LATENT AND WINTER SENSIBLE LOADS
WRITE TOTAL COOLING LOAD
WRITE TOTAL HEATING LOAD
WRITE SUPPLY AIR CFM AND CFM PER SQUARE FOOT REQUIRED TO MEET HEATING AND COOLING LOADS, VARIABLE VOLUME
WRITE SUPPLY AIR CFM AND CFM PER SQUARE FOOT REQUIRED FOR CONSTANT VOLUME SYSTEM, TO MEET HEATING AND COOLING LOADS
RETURN

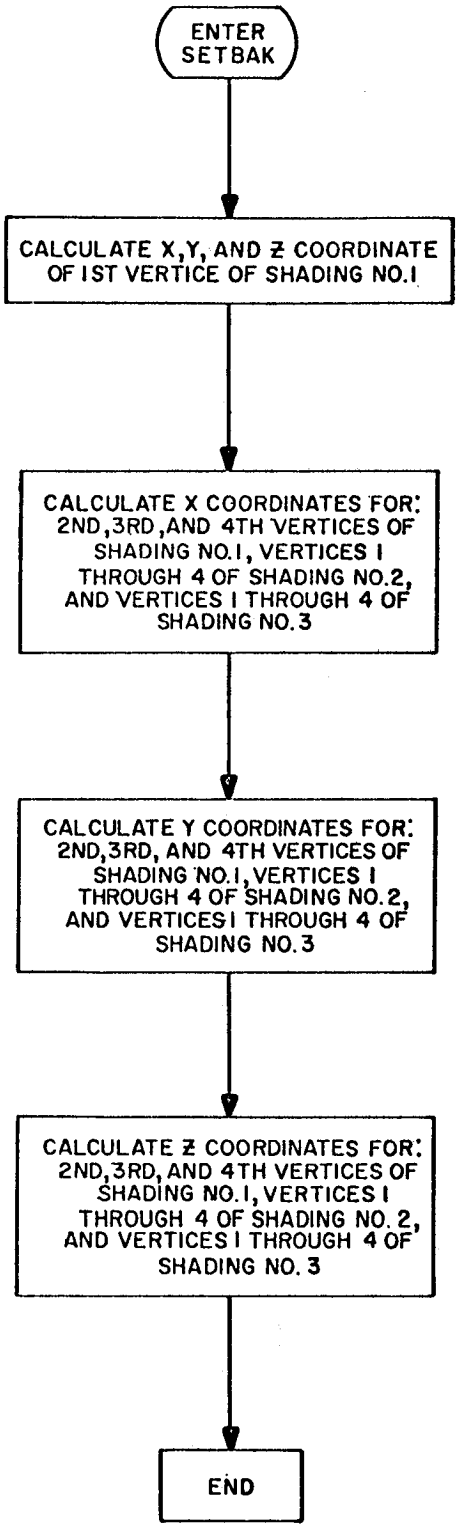

ENTER
RESFAC
CALL ZERO
CALL FALSE
1 CALL MATRIX
2 CALL DER
CALL SLOPE
CALCULATE RESPONSE FACTORS
AND COMMON RATIO
END

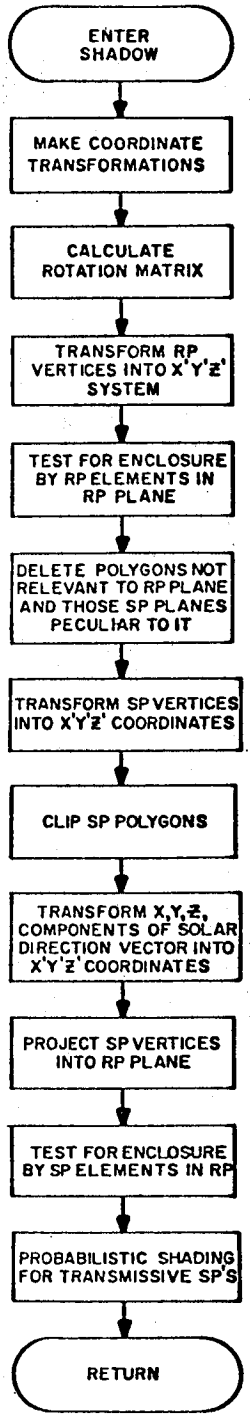

ENTER
RMRSS
SET TYPE OF CONSTRUCTION ON BASIS OF WEIGHT OF FLOOR
SET VALUE OF WEIGHTING FACTORS FOR HANDLING SOLAR HEAT GAIN THROUGH GLASS
SET VALUE OF WEIGHTING FACTORS FOR HANDLING WALL AND SURFACE HEAT GAIN
SET VALUE OF WEIGHTING FACTORS REQUIRED FOR HANDLING SPACE HEAT GAIN FROM LIGHTS
SET WEIGHTING FACTORS FOR REMAINDER OF LIGHT HEAT WHICH IS ASSUME ADDED TO PLENUM SPACE ABOVE
RETURN

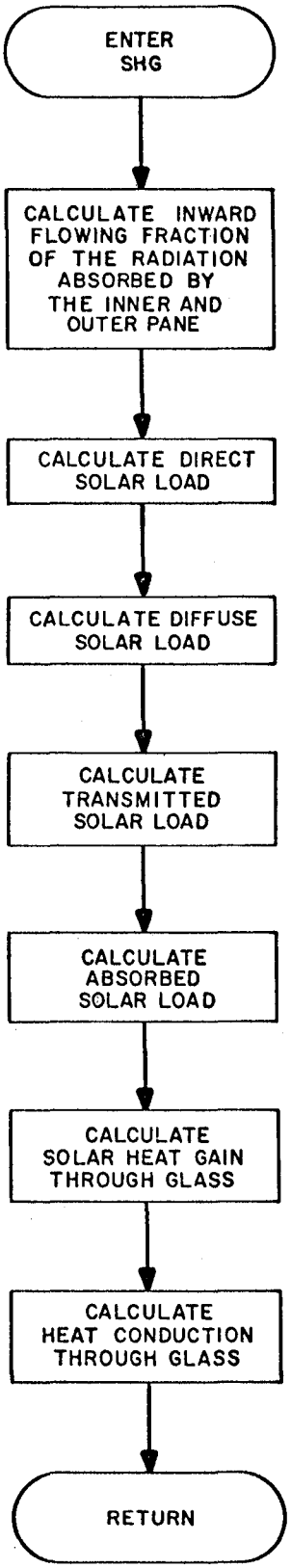

ENTER
SCHDUL
I ← 1,NUMT
READ CODED
SCHEDULE MATRIX
FILL IN MATRIX
FOR STANDARD AND
NON-STANDARD
SCHEDULE
ECHO SCHEDULES
RETURN

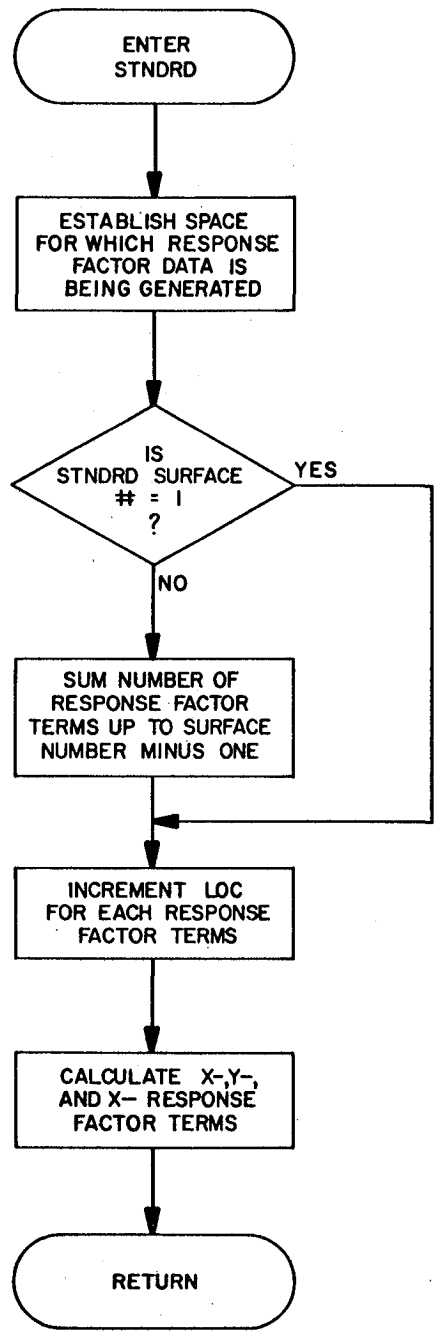

ENTER SCHED
IS IT A HOLIDAY ?
YES
NO
SET TYPE OF DAY INDICATOR TO 8
SET TYPE OF DAY TO DAY OF WEEK
IS IT CHRISTMAS PERIOD ?
NO
IS IT DAYLIGHT SAVING TIME ?
YES
IS IT FIRST HOUR OF DAY ?
YES
YES
NO
NO
TYPE OF DAY = 9
SET CORRECTED TIME TO HOUR OF DAY
SET CORRECTED TIME TO 24
RETURN

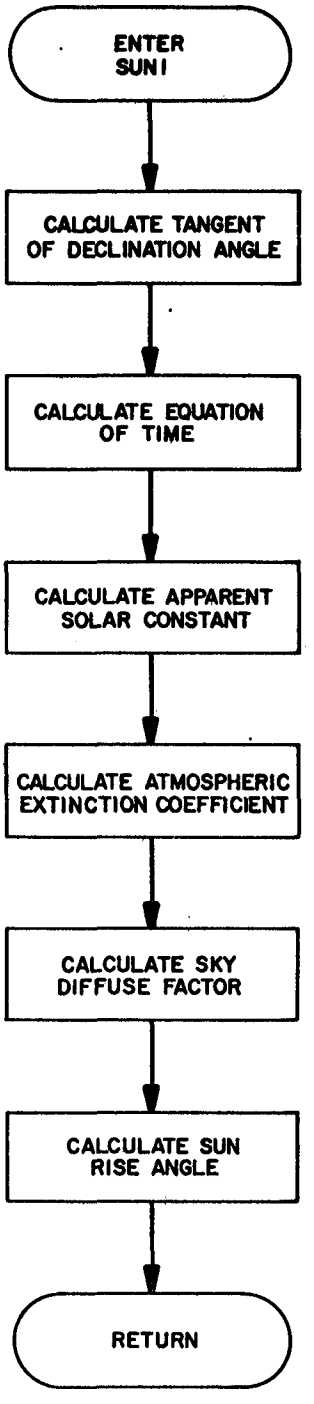

ENTER
SEARCH
I ← 1, N
RETURN
IS
PICTORIAL
OUTPUT DESIRED
FOR SPACE NO.
AT HOUR
AND MONTH
?
YES
NO
J = 1
J = 0

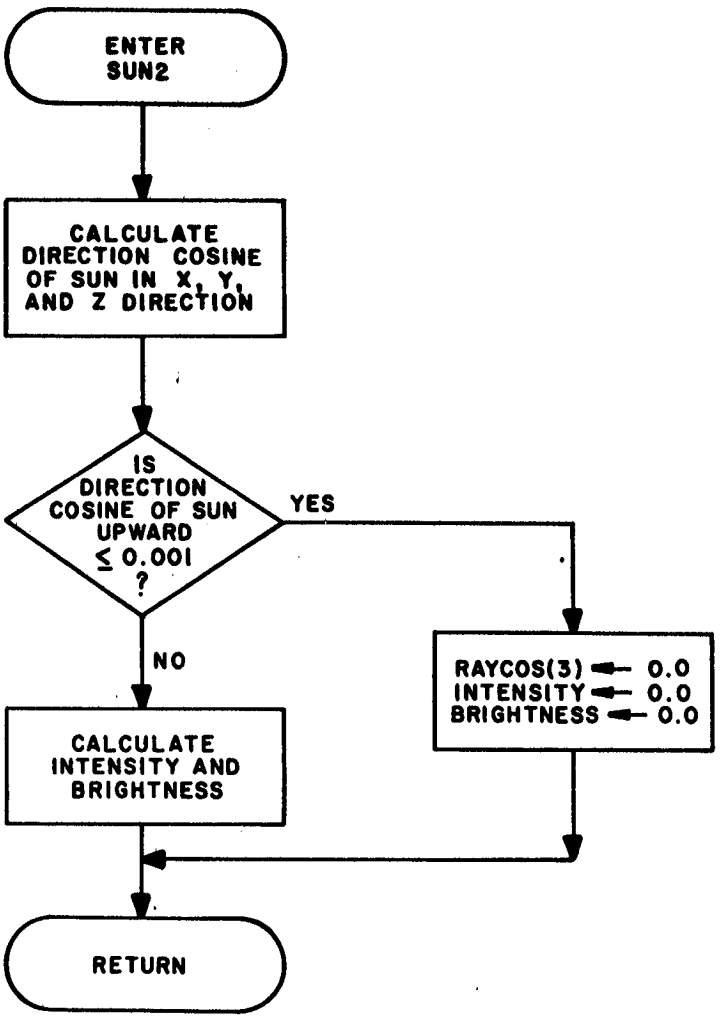

ENTER SETBAK
CALCULATE X,Y, AND Z COORDINATE OF 1ST VERTICE OF SHADING NO.1
CALCULATE X COORDINATES FOR: 2ND,3RD,AND 4TH VERTICES OF SHADING NO.1, VERTICES 1 THROUGH 4 OF SHADING NO.2, AND VERTICES 1 THROUGH 4 OF SHADING NO.3
CALCULATE Y COORDINATES FOR: 2ND,3RD, AND 4TH VERTICES OF SHADING NO.1, VERTICES 1 THROUGH 4 OF SHADING NO.2, AND VERTICES 1 THROUGH 4 OF SHADING NO.3
CALCULATE Z COORDINATES FOR: 2ND,3RD, AND 4TH VERTICES OF SHADING NO.1, VERTICES 1 THROUGH 4 OF SHADING NO.2, AND VERTICES 1 THROUGH 4 OF SHADING NO.3
END

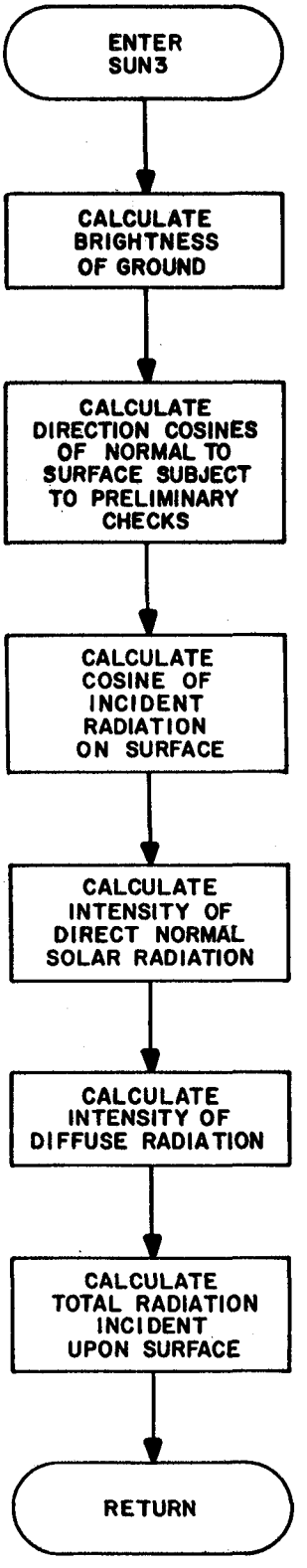

ENTER SHADOW
MAKE COORDINATE TRANSFORMATIONS
CALCULATE ROTATION MATRIX
TRANSFORM RP VERTICES INTO X'Y'Z' SYSTEM
TEST FOR ENCLOSURE BY RP ELEMENTS IN RP PLANE
DELETE POLYGONS NOT RELEVANT TO RP PLANE AND THOSE SP PLANES PECULIAR TO IT
TRANSFORM SP VERTICES INTO X'Y'Z' COORDINATES
CLIP SP POLYGONS
TRANSFORM X,Y,Z, COMPONENTS OF SOLAR DIRECTION VECTOR INTO X'Y'Z' COORDINATES
PROJECT SP VERTICES INTO RP PLANE
TEST FOR ENCLOSURE BY SP ELEMENTS IN RP
PROBABILISTIC SHADING FOR TRANSMISSIVE SP'S
RETURN

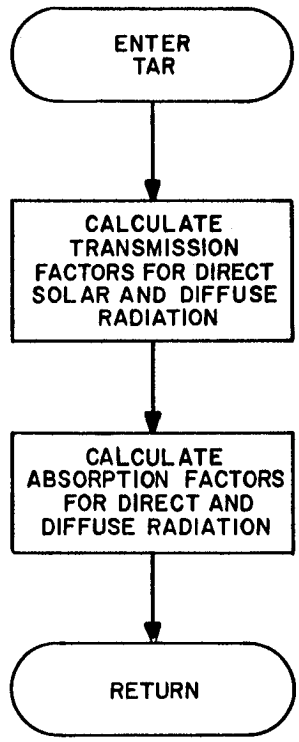

ENTER
SHG
CALCULATE INWARD FLOWING FRACTION OF THE RADIATION ABSORBED BY THE INNER AND OUTER PANE
CALCULATE DIRECT SOLAR LOAD
CALCULATE DIFFUSE SOLAR LOAD
CALCULATE TRANSMITTED SOLAR LOAD
CALCULATE ABSORBED SOLAR LOAD
CALCULATE SOLAR HEAT GAIN THROUGH GLASS
CALCULATE HEAT CONDUCTION THROUGH GLASS
RETURN

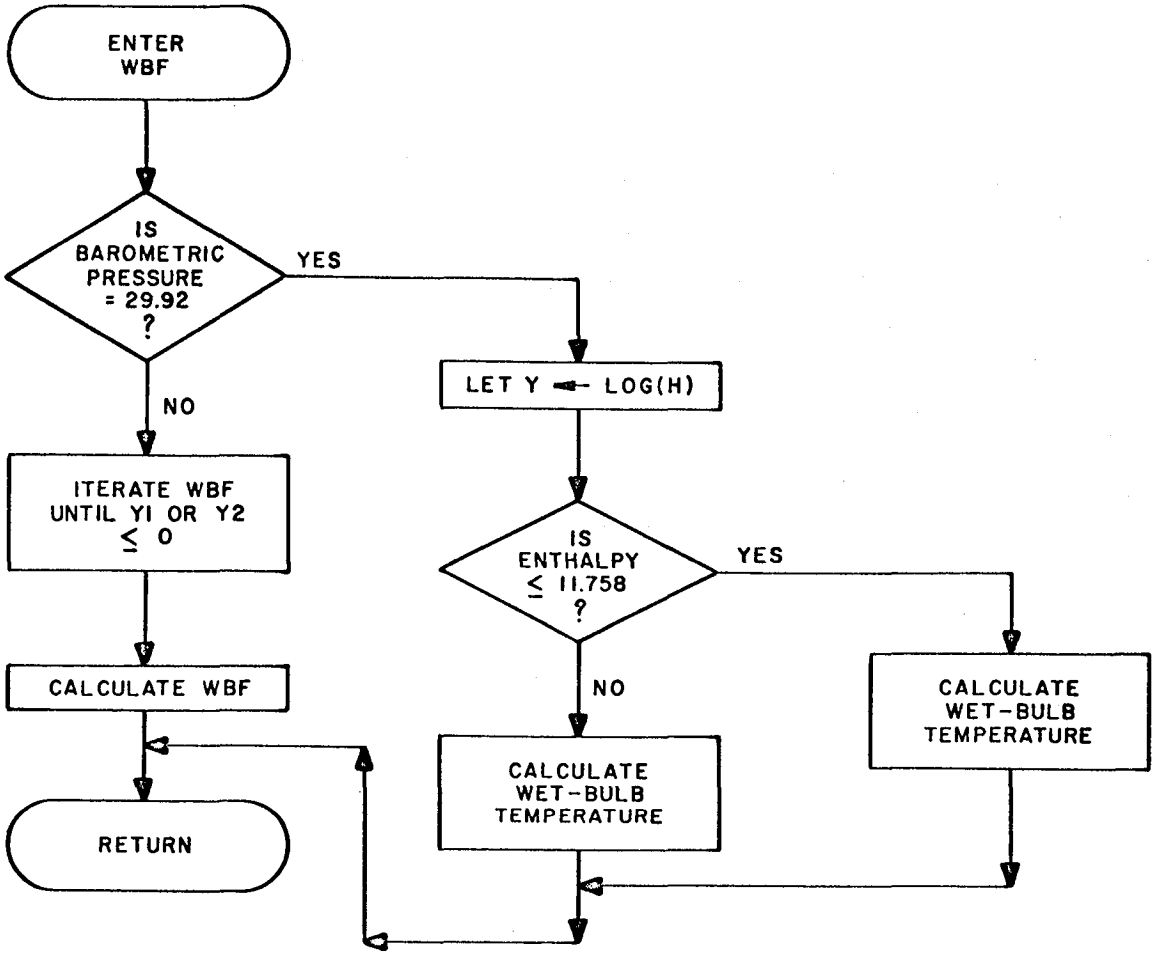

ENTER
STNDRD
ESTABLISH SPACE FOR WHICH RESPONSE FACTOR DATA IS BEING GENERATED
IS STNDRD SURFACE # = 1 ?
YES
NO
SUM NUMBER OF RESPONSE FACTOR TERMS UP TO SURFACE NUMBER MINUS ONE
INCREMENT LOC FOR EACH RESPONSE FACTOR TERMS
CALCULATE X-,Y-, AND X- RESPONSE FACTOR TERMS
RETURN


ENTER
SUNI
CALCULATE TANGENT
OF DECLINATION ANGLE
CALCULATE EQUATION
OF TIME
CALCULATE APPARENT
SOLAR CONSTANT
CALCULATE ATMOSPHERIC
EXTINCTION COEFFICIENT
CALCULATE SKY
DIFFUSE FACTOR
CALCULATE SUN
RISE ANGLE
RETURN


ENTER
SUN2
CALCULATE DIRECTION COSINE OF SUN IN X, Y, AND Z DIRECTION
IS DIRECTION COSINE OF SUN UPWARD ≤ 0.001 ?
YES
NO
RAYCOS(3) ← 0.0
INTENSITY ← 0.0
BRIGHTNESS ← 0.0
CALCULATE INTENSITY AND BRIGHTNESS
RETURN

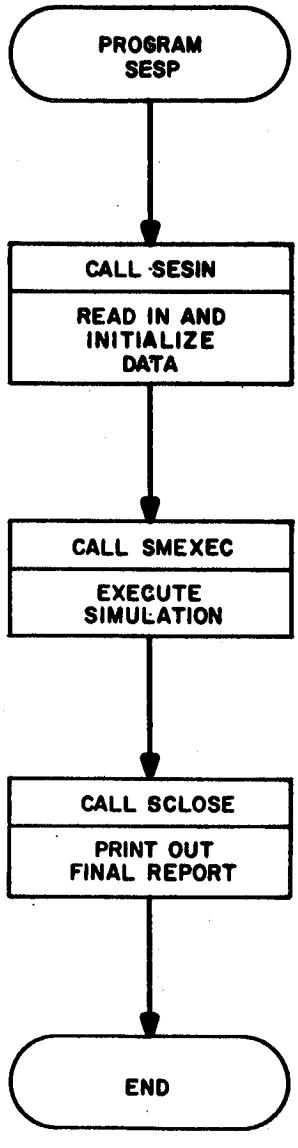

ENTER
SUN3
CALCULATE
BRIGHTNESS
OF GROUND
CALCULATE
DIRECTION COSINES
OF NORMAL TO
SURFACE SUBJECT
TO PRELIMINARY
CHECKS
CALCULATE
COSINE OF
INCIDENT
RADIATION
ON SURFACE
CALCULATE
INTENSITY OF
DIRECT NORMAL
SOLAR RADIATION
CALCULATE
INTENSITY OF
DIFFUSE RADIATION
CALCULATE
TOTAL RADIATION
INCIDENT
UPON SURFACE
RETURN

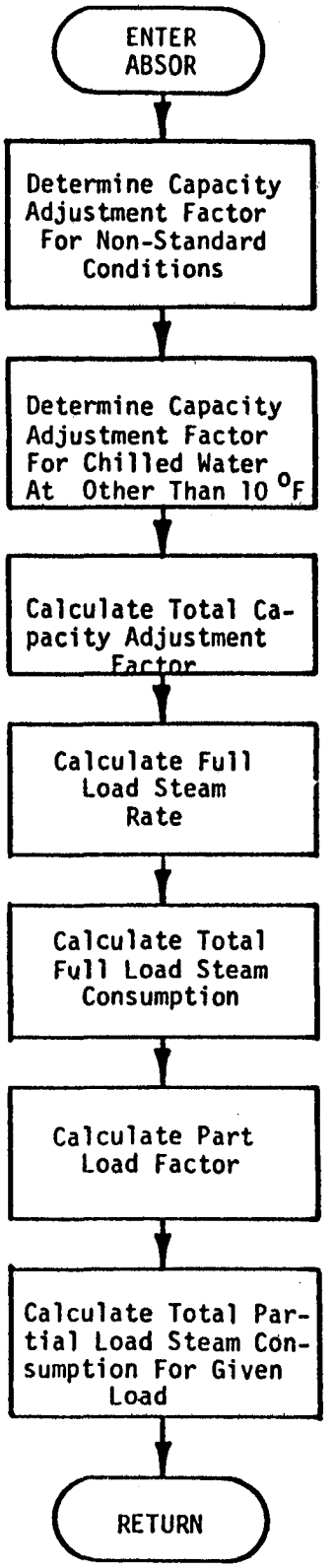

ENTER
TAR
CALCULATE
TRANSMISSION
FACTORS FOR DIRECT
SOLAR AND DIFFUSE
RADIATION
CALCULATE
ABSORPTION FACTORS
FOR DIRECT AND
DIFFUSE RADIATION
RETURN

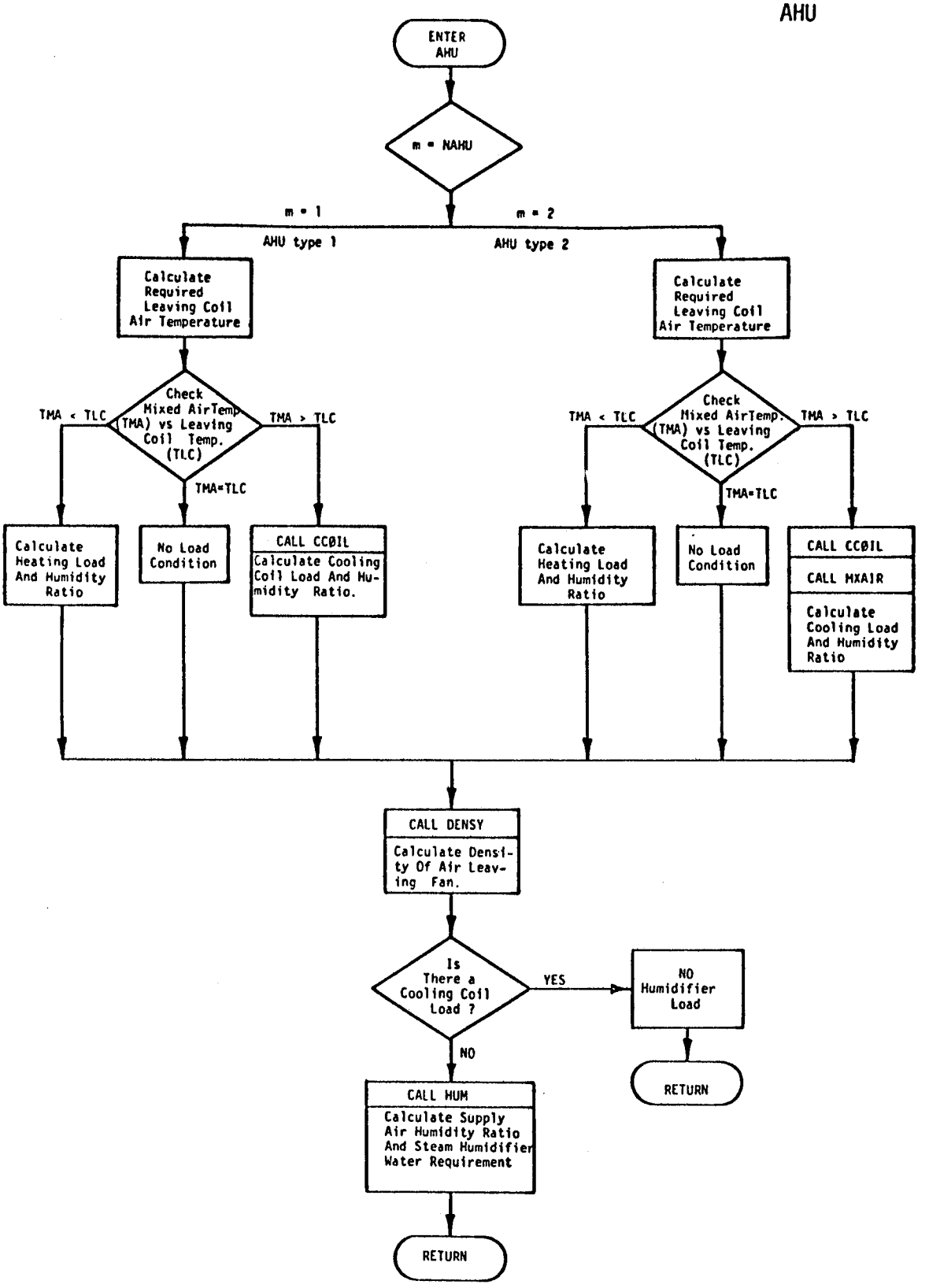

ENTER
WBF
IS
BAROMETRIC
PRESSURE
= 29.92
?
YES
NO
LET Y ← LOG(H)
ITERATE WBF
UNTIL Y1 OR Y2
≤ 0
IS
ENTHALPY
≤ 11.758
?
YES
NO
CALCULATE WBF
CALCULATE
WET-BULB
TEMPERATURE
CALCULATE
WET-BULB
TEMPERATURE
RETURN

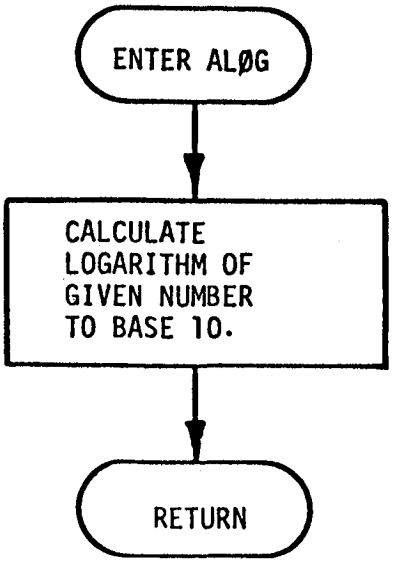
Section 4

SYSTEMS ENERGY SIMULATION PROGRAM

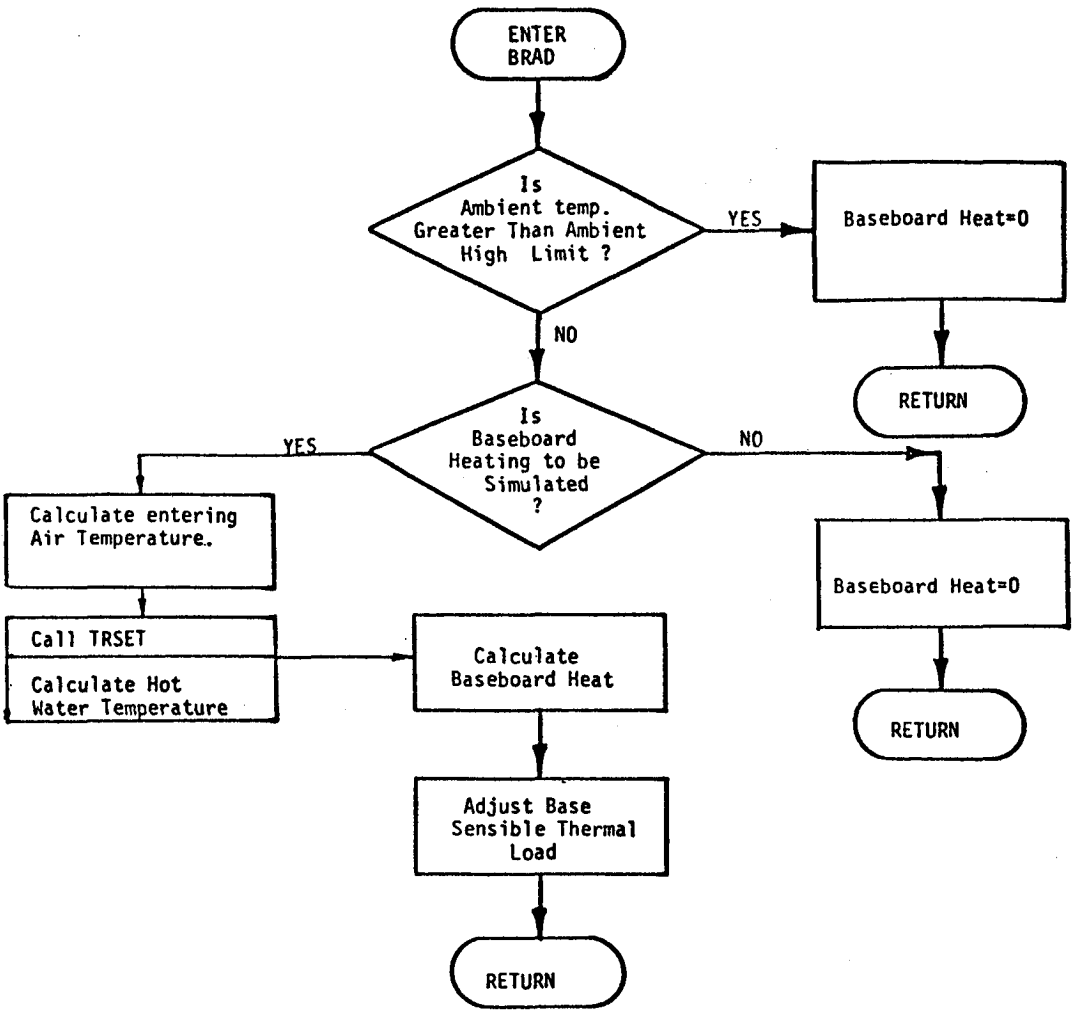

PROGRAM
SESP
CALL SESIN
READ IN AND
INITIALIZE
DATA
CALL SMEXEC
EXECUTE
SIMULATION
CALL SCLOSE
PRINT OUT
FINAL REPORT
END

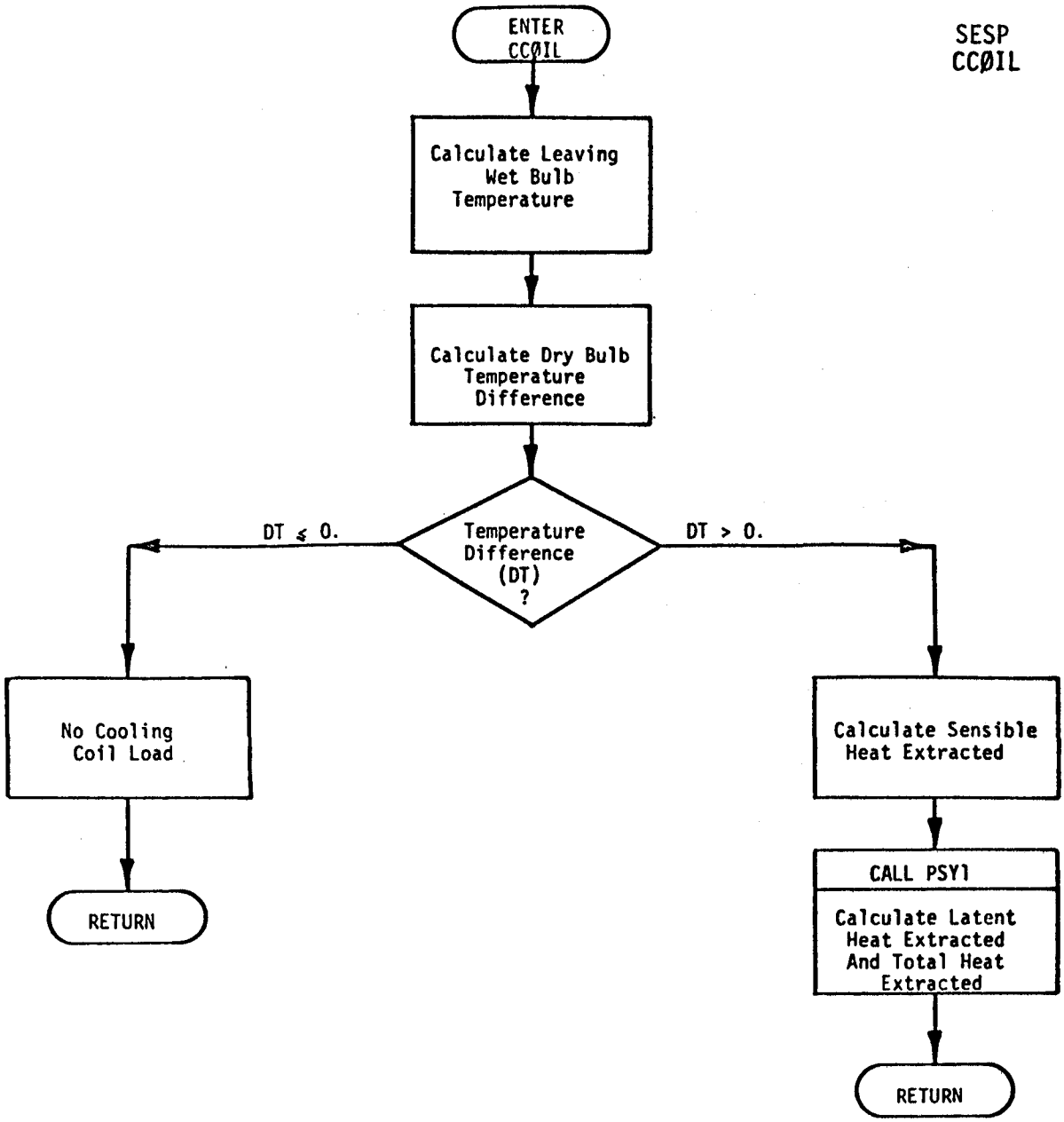

ENTER ABSOR
Determine Capacity Adjustment Factor For Non-Standard Conditions
Determine Capacity Adjustment Factor For Chilled Water At Other Than 10 °F
Calculate Total Capacity Adjustment Factor
Calculate Full Load Steam Rate
Calculate Total Full Load Steam Consumption
Calculate Part Load Factor
Calculate Total Partial Load Steam Consumption For Given Load
RETURN

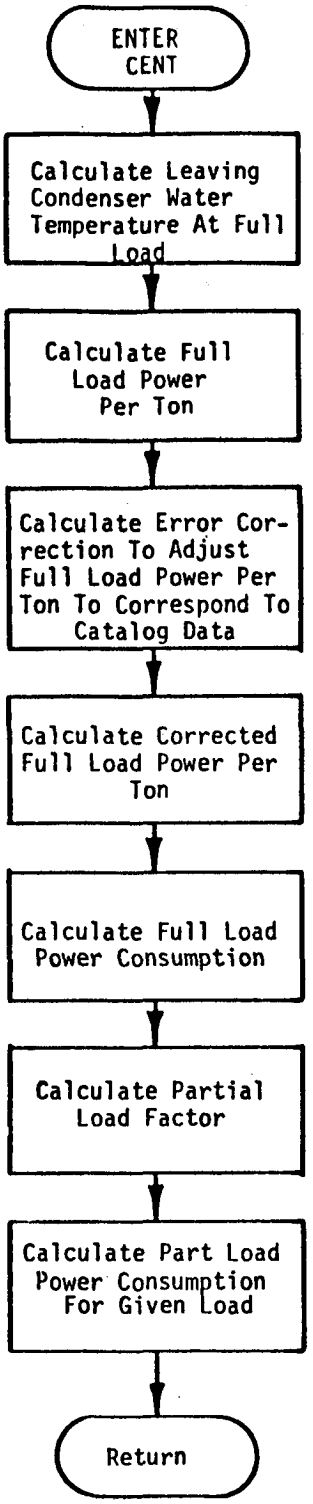

ENTER AHU
m = NAHU
m = 1
AHU type 1
m = 2
AHU type 2
Calculate Required Leaving Coil Air Temperature
Check Mixed AirTemp (TMA) vs Leaving Coil Temp. (TLC)
TMA < TLC
TMA > TLC
TMA=TLC
Calculate Heating Load And Humidity Ratio
No Load Condition
CALL CCØIL
Calculate Cooling Coil Load And Humidity Ratio.
Calculate Required Leaving Coil Air Temperature
Check Mixed AirTemp. (TMA) vs Leaving Coil Temp. (TLC)
TMA < TLC
TMA > TLC
TMA=TLC
Calculate Heating Load And Humidity Ratio
No Load Condition
CALL CCØIL
CALL MXAIR
Calculate Cooling Load And Humidity Ratio
CALL DENSY
Calculate Density Of Air Leaving Fan.
Is There a Cooling Coil Load ?
YES
NO Humidifier Load
RETURN
NO
CALL HUM
Calculate Supply Air Humidity Ratio And Steam Humidifier Water Requirement
RETURN

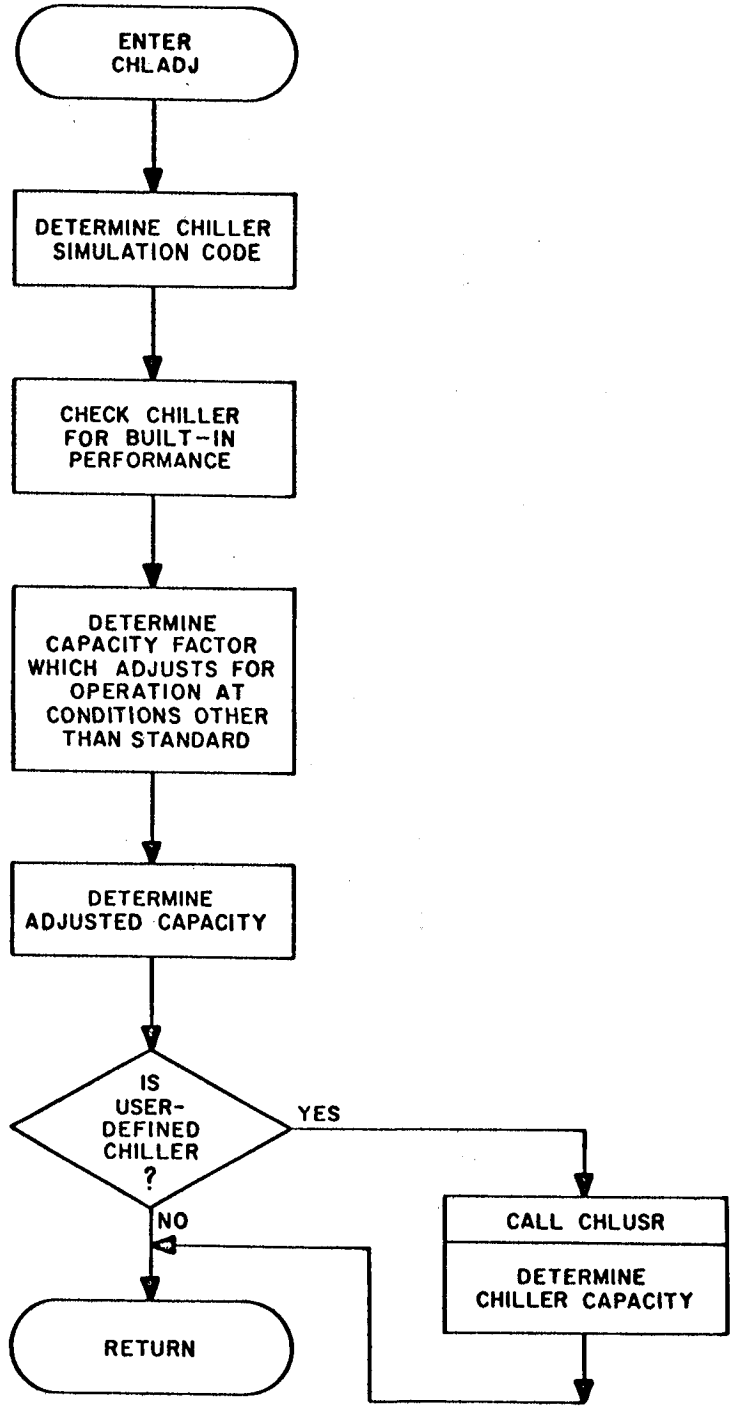

ENTER ALØG
CALCULATE LOGARITHM OF GIVEN NUMBER TO BASE 10.
RETURN

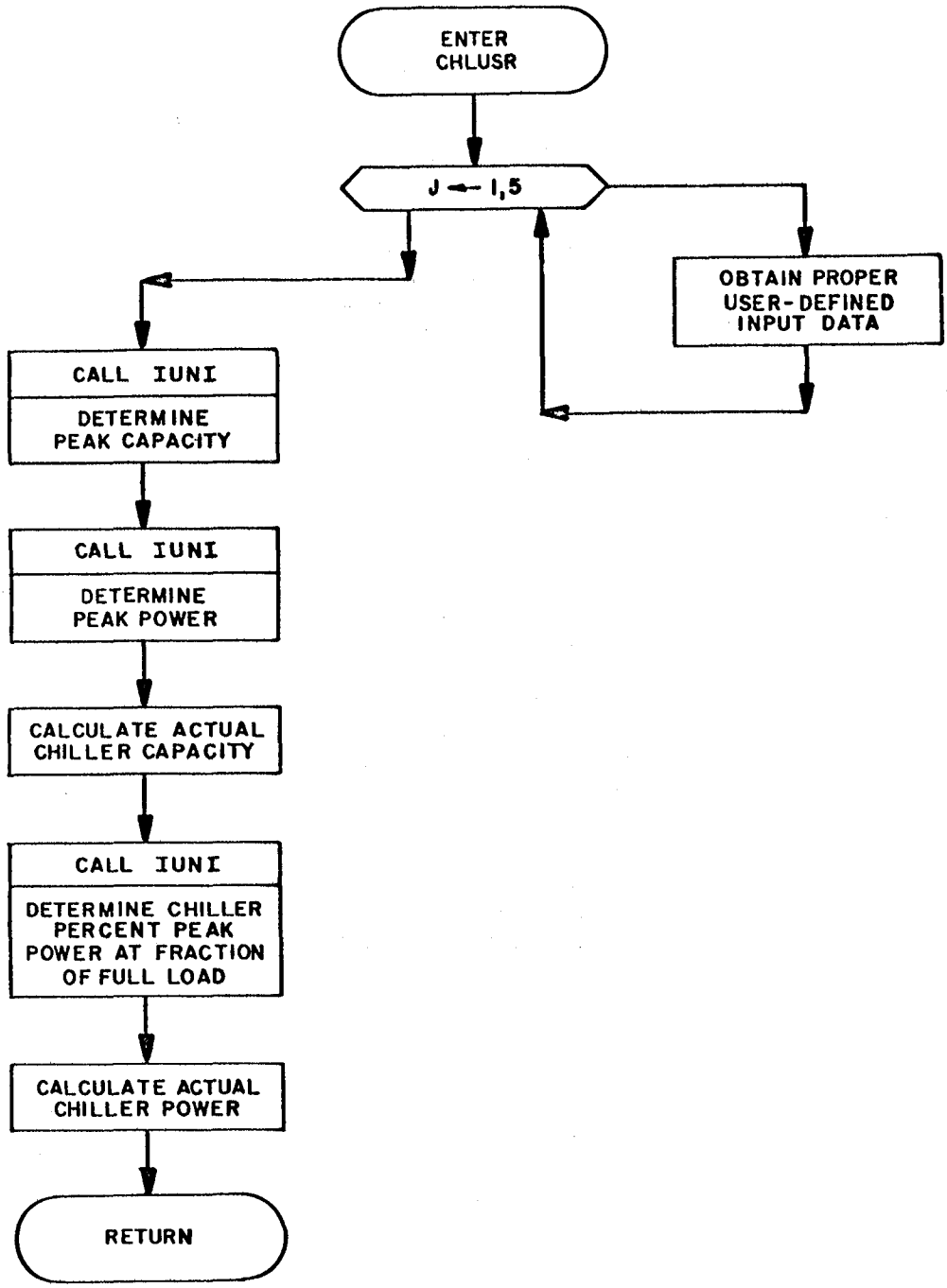
SESP
BRAD

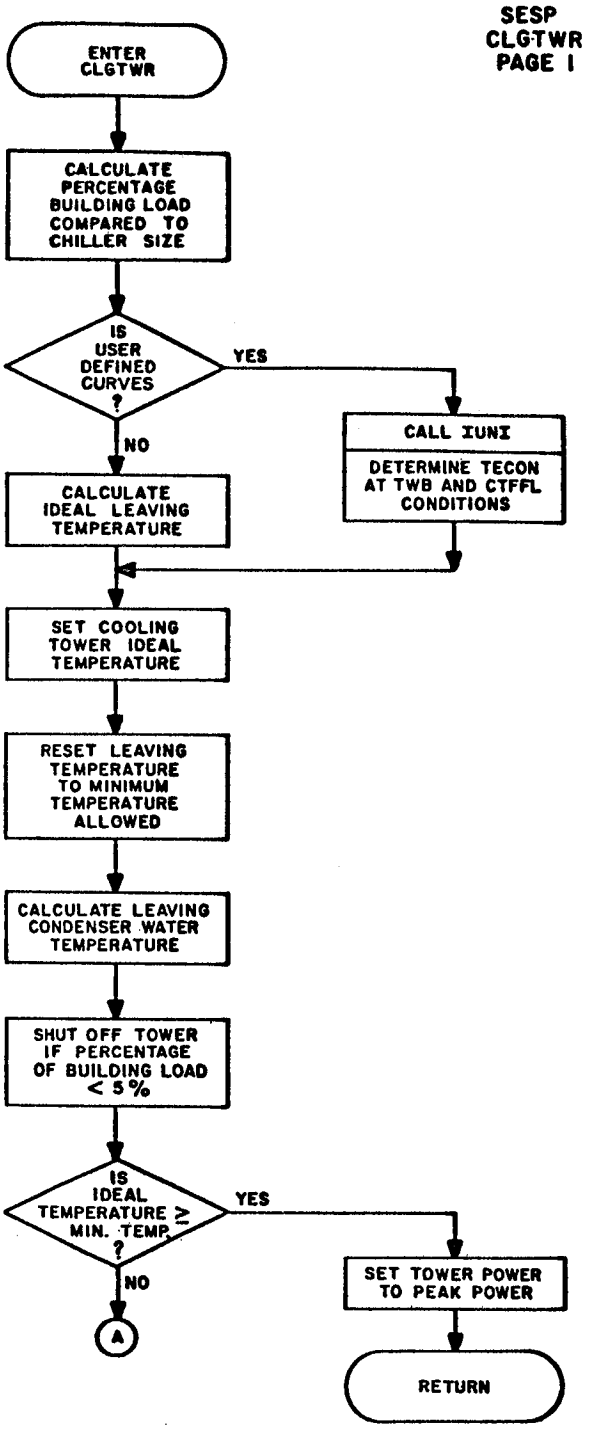

ENTER
BRAD
Is
Ambient temp.
Greater Than Ambient
High Limit ?
YES
Baseboard Heat=0
RETURN
NO
Is
Baseboard
Heating to be
Simulated
?
YES
NO
Calculate entering
Air Temperature.
Call TRSET
Calculate Hot
Water Temperature
Calculate
Baseboard Heat
Adjust Base
Sensible Thermal
Load
RETURN
Baseboard Heat=0
RETURN

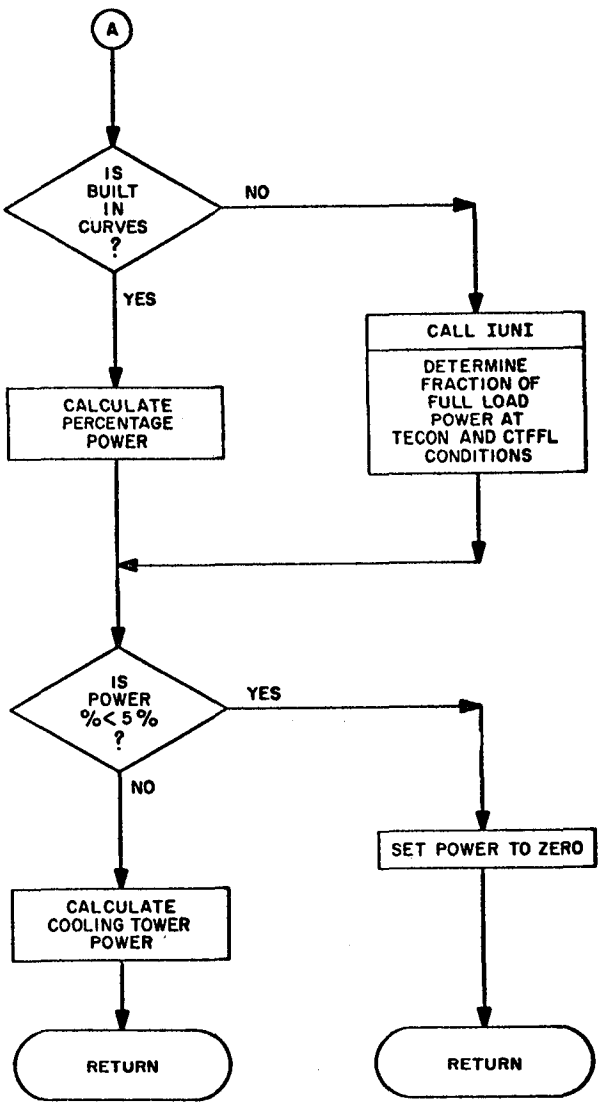

SESP
CCØIL
ENTER
CCØIL
Calculate Leaving
Wet Bulb
Temperature
Calculate Dry Bulb
Temperature
Difference
Temperature
Difference
(DT)
?
DT ≤ 0.
DT > 0.
No Cooling
Coil Load
RETURN
Calculate Sensible
Heat Extracted
CALL PSY1
Calculate Latent
Heat Extracted
And Total Heat
Extracted
RETURN


ENTER
CENT
Calculate Leaving Condenser Water Temperature At Full Load
Calculate Full Load Power Per Ton
Calculate Error Correction To Adjust Full Load Power Per Ton To Correspond To Catalog Data
Calculate Corrected Full Load Power Per Ton
Calculate Full Load Power Consumption
Calculate Partial Load Factor
Calculate Part Load Power Consumption For Given Load
Return

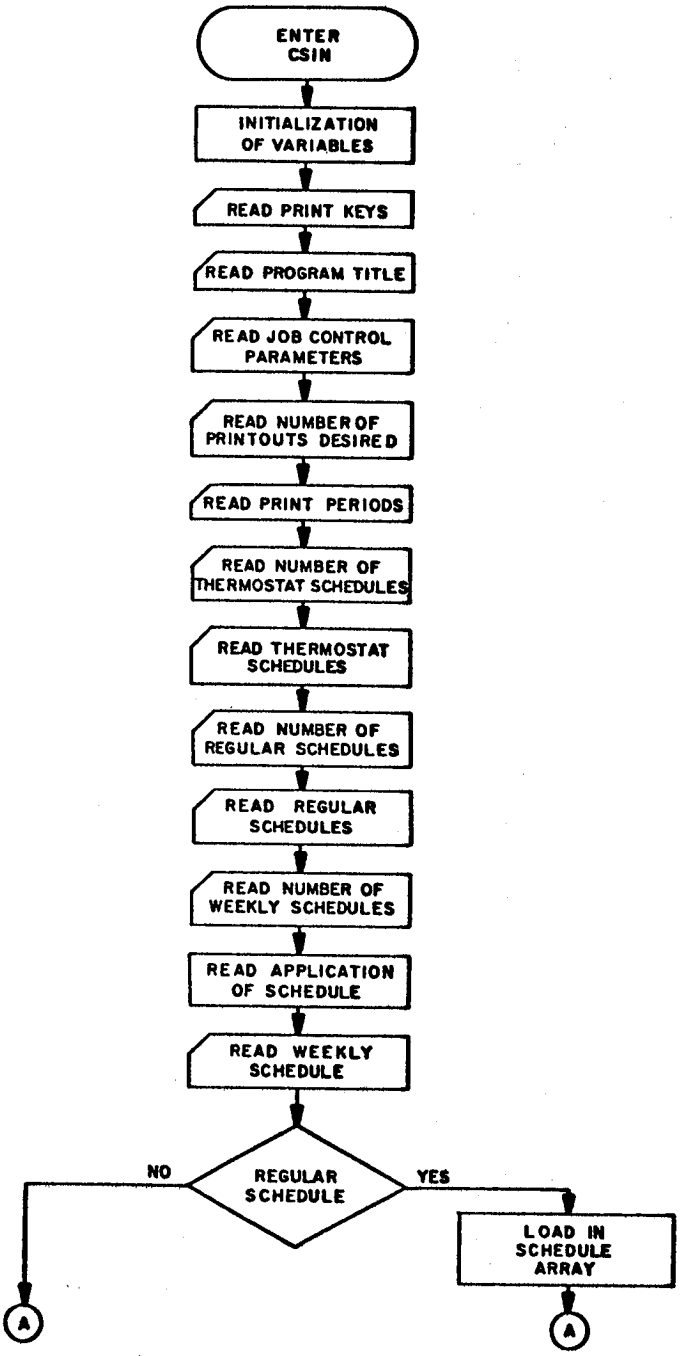

ENTER
CHLADJ
DETERMINE CHILLER SIMULATION CODE
CHECK CHILLER FOR BUILT-IN PERFORMANCE
DETERMINE CAPACITY FACTOR WHICH ADJUSTS FOR OPERATION AT CONDITIONS OTHER THAN STANDARD
DETERMINE ADJUSTED CAPACITY
IS USER-DEFINED CHILLER ?
YES
NO
CALL CHLUSR
DETERMINE CHILLER CAPACITY
RETURN

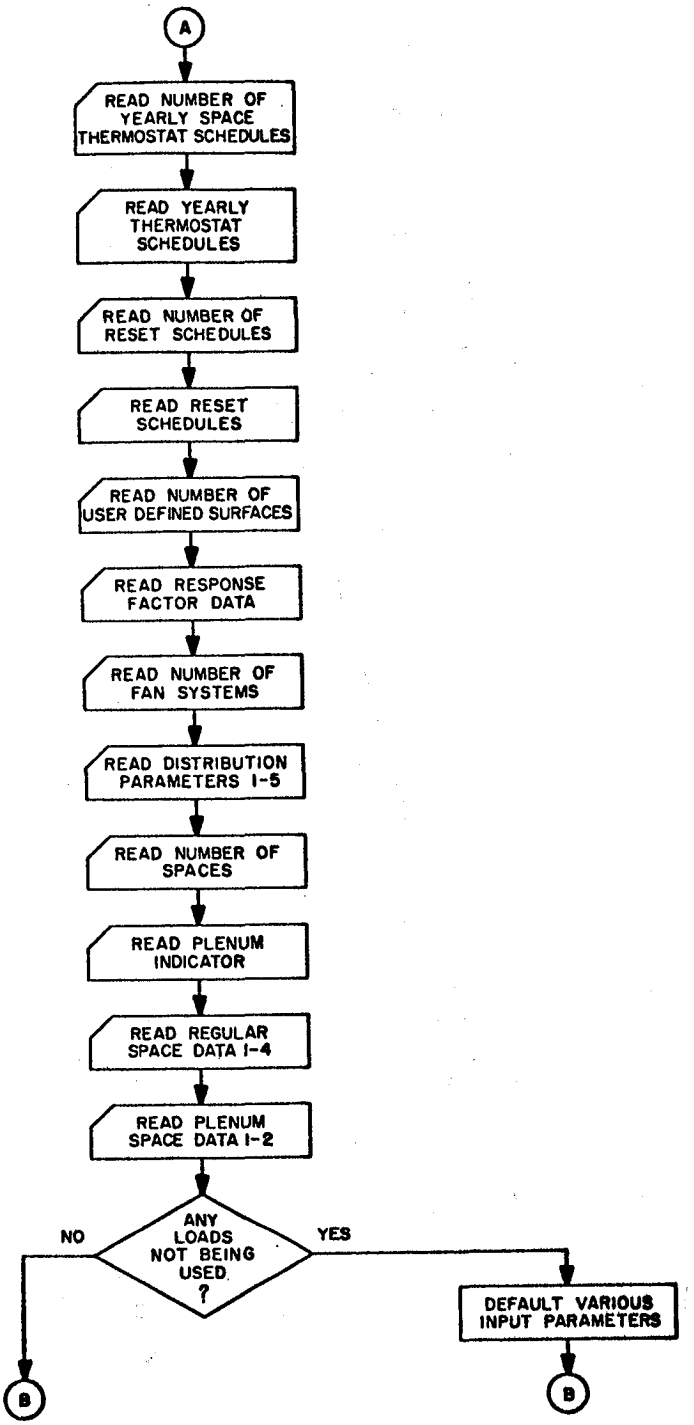

ENTER
CHLUSR
J ← 1,5
OBTAIN PROPER
USER-DEFINED
INPUT DATA
CALL IUNI
DETERMINE
PEAK CAPACITY
CALL IUNI
DETERMINE
PEAK POWER
CALCULATE ACTUAL
CHILLER CAPACITY
CALL IUNI
DETERMINE CHILLER
PERCENT PEAK
POWER AT FRACTION
OF FULL LOAD
CALCULATE ACTUAL
CHILLER POWER
RETURN

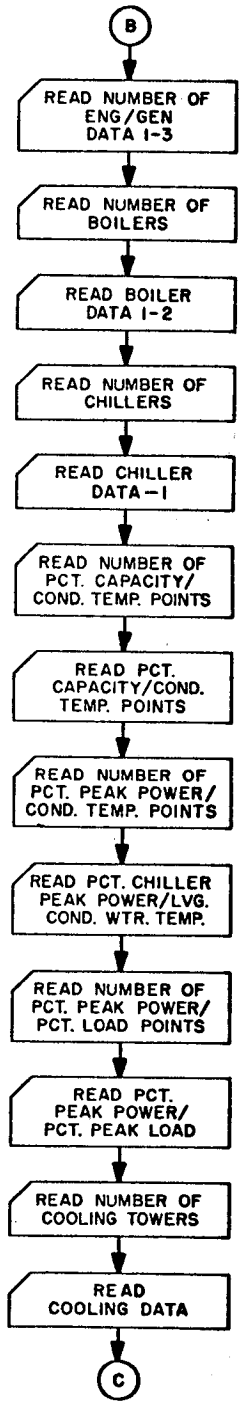

SESP
CLGTWR
PAGE I
ENTER CLGTWR
CALCULATE PERCENTAGE BUILDING LOAD COMPARED TO CHILLER SIZE
IS USER DEFINED CURVES ?
YES
NO
CALL IUNI
DETERMINE TECON AT TWB AND CTFFL CONDITIONS
CALCULATE IDEAL LEAVING TEMPERATURE
SET COOLING TOWER IDEAL TEMPERATURE
RESET LEAVING TEMPERATURE TO MINIMUM TEMPERATURE ALLOWED
CALCULATE LEAVING CONDENSER WATER TEMPERATURE
SHUT OFF TOWER IF PERCENTAGE OF BUILDING LOAD < 5%
IS IDEAL TEMPERATURE ≥ MIN. TEMP. ?
YES
NO
A
SET TOWER POWER TO PEAK POWER
RETURN

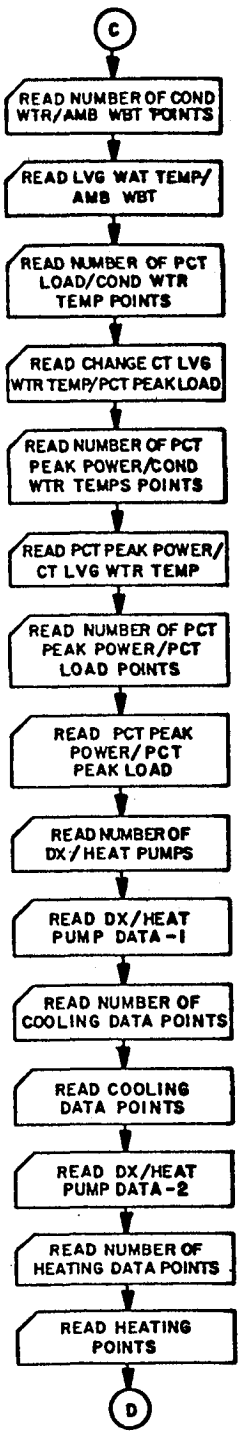

A
IS BUILT IN CURVES ?
NO
YES
CALL IUNI
DETERMINE FRACTION OF FULL LOAD POWER AT TECON AND CTFFL CONDITIONS
CALCULATE PERCENTAGE POWER
IS POWER %< 5% ?
YES
NO
SET POWER TO ZERO
CALCULATE COOLING TOWER POWER
RETURN
RETURN

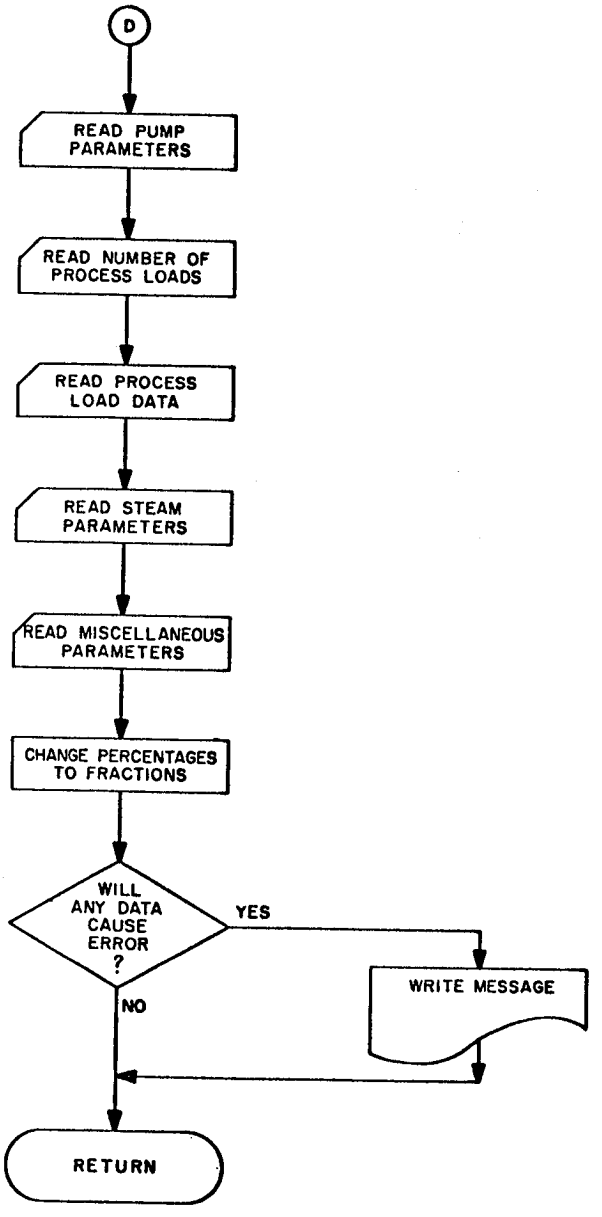
SESP
CSIN
PAGE I

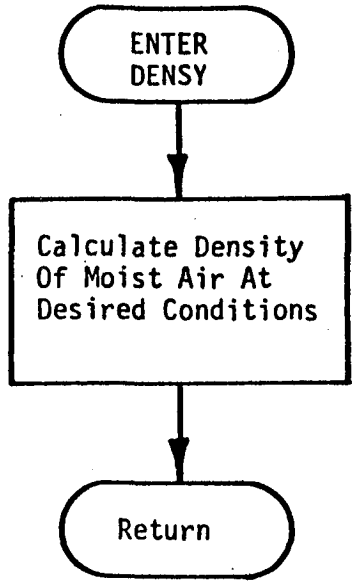


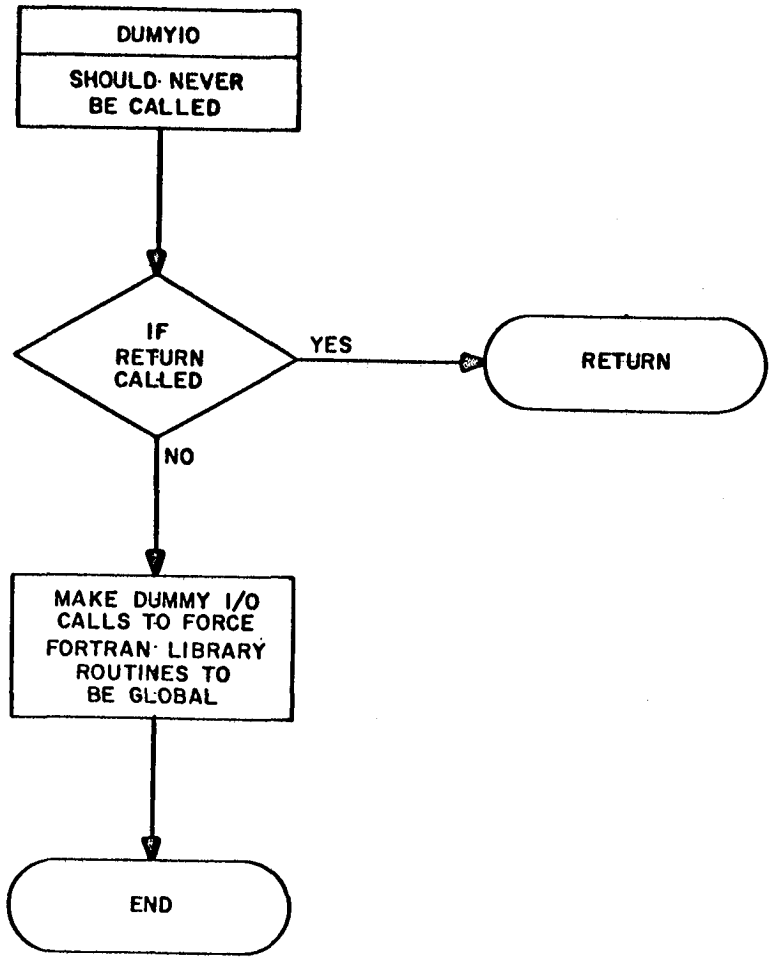

A
READ NUMBER OF YEARLY SPACE THERMOSTAT SCHEDULES
READ YEARLY THERMOSTAT SCHEDULES
READ NUMBER OF RESET SCHEDULES
READ RESET SCHEDULES
READ NUMBER OF USER DEFINED SURFACES
READ RESPONSE FACTOR DATA
READ NUMBER OF FAN SYSTEMS
READ DISTRIBUTION PARAMETERS 1-5
READ NUMBER OF SPACES
READ PLENUM INDICATOR
READ REGULAR SPACE DATA 1-4
READ PLENUM SPACE DATA 1-2
ANY LOADS NOT BEING USED ?
NO
YES
DEFAULT VARIOUS INPUT PARAMETERS
B
B


B
READ NUMBER OF ENG/GEN DATA 1-3
READ NUMBER OF BOILERS
READ BOILER DATA 1-2
READ NUMBER OF CHILLERS
READ CHILLER DATA-1
READ NUMBER OF PCT. CAPACITY/ COND. TEMP. POINTS
READ PCT. CAPACITY/COND. TEMP. POINTS
READ NUMBER OF PCT. PEAK POWER/ COND. TEMP. POINTS
READ PCT. CHILLER PEAK POWER/LVG. COND. WTR. TEMP.
READ NUMBER OF PCT. PEAK POWER/ PCT. LOAD POINTS
READ PCT. PEAK POWER/ PCT. PEAK LOAD
READ NUMBER OF COOLING TOWERS
READ COOLING DATA
C

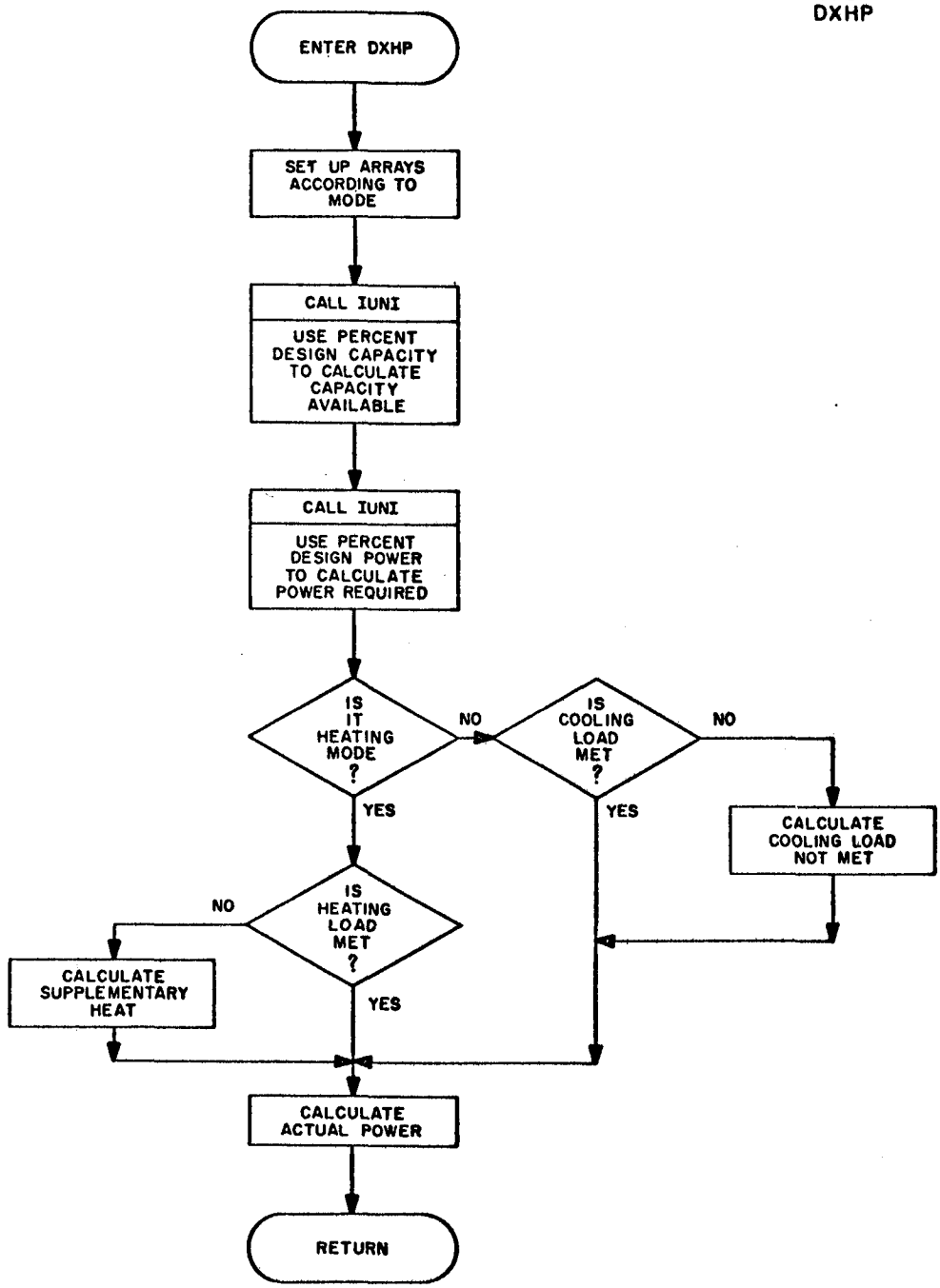

C
READ NUMBER OF COND WTR/AMB WBT POINTS
READ LVG WAT TEMP/ AMB WBT
READ NUMBER OF PCT LOAD/COND WTR TEMP POINTS
READ CHANGE CT LVG WTR TEMP/PCT PEAK LOAD
READ NUMBER OF PCT PEAK POWER/COND WTR TEMPS POINTS
READ PCT PEAK POWER/ CT LVG WTR TEMP
READ NUMBER OF PCT PEAK POWER/PCT LOAD POINTS
READ PCT PEAK POWER/PCT PEAK LOAD
READ NUMBER OF DX/HEAT PUMPS
READ DX/HEAT PUMP DATA-1
READ NUMBER OF COOLING DATA POINTS
READ COOLING DATA POINTS
READ DX/HEAT PUMP DATA-2
READ NUMBER OF HEATING DATA POINTS
READ HEATING POINTS
D

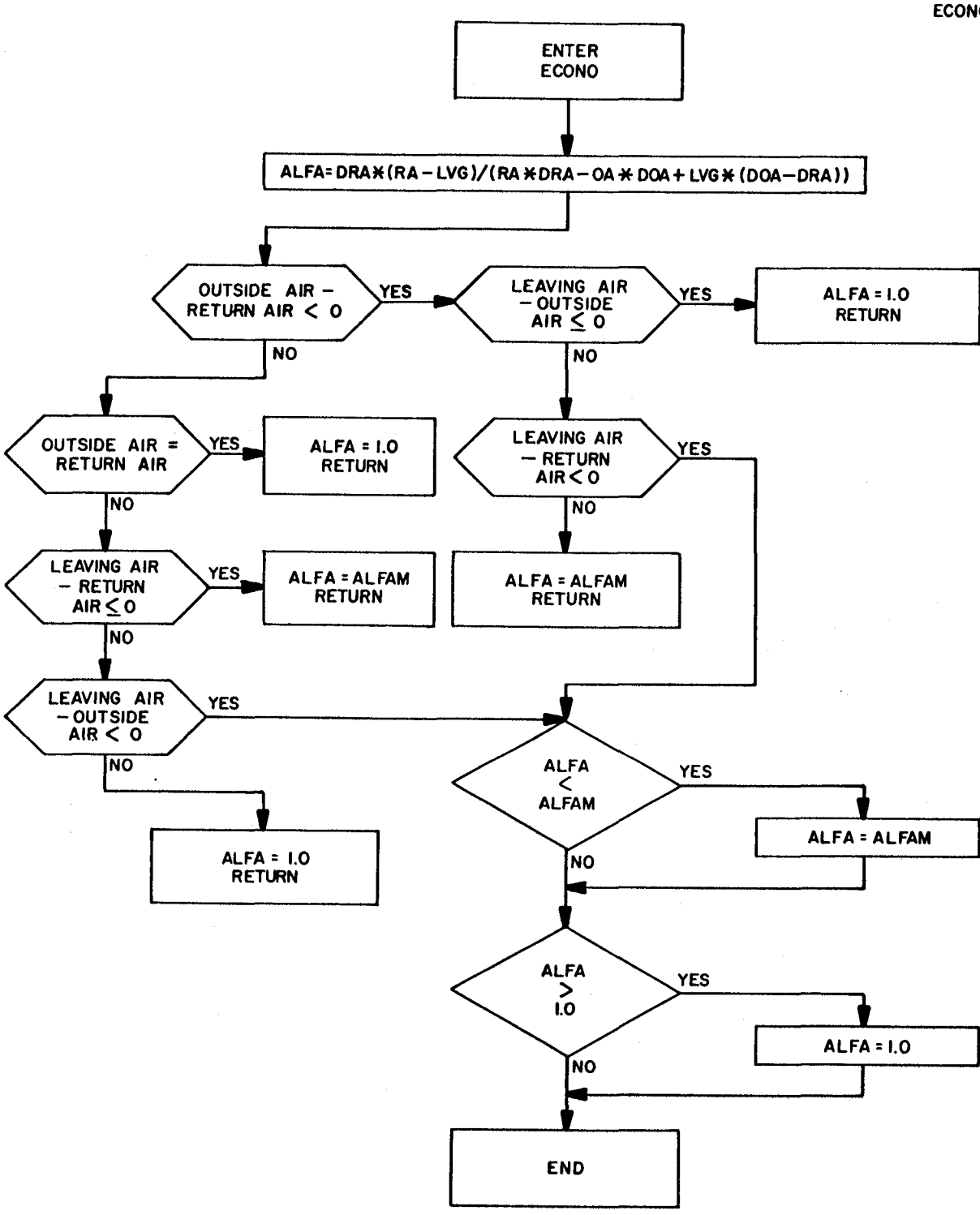

D
READ PUMP PARAMETERS
READ NUMBER OF PROCESS LOADS
READ PROCESS LOAD DATA
READ STEAM PARAMETERS
READ MISCELLANEOUS PARAMETERS
CHANGE PERCENTAGES TO FRACTIONS
WILL ANY DATA CAUSE ERROR ?
YES
NO
WRITE MESSAGE
RETURN

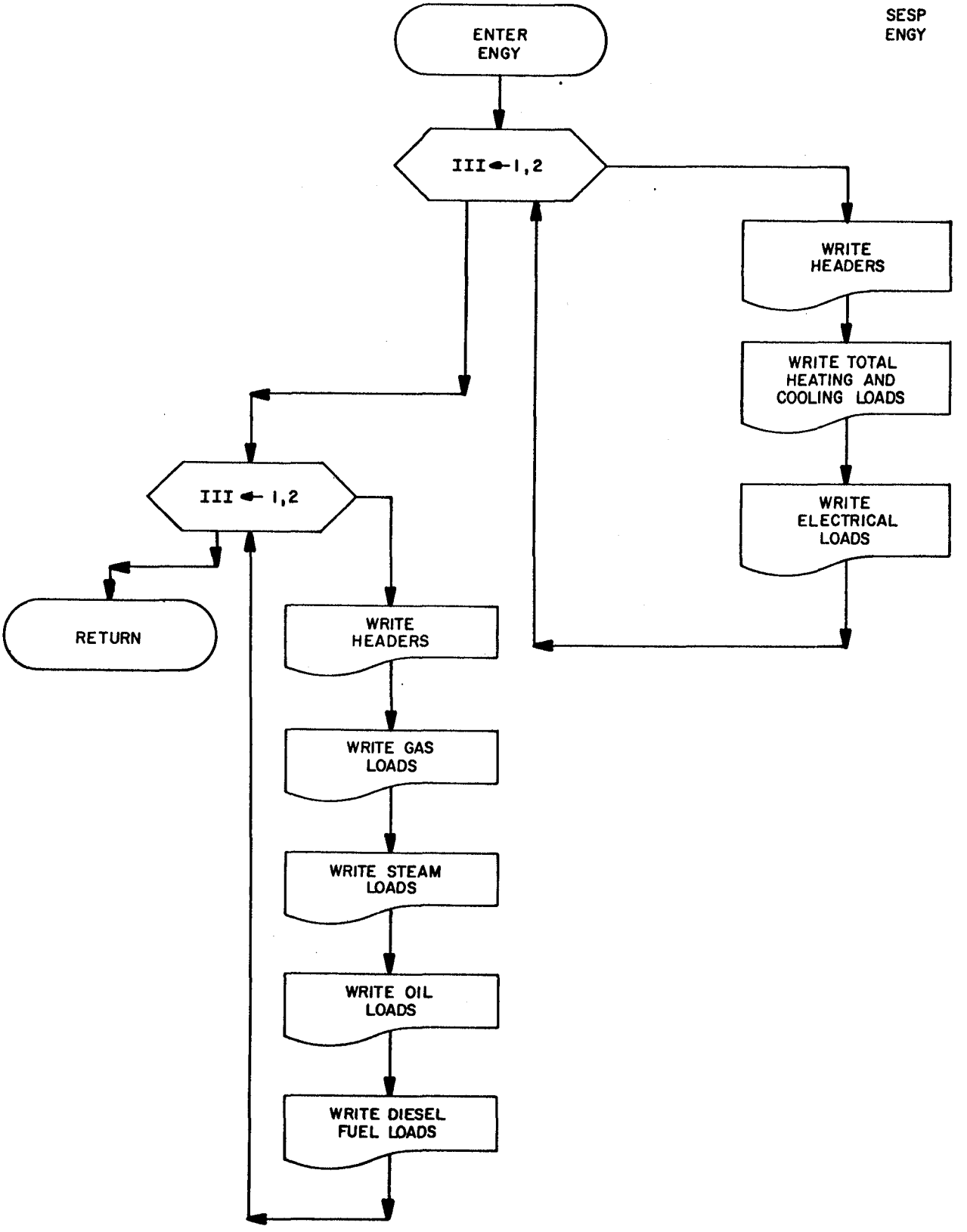

ENTER
DENSY
Calculate Density
Of Moist Air At
Desired Conditions
Return


DUMYIO
SHOULD NEVER BE CALLED
IF RETURN CALLED
YES
RETURN
NO
MAKE DUMMY I/O CALLS TO FORCE FORTRAN LIBRARY ROUTINES TO BE GLOBAL
END

SESP
DXHP

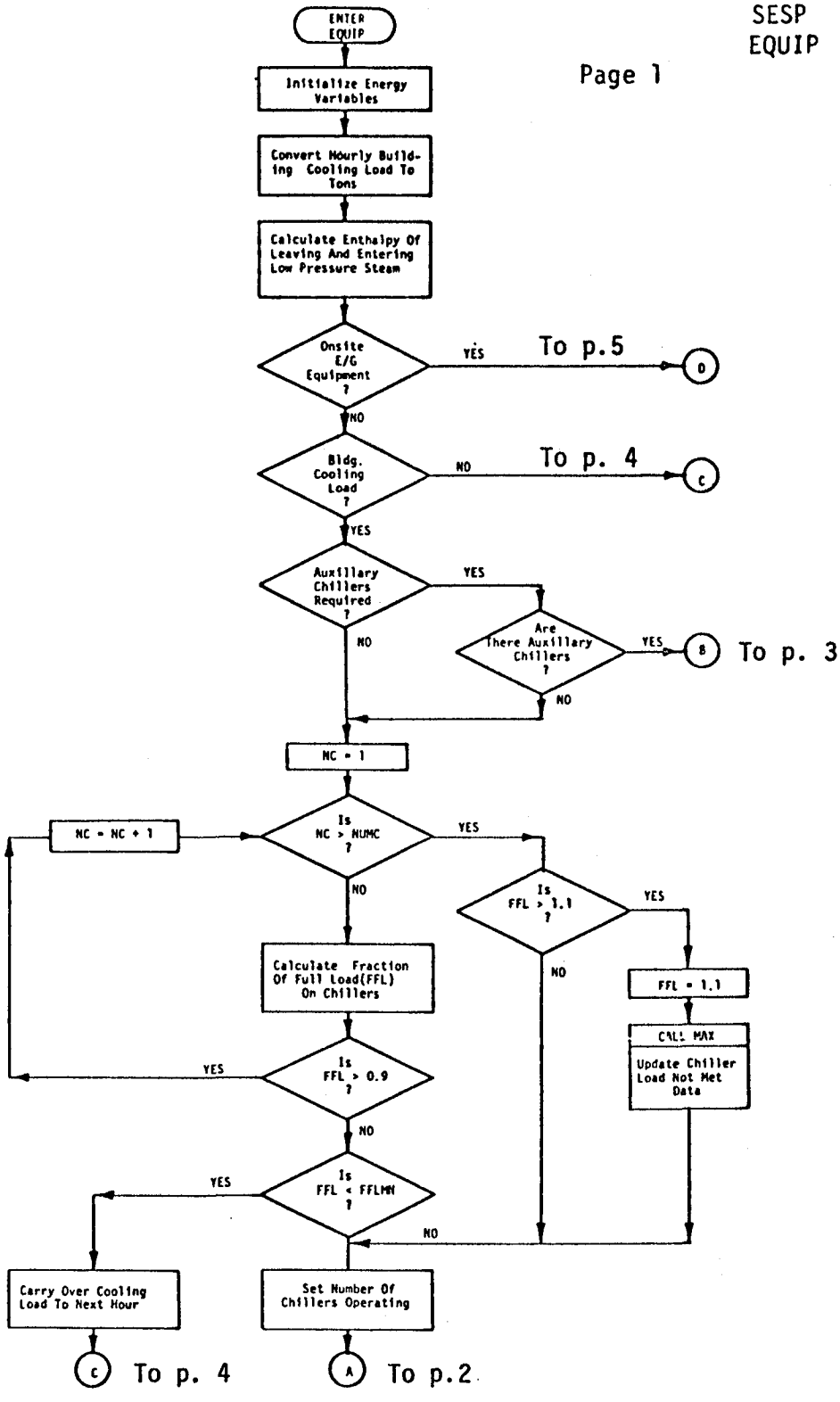

ENTER DXHP
SET UP ARRAYS ACCORDING TO MODE
CALL IUNI
USE PERCENT DESIGN CAPACITY TO CALCULATE CAPACITY AVAILABLE
CALL IUNI
USE PERCENT DESIGN POWER TO CALCULATE POWER REQUIRED
IS IT HEATING MODE ?
NO
IS COOLING LOAD MET ?
NO
YES
YES
CALCULATE COOLING LOAD NOT MET
IS HEATING LOAD MET ?
NO
CALCULATE SUPPLEMENTARY HEAT
YES
CALCULATE ACTUAL POWER
RETURN


ENTER
ECONO
ALFA=DRA*(RA-LVG)/(RA*DRA-OA*DOA+LVG*(DOA-DRA))
OUTSIDE AIR - RETURN AIR < 0
YES
LEAVING AIR - OUTSIDE AIR ≤ 0
YES
ALFA = 1.0 RETURN
NO
NO
OUTSIDE AIR = RETURN AIR
YES
ALFA = 1.0 RETURN
LEAVING AIR - RETURN AIR < 0
YES
NO
NO
LEAVING AIR - RETURN AIR ≤ 0
YES
ALFA = ALFAM RETURN
ALFA = ALFAM RETURN
NO
LEAVING AIR - OUTSIDE AIR < 0
YES
NO
ALFA < ALFAM
YES
ALFA = ALFAM
ALFA = 1.0 RETURN
NO
ALFA > 1.0
YES
ALFA = 1.0
NO
END

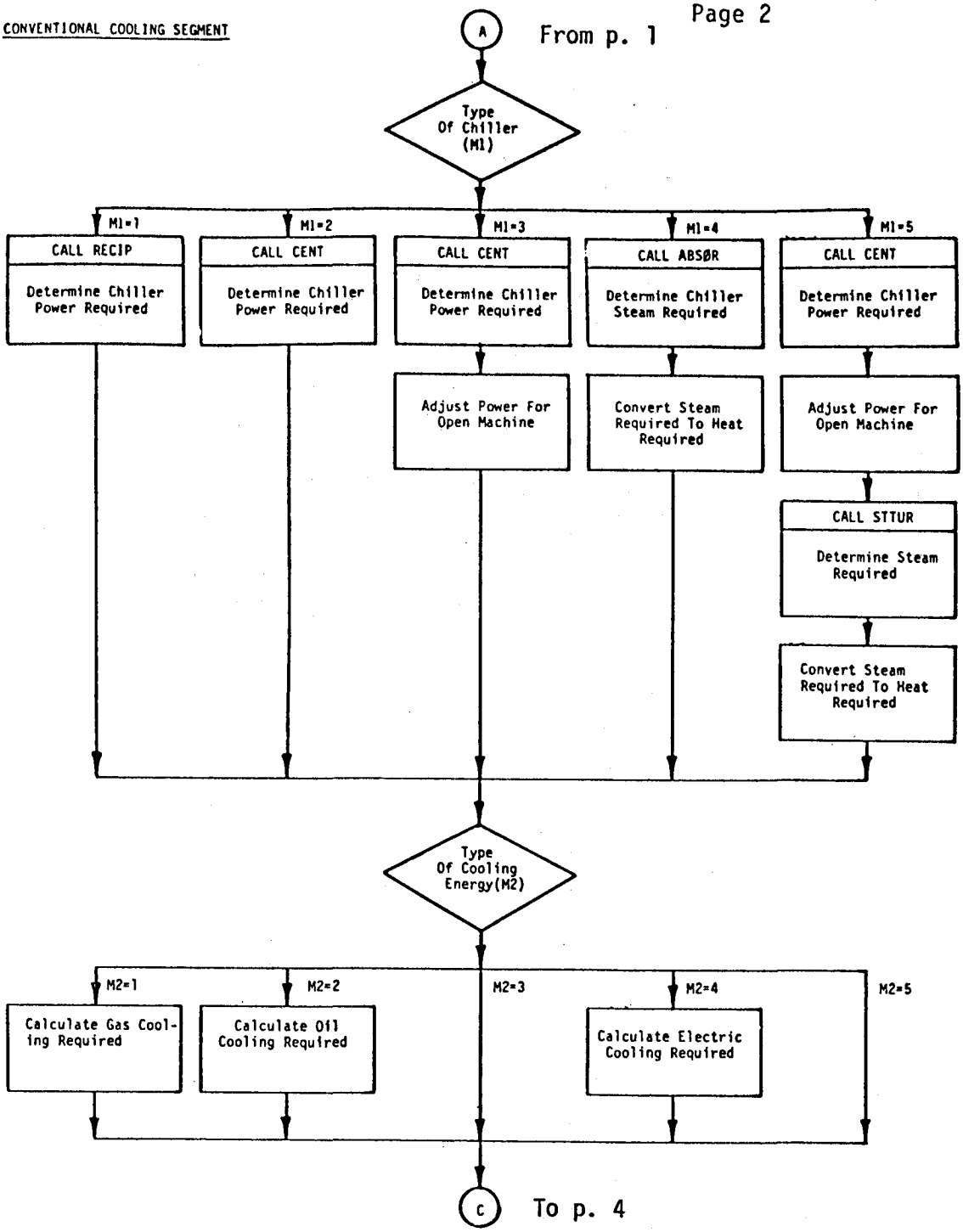

SESP
ENGY
ENTER
ENGY
III ← 1,2
WRITE
HEADERS
WRITE TOTAL
HEATING AND
COOLING LOADS
WRITE
ELECTRICAL
LOADS
III ← 1,2
RETURN
WRITE
HEADERS
WRITE GAS
LOADS
WRITE STEAM
LOADS
WRITE OIL
LOADS
WRITE DIESEL
FUEL LOADS

SESP
EQUIP

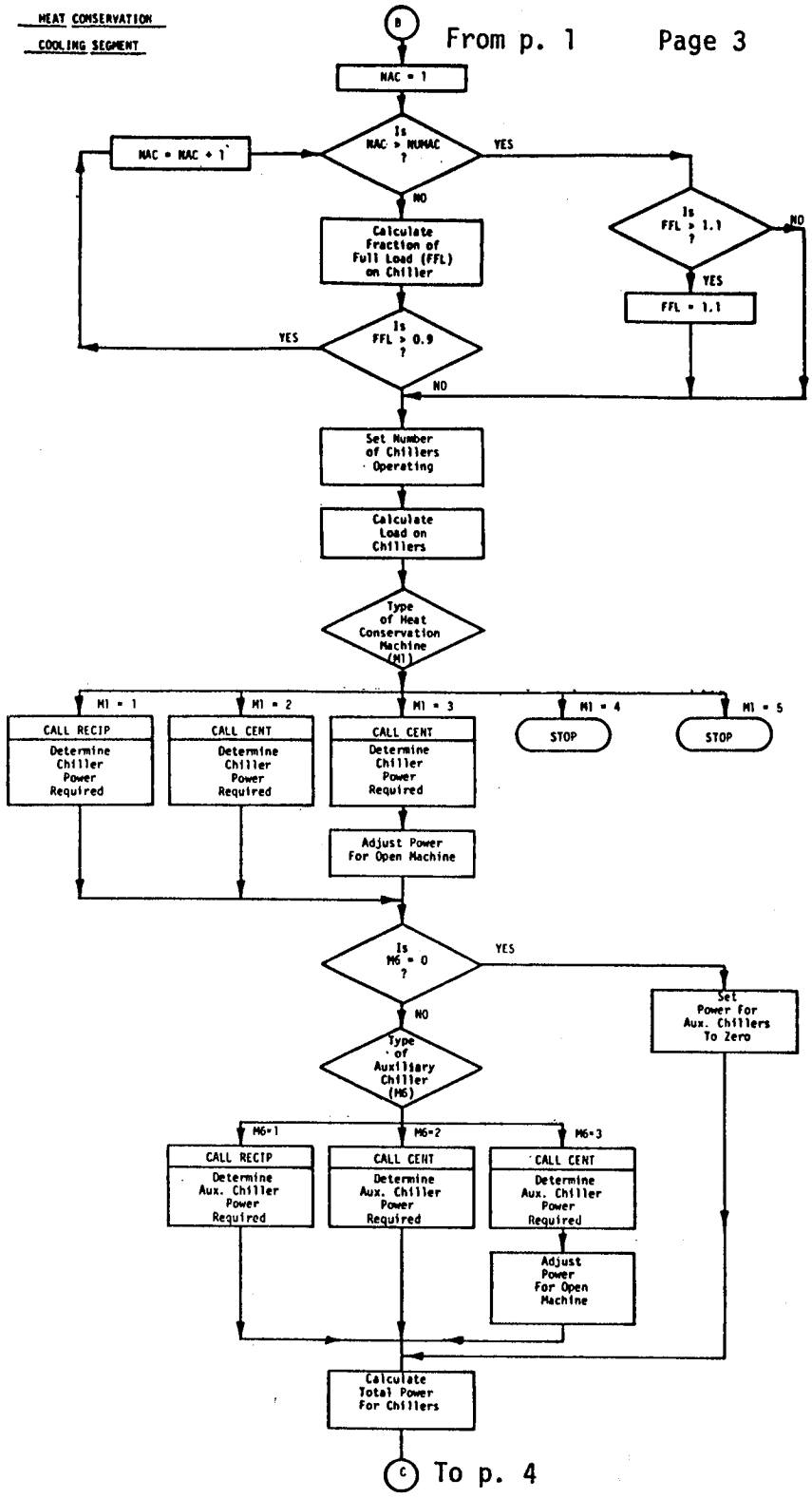
Page 1



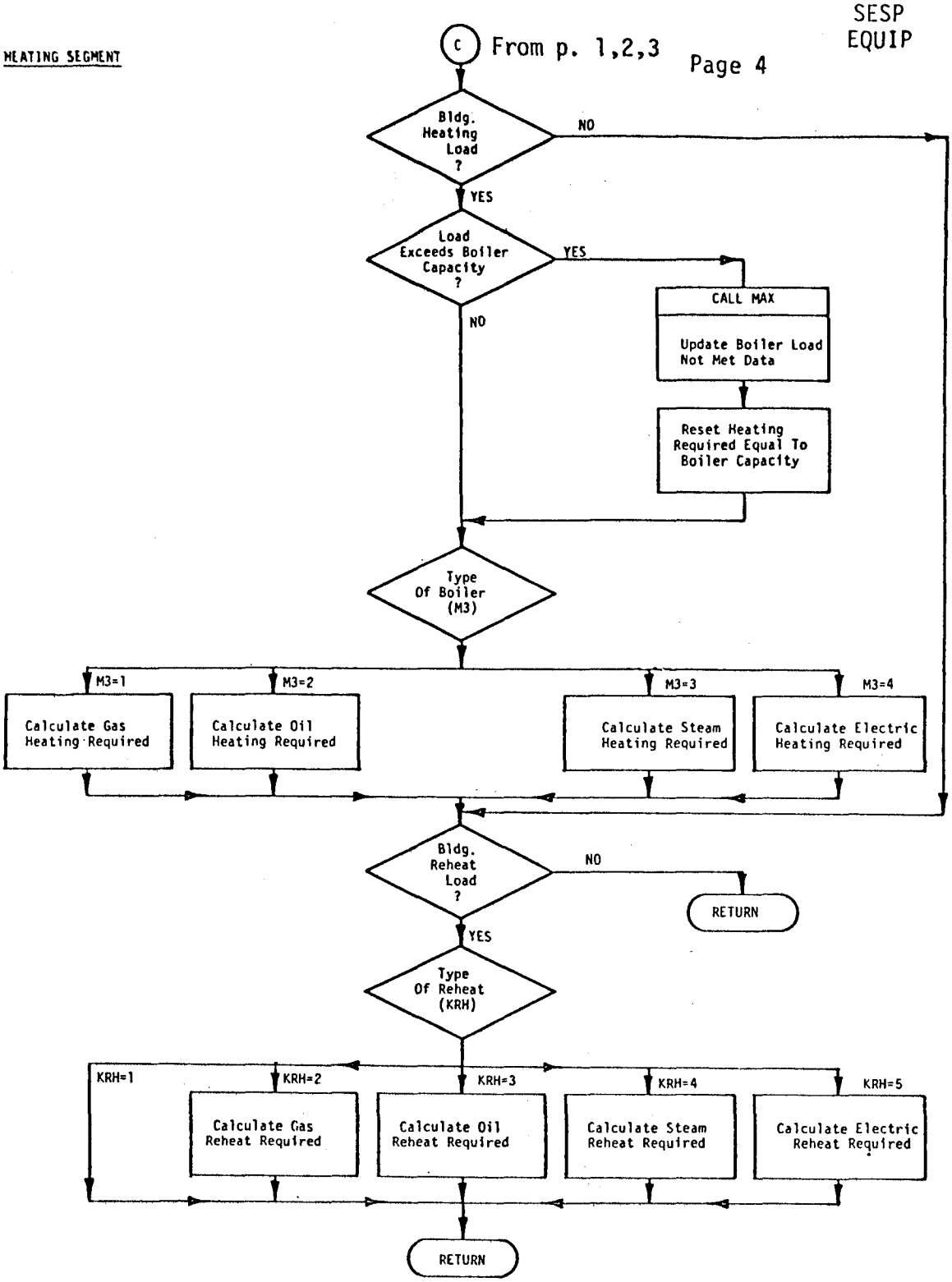
CONVENTIONAL COOLING SEGMENT



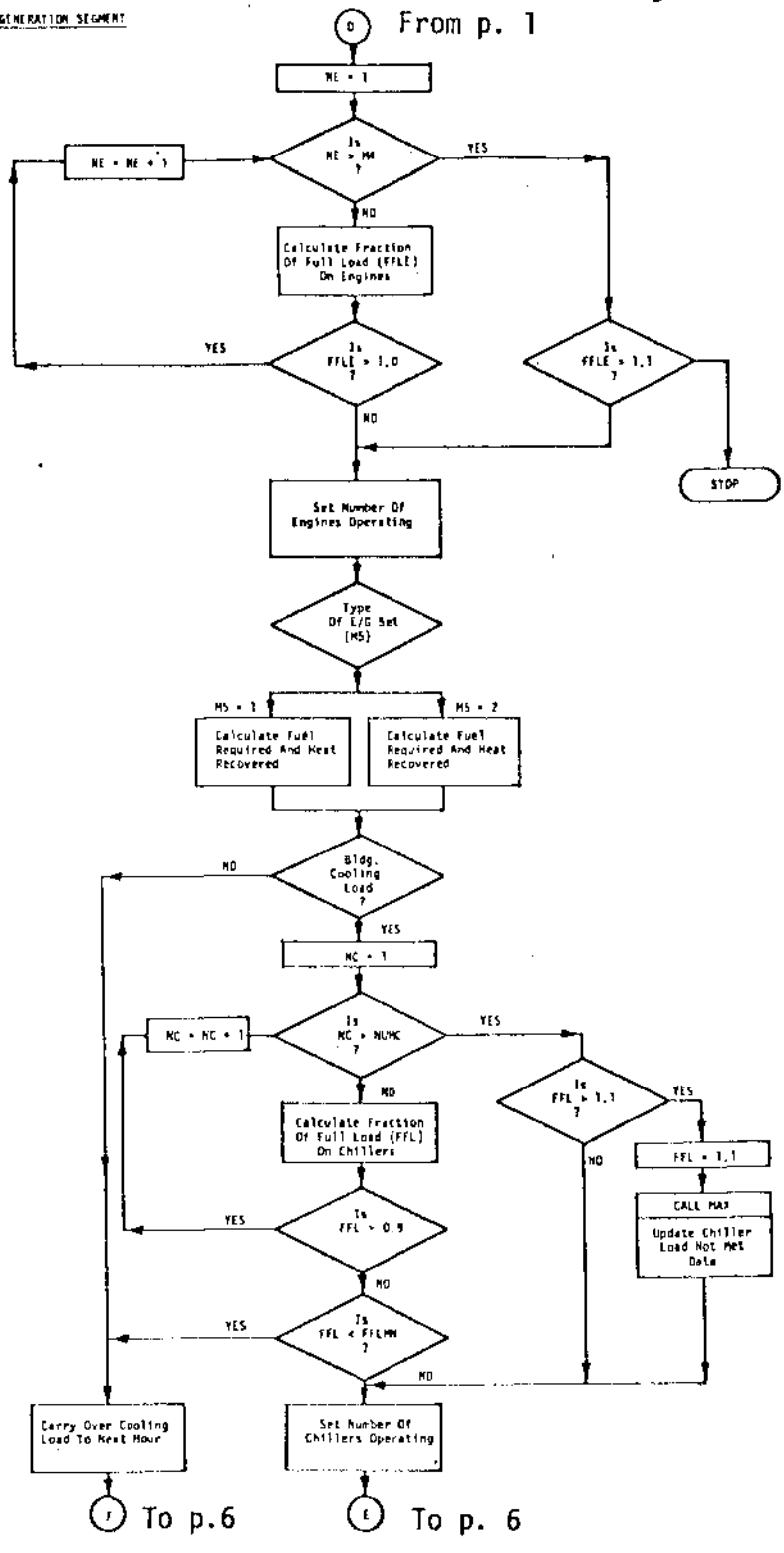
HEAT CONSERVATION
COOLING SEGMENT

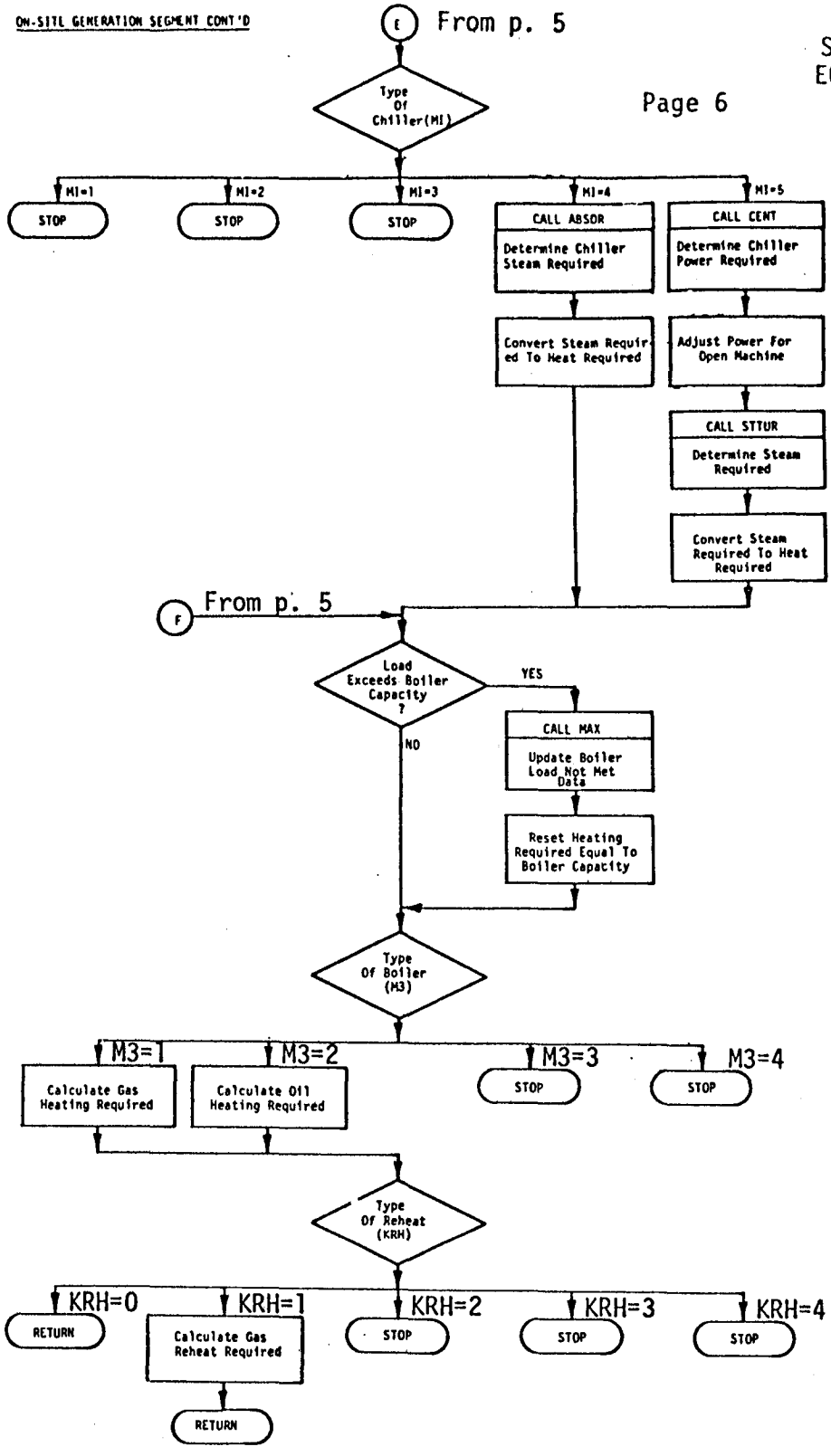


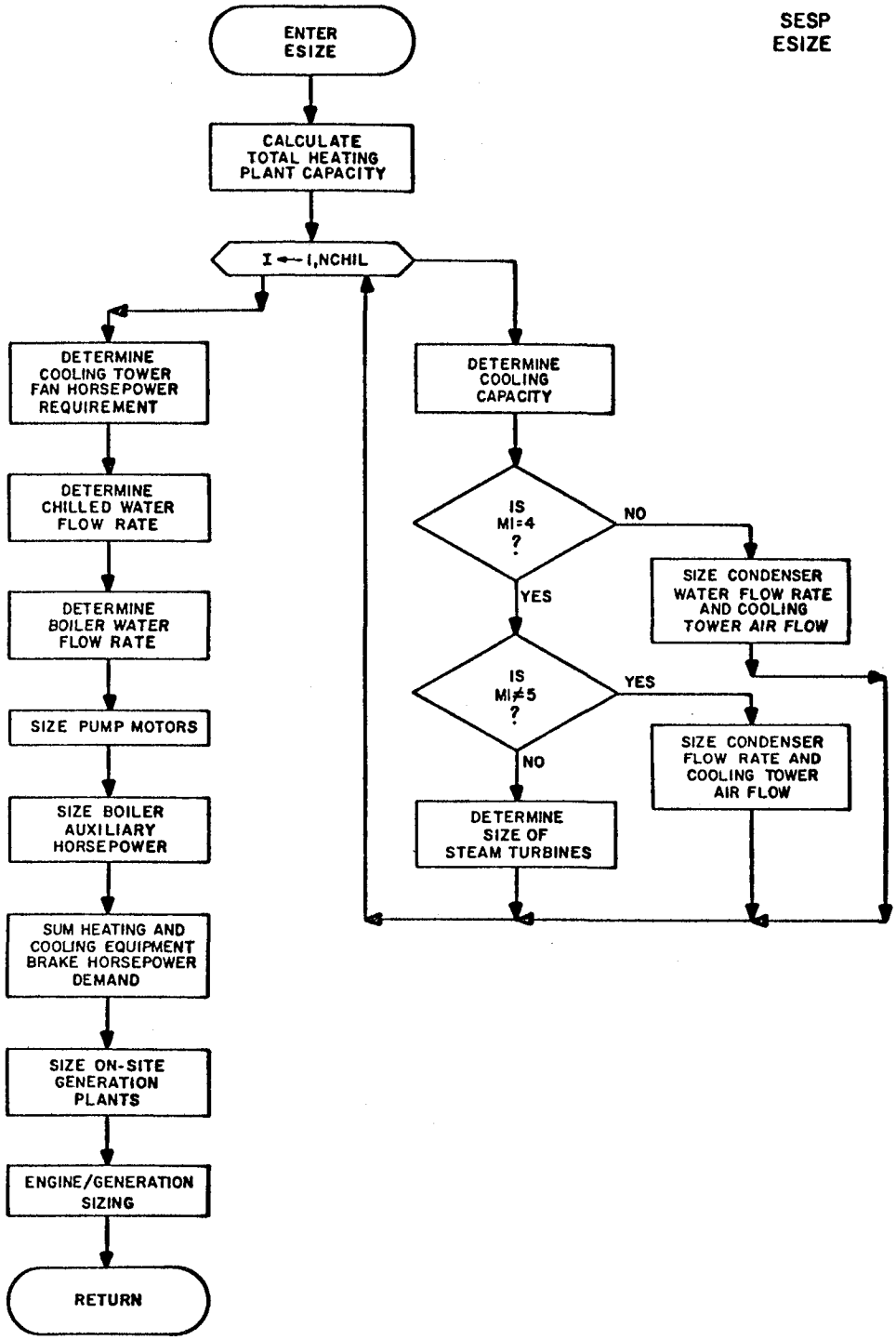
HEATING SEGMENT

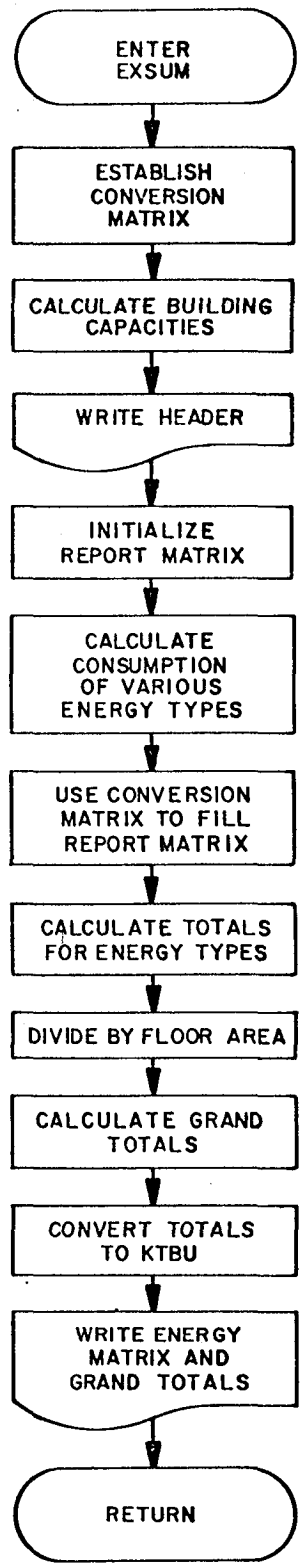


ON-SITE GENERATION SEGMENT

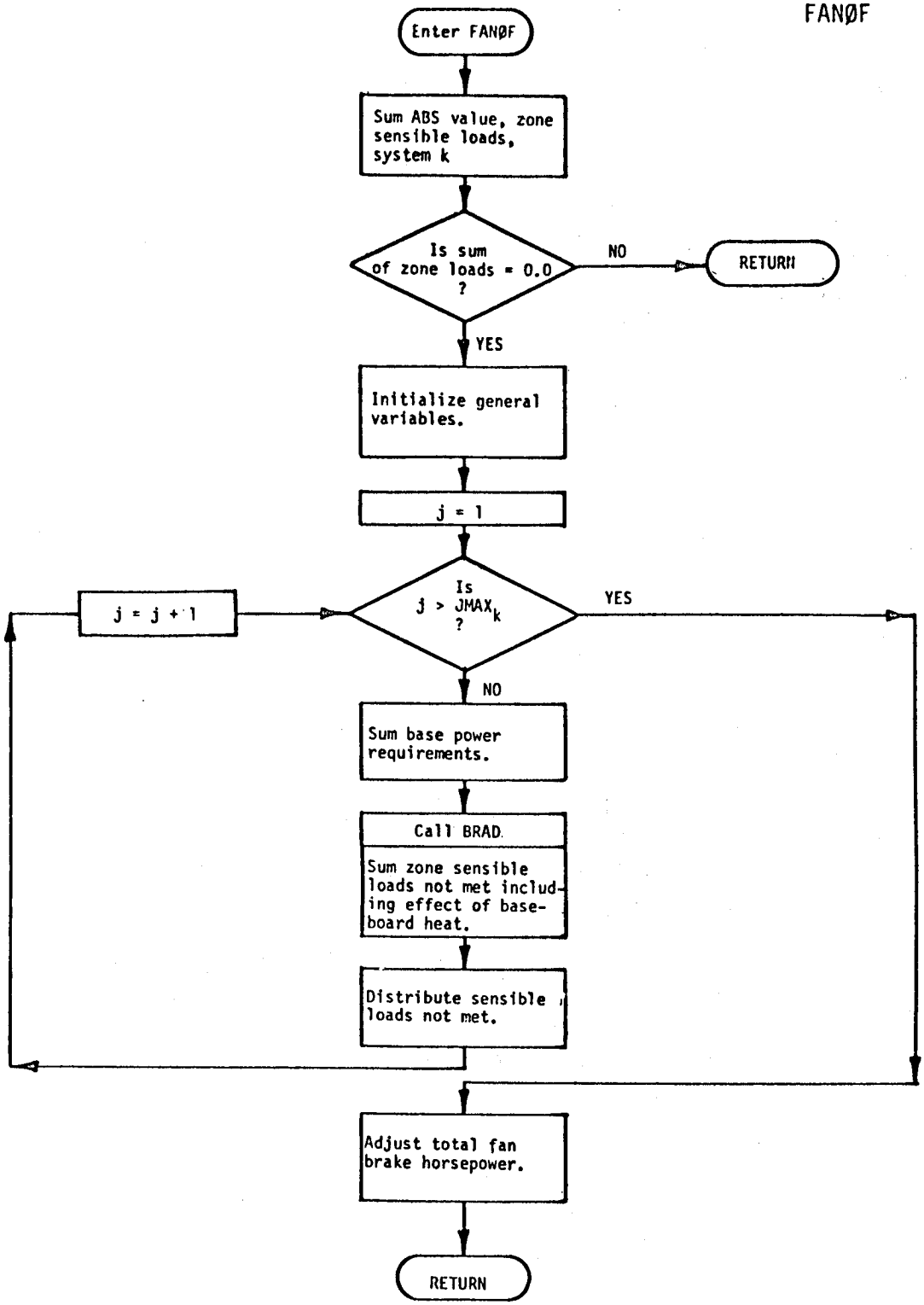


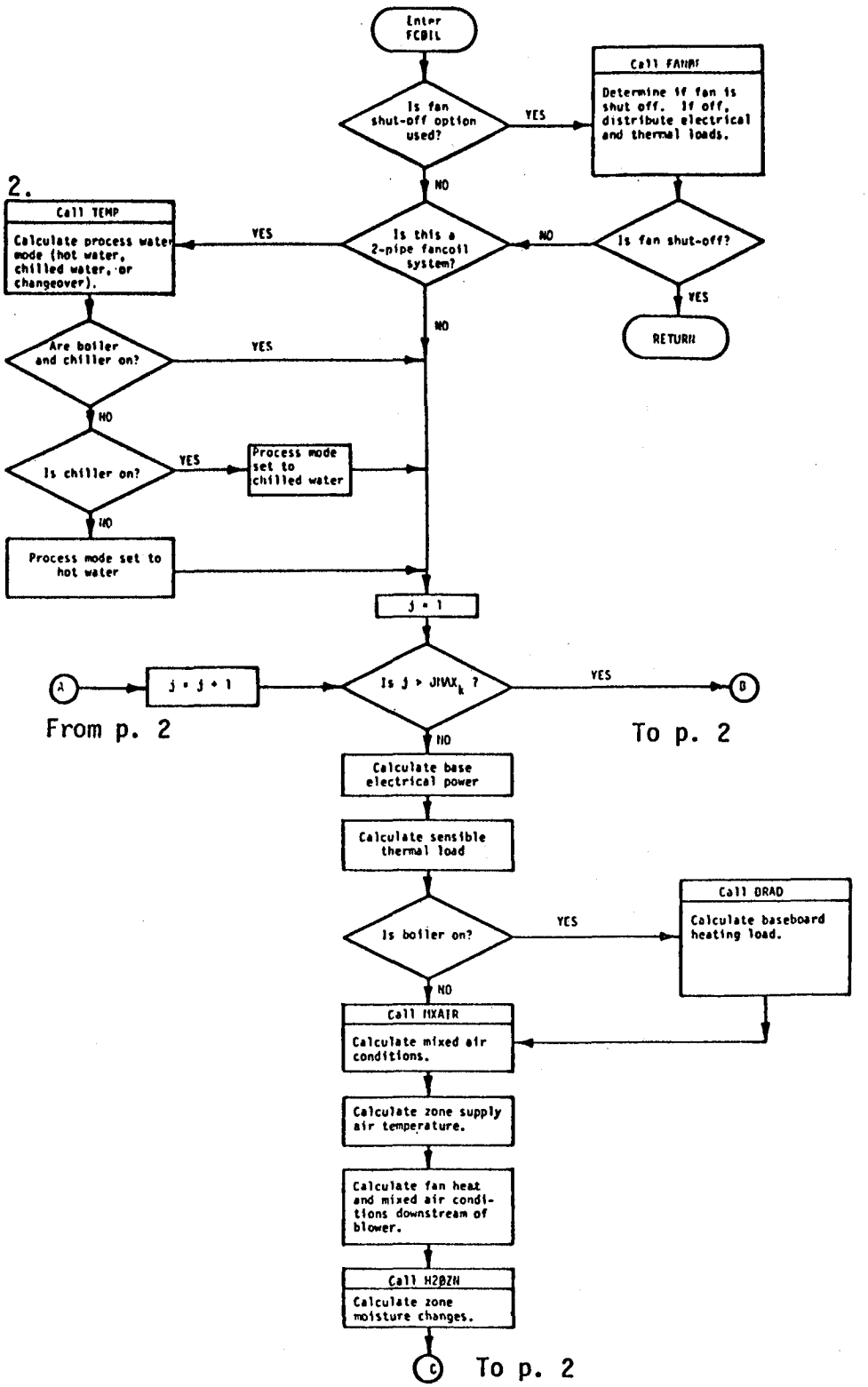

E
From p. 5
Type Of Chiller(MI)
MI=1
STOP
MI=2
STOP
MI=3
STOP
MI=4
CALL ABSOR
Determine Chiller Steam Required
Convert Steam Required To Heat Required
MI=5
CALL CENT
Determine Chiller Power Required
Adjust Power For Open Machine
CALL STTUR
Determine Steam Required
Convert Steam Required To Heat Required
F
From p. 5
Load Exceeds Boiler Capacity ?
YES
CALL MAX
Update Boiler Load Not Met Data
Reset Heating Required Equal To Boiler Capacity
NO
Type Of Boiler (M3)
M3=1
Calculate Gas Heating Required
M3=2
Calculate Oil Heating Required
M3=3
STOP
M3=4
STOP
Type Of Reheat (KRH)
KRH=0
RETURN
KRH=1
Calculate Gas Reheat Required
RETURN
KRH=2
STOP
KRH=3
STOP
KRH=4
STOP

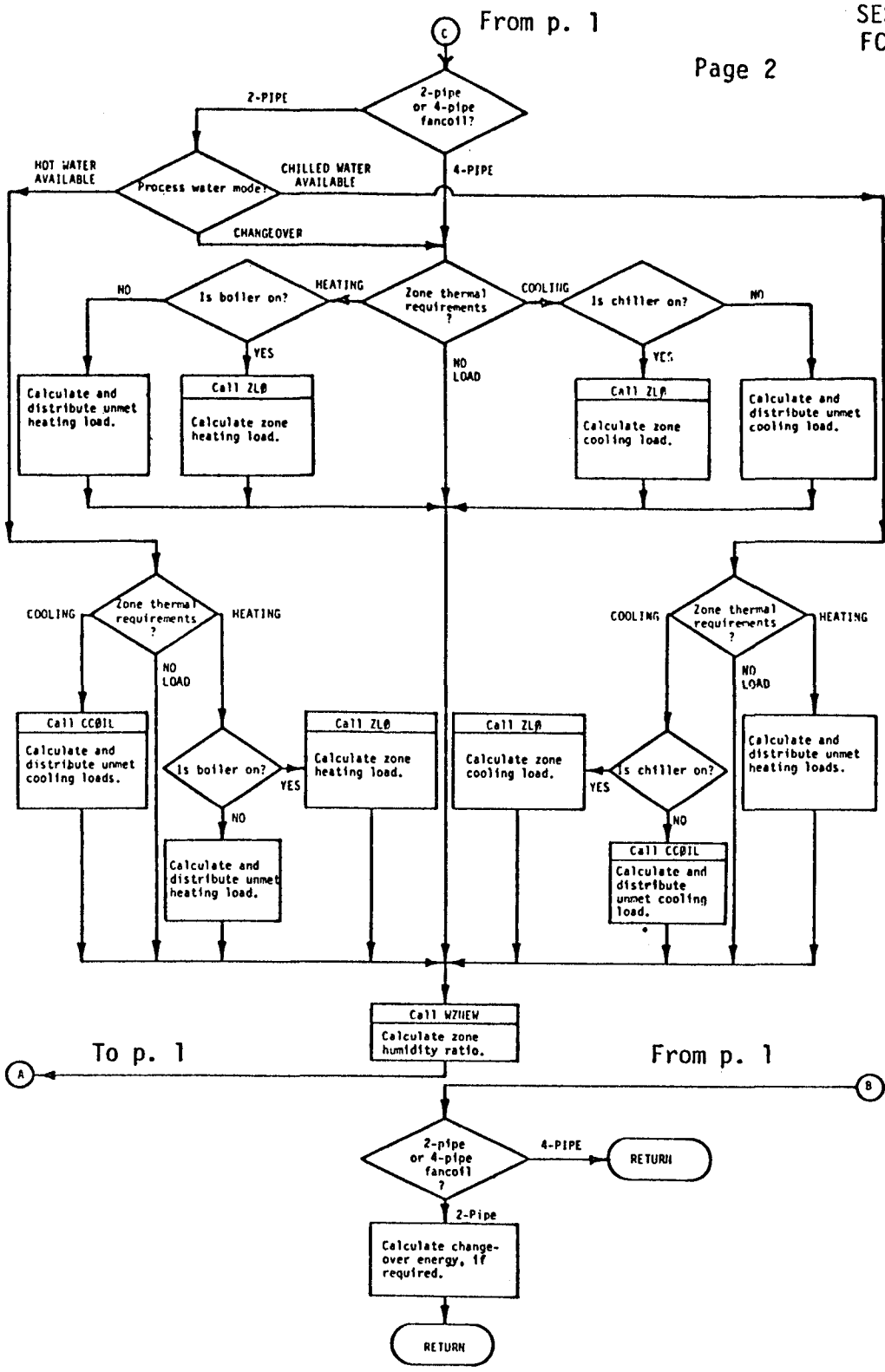

SESP
ESIZE
ENTER
ESIZE
CALCULATE
TOTAL HEATING
PLANT CAPACITY
I ← 1,NCHIL
DETERMINE
COOLING TOWER
FAN HORSEPOWER
REQUIREMENT
DETERMINE
CHILLED WATER
FLOW RATE
DETERMINE
BOILER WATER
FLOW RATE
SIZE PUMP MOTORS
SIZE BOILER
AUXILIARY
HORSEPOWER
SUM HEATING AND
COOLING EQUIPMENT
BRAKE HORSEPOWER
DEMAND
SIZE ON-SITE
GENERATION
PLANTS
ENGINE/GENERATION
SIZING
RETURN
DETERMINE
COOLING
CAPACITY
IS
MI=4
?
NO
YES
SIZE CONDENSER
WATER FLOW RATE
AND COOLING
TOWER AIR FLOW
IS
MI≠5
?
YES
NO
SIZE CONDENSER
FLOW RATE AND
COOLING TOWER
AIR FLOW
DETERMINE
SIZE OF
STEAM TURBINES


ENTER EXSUM
ESTABLISH CONVERSION MATRIX
CALCULATE BUILDING CAPACITIES
WRITE HEADER
INITIALIZE REPORT MATRIX
CALCULATE CONSUMPTION OF VARIOUS ENERGY TYPES
USE CONVERSION MATRIX TO FILL REPORT MATRIX
CALCULATE TOTALS FOR ENERGY TYPES
DIVIDE BY FLOOR AREA
CALCULATE GRAND TOTALS
CONVERT TOTALS TO KTBU
WRITE ENERGY MATRIX AND GRAND TOTALS
RETURN

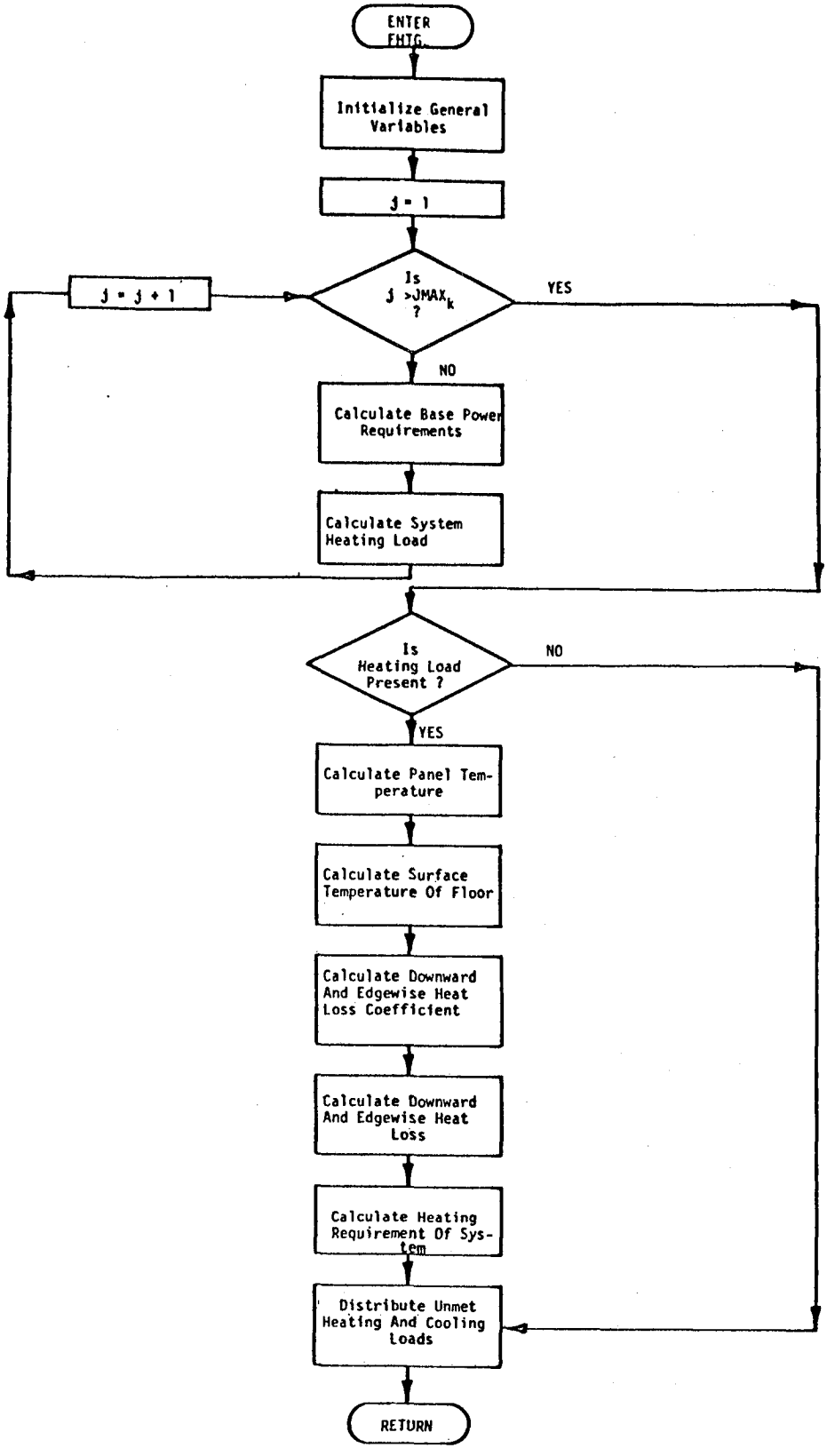
SESP
FANØF

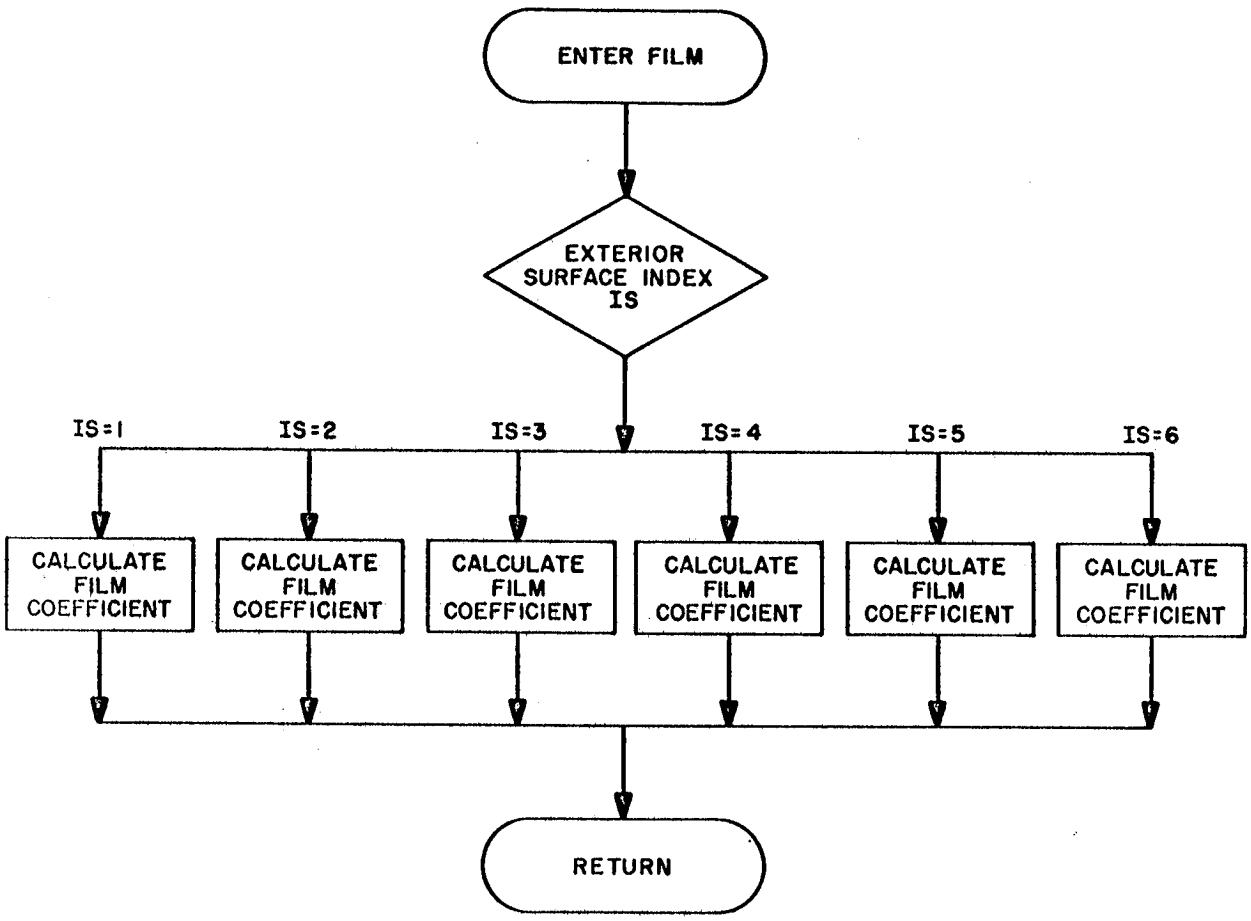

Enter FANØF
Sum ABS value, zone sensible loads, system k
Is sum of zone loads = 0.0 ?
NO
RETURN
YES
Initialize general variables.
j = 1
Is j > JMAX$_k$?
YES
j = j + 1
NO
Sum base power requirements.
Call BRAD
Sum zone sensible loads not met including effect of baseboard heat.
Distribute sensible loads not met.
Adjust total fan brake horsepower.
RETURN


Enter FCØIL
Is fan shut-off option used?
YES
Call FANMF
Determine if fan is shut off. If off, distribute electrical and thermal loads.
NO
Is fan shut-off?
YES
RETURN
NO
Is this a 2-pipe fancoil system?
YES
2.
Call TEMP
Calculate process water mode (hot water, chilled water, or changeover).
NO
Are boiler and chiller on?
YES
NO
Is chiller on?
YES
Process mode set to chilled water
NO
Process mode set to hot water
j = 1
A
j = j + 1
Is j > JMAX_k ?
YES
B
From p. 2
To p. 2
NO
Calculate base electrical power
Calculate sensible thermal load
Is boiler on?
YES
Call DRAD
Calculate baseboard heating load.
NO
Call MXAIR
Calculate mixed air conditions.
Calculate zone supply air temperature.
Calculate fan heat and mixed air conditions downstream of blower.
Call H2ØZN
Calculate zone moisture changes.
C
To p. 2


From p. 1
C
2-pipe or 4-pipe fancoil?
2-PIPE
4-PIPE
HOT WATER AVAILABLE
Process water mode?
CHILLED WATER AVAILABLE
CHANGEOVER
Zone thermal requirements ?
HEATING
COOLING
NO LOAD
Is boiler on?
NO
YES
Calculate and distribute unmet heating load.
Call ZLØ
Calculate zone heating load.
Is chiller on?
Call ZLØ
Calculate zone cooling load.
Calculate and distribute unmet cooling load.
Call CCØIL
Calculate and distribute unmet cooling loads.
Calculate and distribute unmet heating load.
Calculate and distribute unmet heating loads.
Call WZHEW
Calculate zone humidity ratio.
To p. 1
A
From p. 1
B
RETURN
Calculate change-over energy, if required.

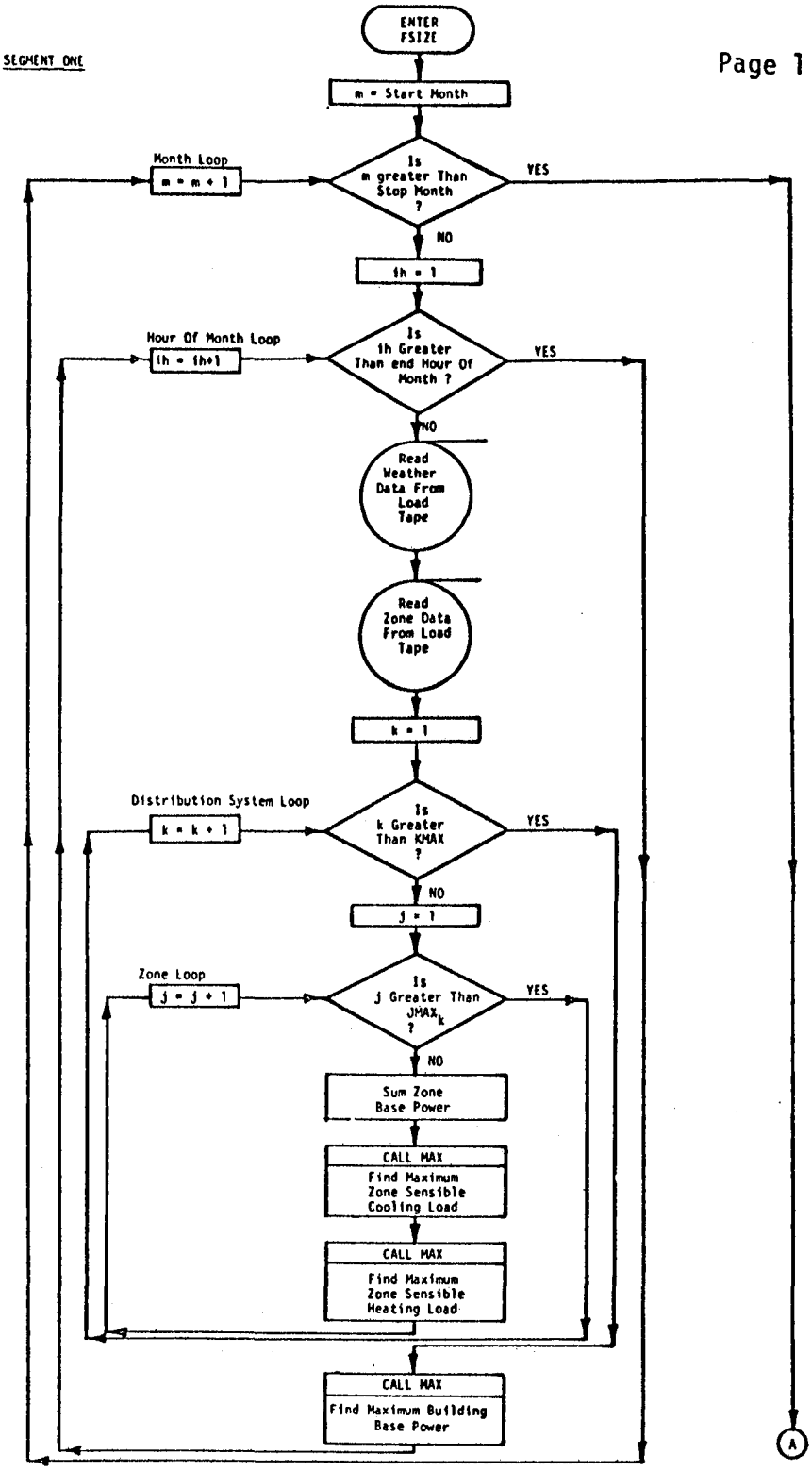
SESP
FHTG


ENTER FHTG
Initialize General Variables
j = 1
Is j >JMAX$_k$?
YES
NO
j = j + 1
Calculate Base Power Requirements
Calculate System Heating Load
Is Heating Load Present ?
NO
YES
Calculate Panel Temperature
Calculate Surface Temperature Of Floor
Calculate Downward And Edgewise Heat Loss Coefficient
Calculate Downward And Edgewise Heat Loss
Calculate Heating Requirement Of System
Distribute Unmet Heating And Cooling Loads
RETURN


ENTER FILM
EXTERIOR SURFACE INDEX IS
IS=1
IS=2
IS=3
IS=4
IS=5
IS=6
CALCULATE FILM COEFFICIENT
CALCULATE FILM COEFFICIENT
CALCULATE FILM COEFFICIENT
CALCULATE FILM COEFFICIENT
CALCULATE FILM COEFFICIENT
CALCULATE FILM COEFFICIENT
RETURN

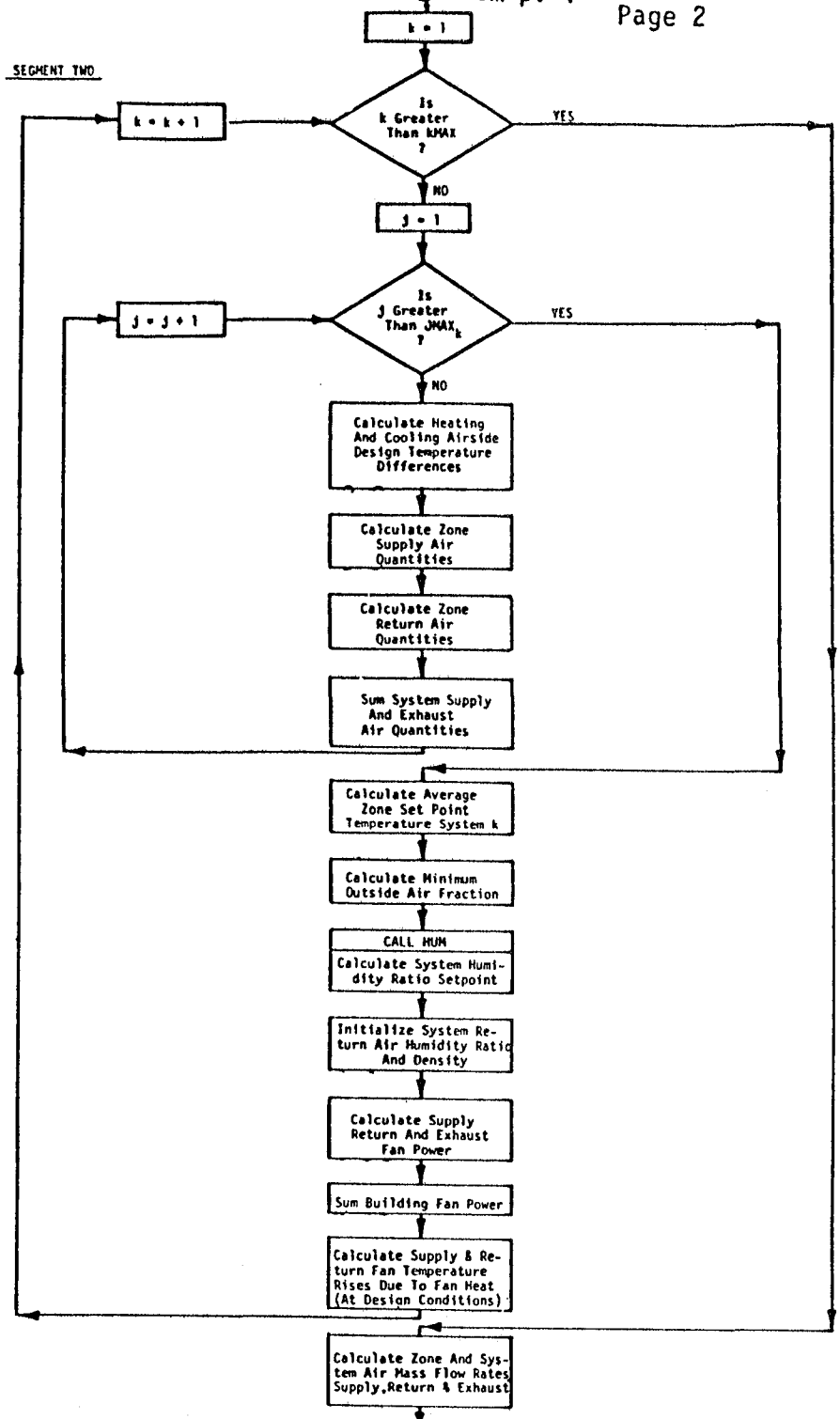
SEGMENT ONE

Page 1



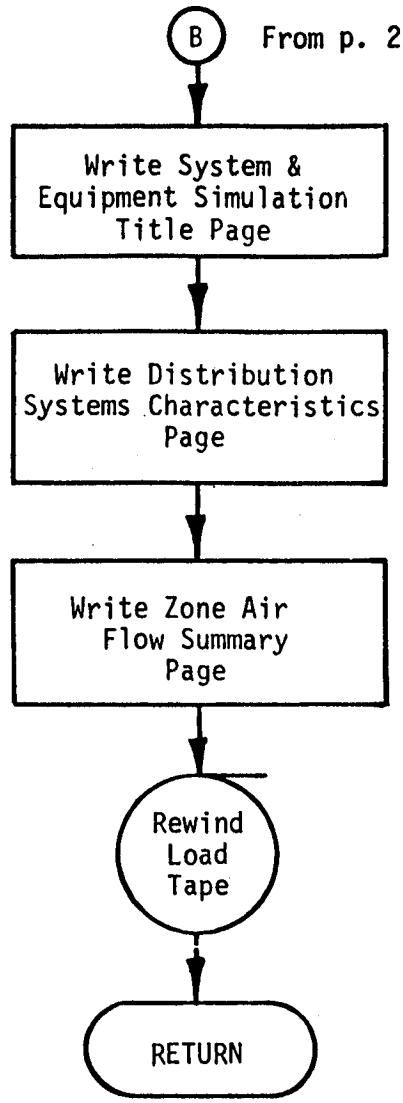
(A) To p. 2

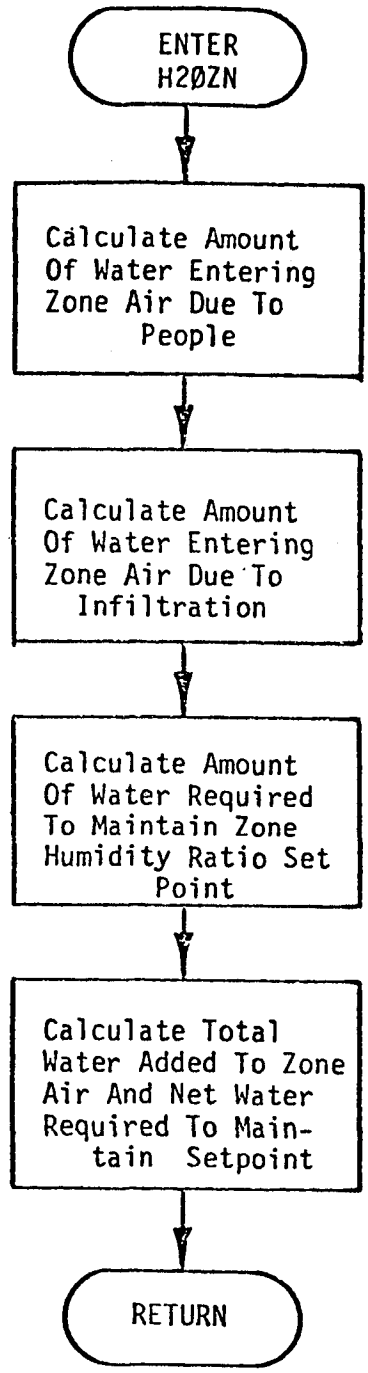
(A) From p. 1

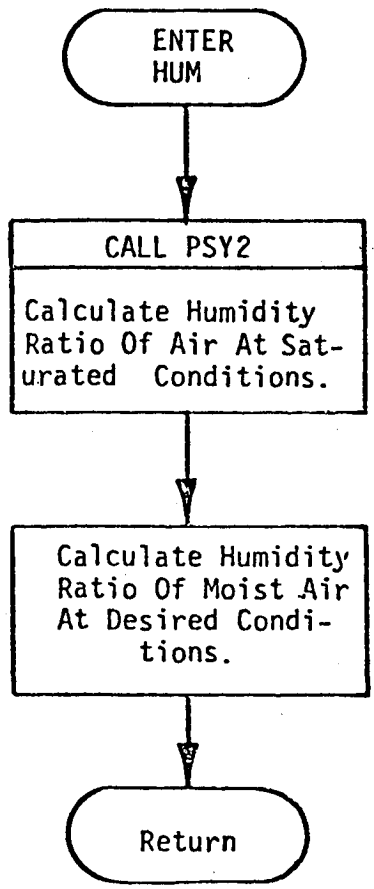


(B) To p.3

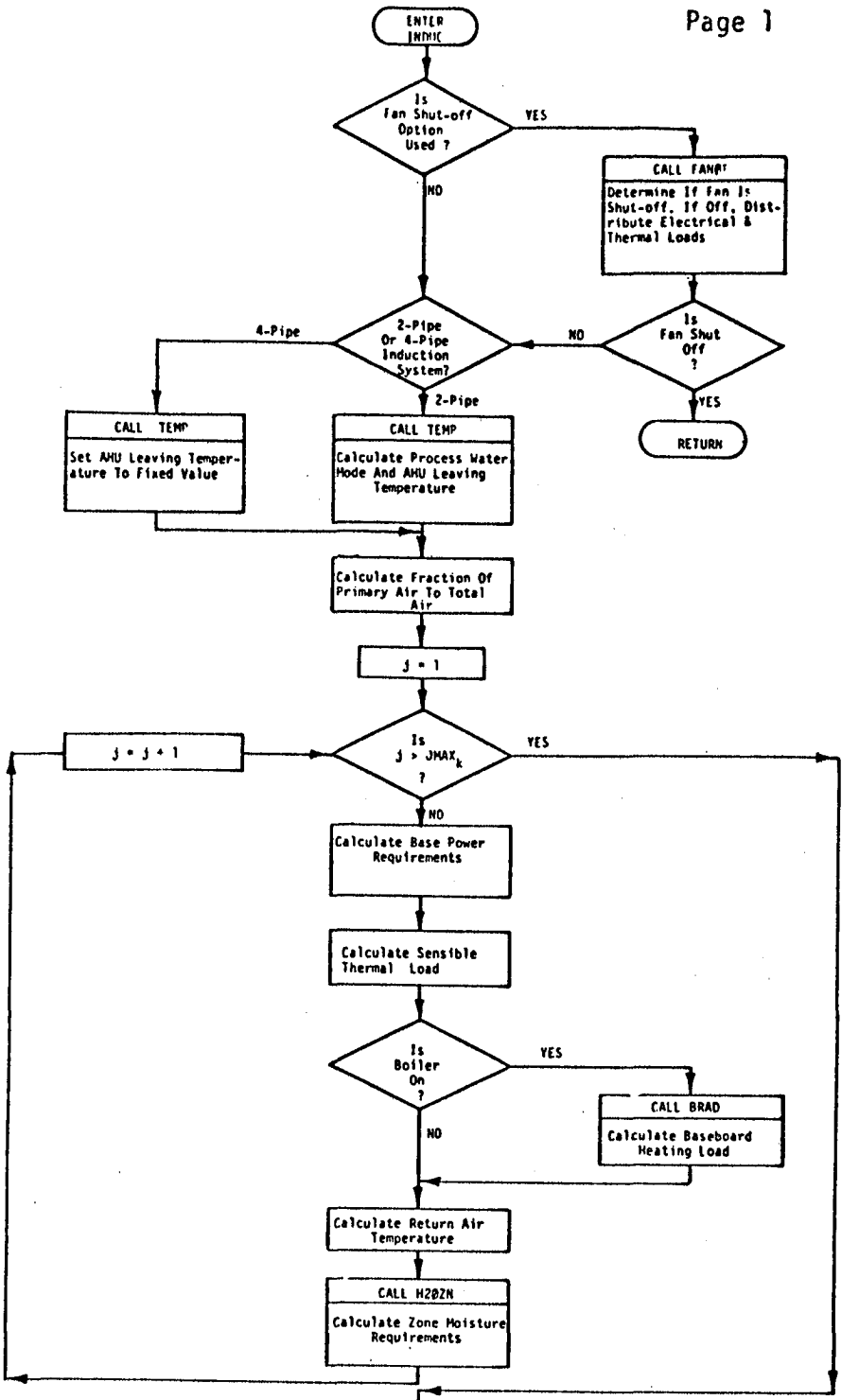
SEGMENT THREE




ENTER
H2ØZN
Calculate Amount Of Water Entering Zone Air Due To People
Calculate Amount Of Water Entering Zone Air Due To Infiltration
Calculate Amount Of Water Required To Maintain Zone Humidity Ratio Set Point
Calculate Total Water Added To Zone Air And Net Water Required To Maintain Setpoint
RETURN

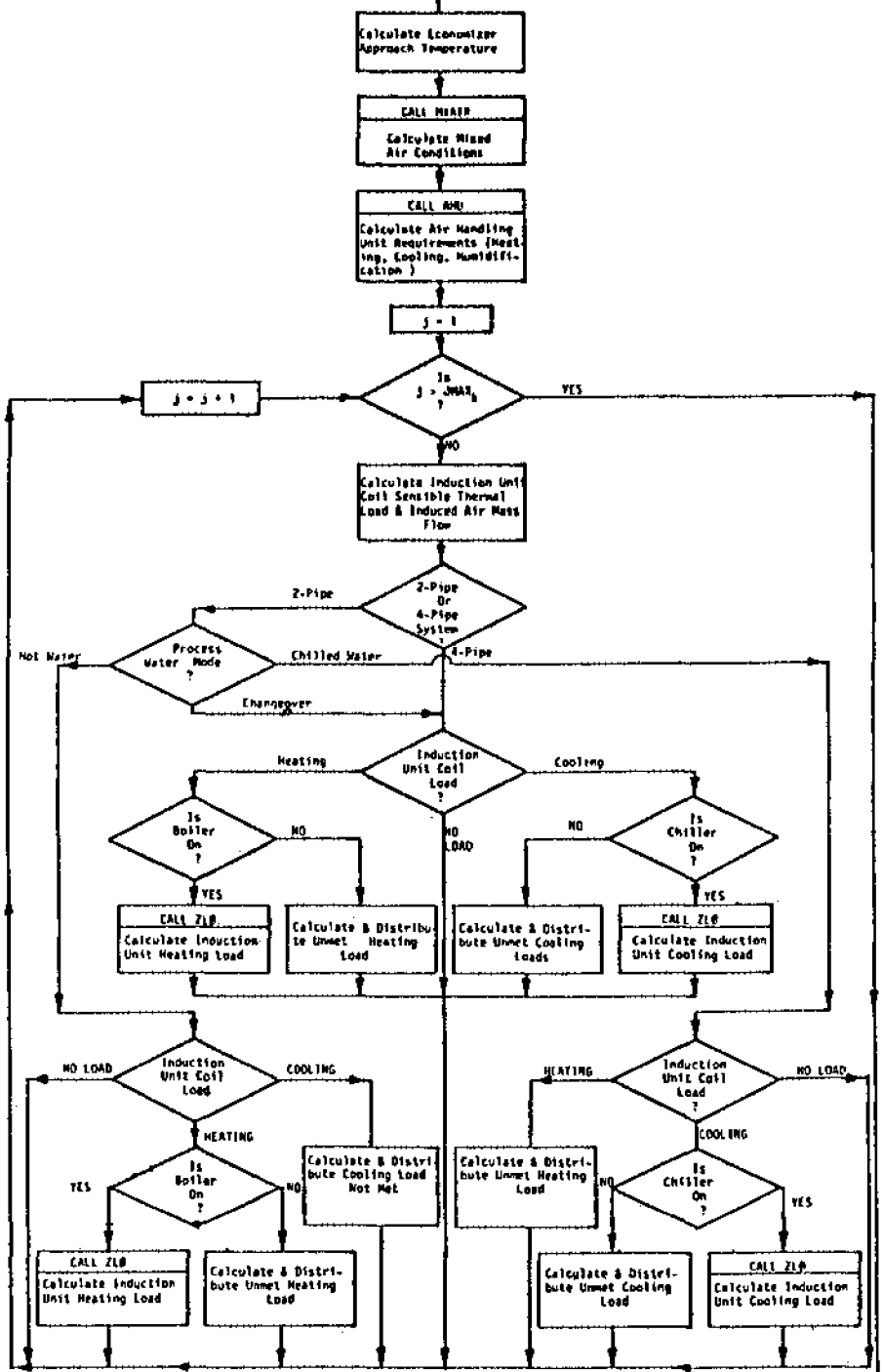

ENTER
HUM
CALL PSY2
Calculate Humidity Ratio Of Air At Saturated Conditions.
Calculate Humidity Ratio Of Moist Air At Desired Conditions.
Return

Page 1

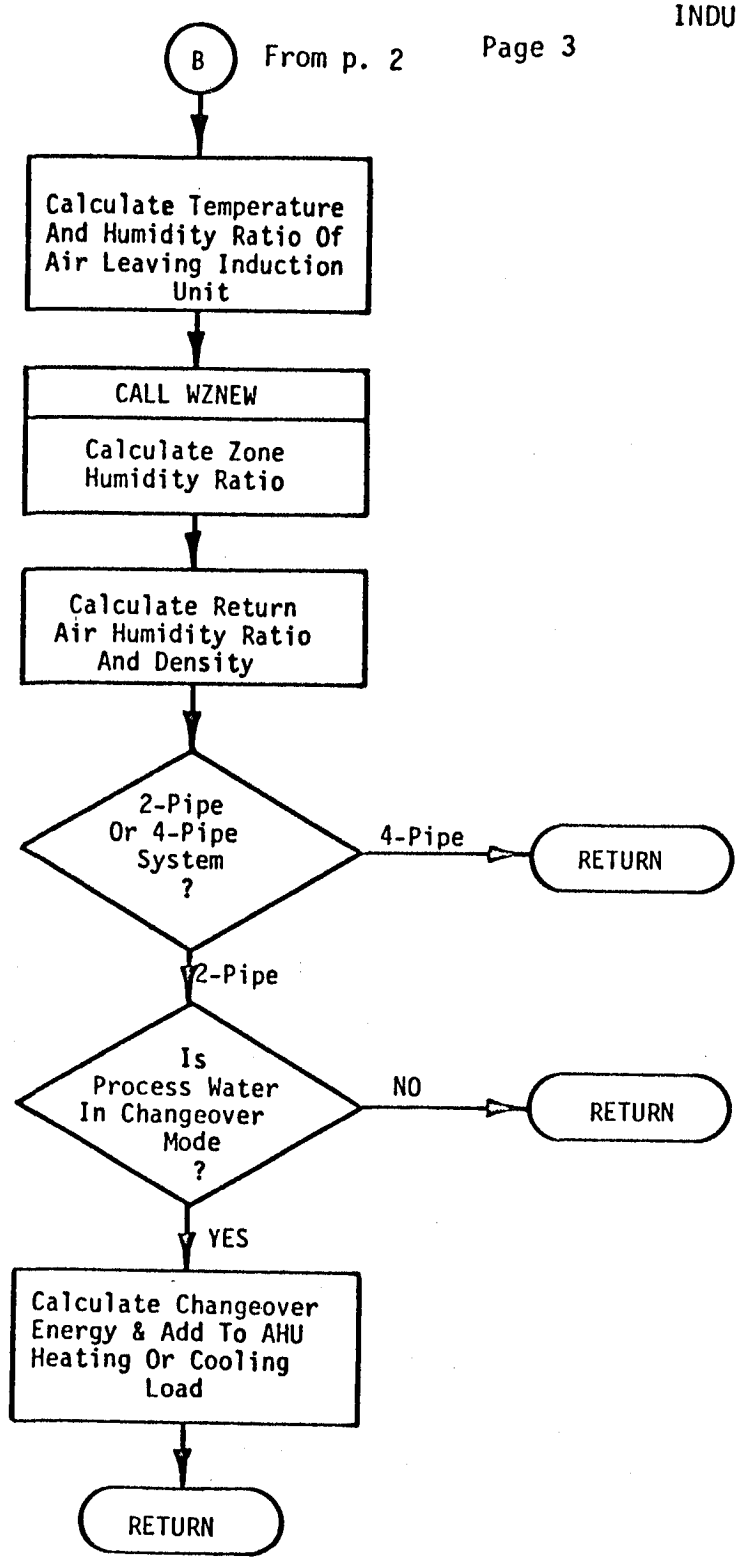

ENTER INDUC
Is Fan Shut-off Option Used ?
YES
NO
CALL FANØT
Determine If Fan Is Shut-off. If Off, Distribute Electrical & Thermal Loads
Is Fan Shut Off ?
NO
YES
RETURN
2-Pipe Or 4-Pipe Induction System?
4-Pipe
2-Pipe
CALL TEMP
Set AHU Leaving Temperature To Fixed Value
CALL TEMP
Calculate Process Water Mode And AHU Leaving Temperature
Calculate Fraction Of Primary Air To Total Air
j = 1
j = j + 1
Is j > JMAX_k ?
YES
NO
Calculate Base Power Requirements
Calculate Sensible Thermal Load
Is Boiler On ?
YES
NO
CALL BRAD
Calculate Baseboard Heating Load
Calculate Return Air Temperature
CALL H2ØZN
Calculate Zone Moisture Requirements
A

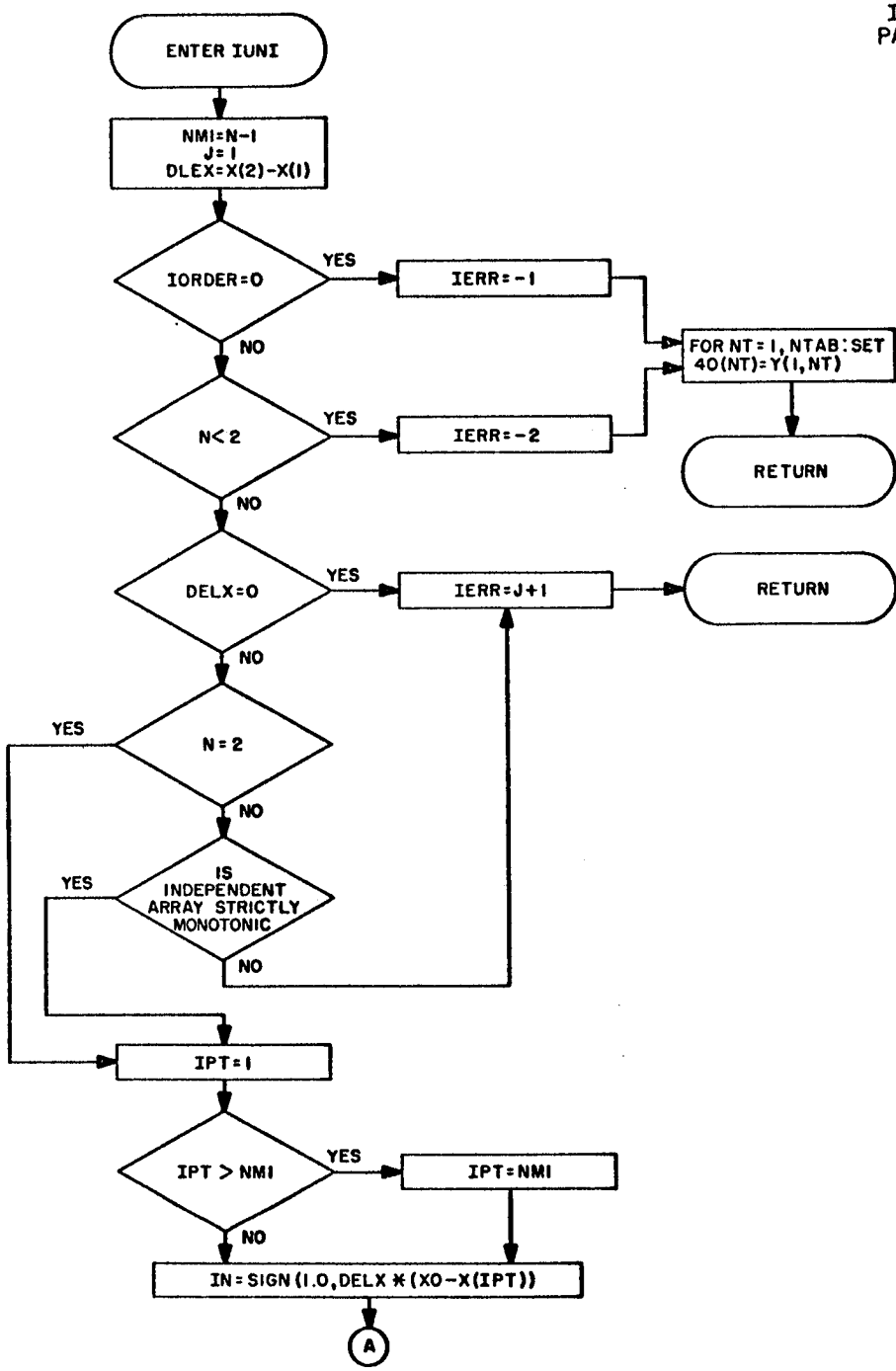
To p. 2

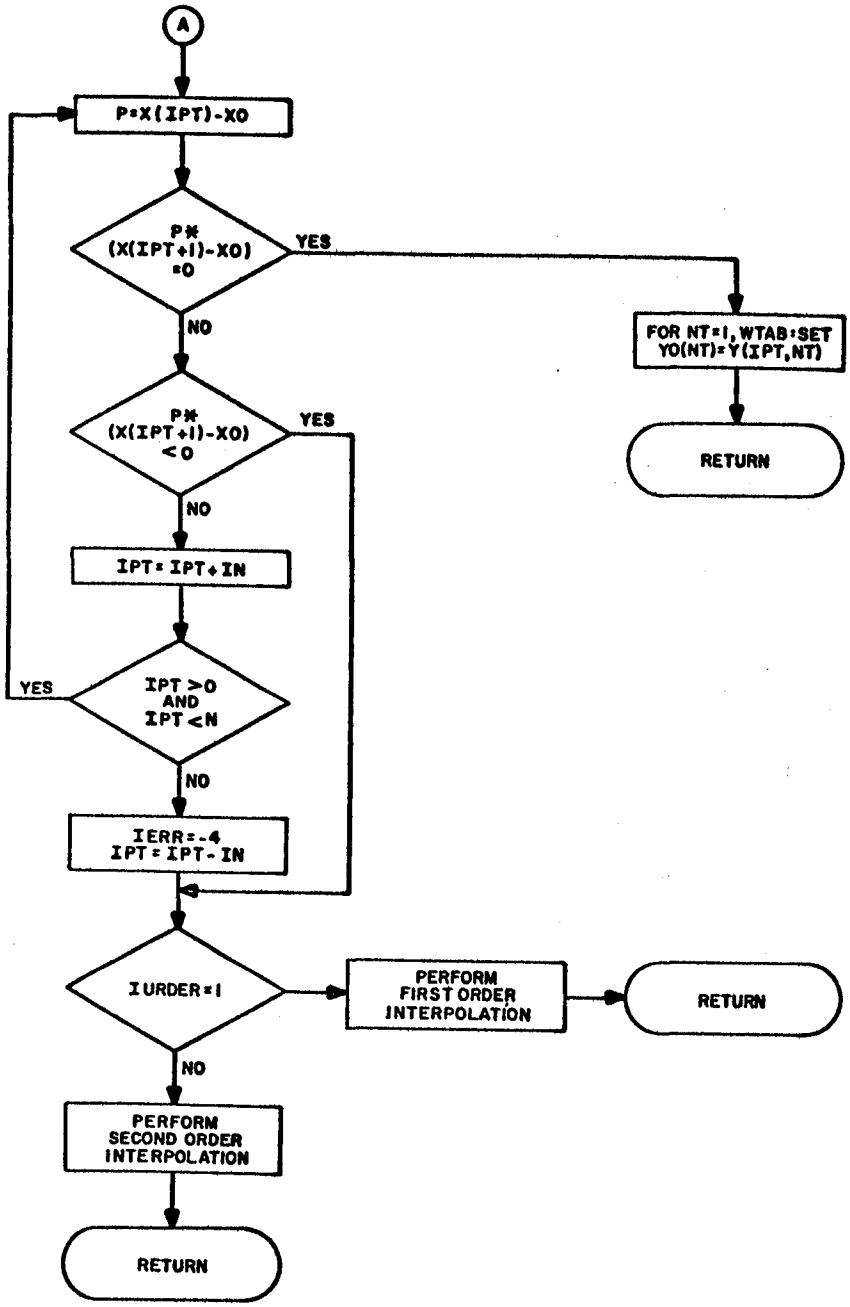
(A) From p. 1 Page 2

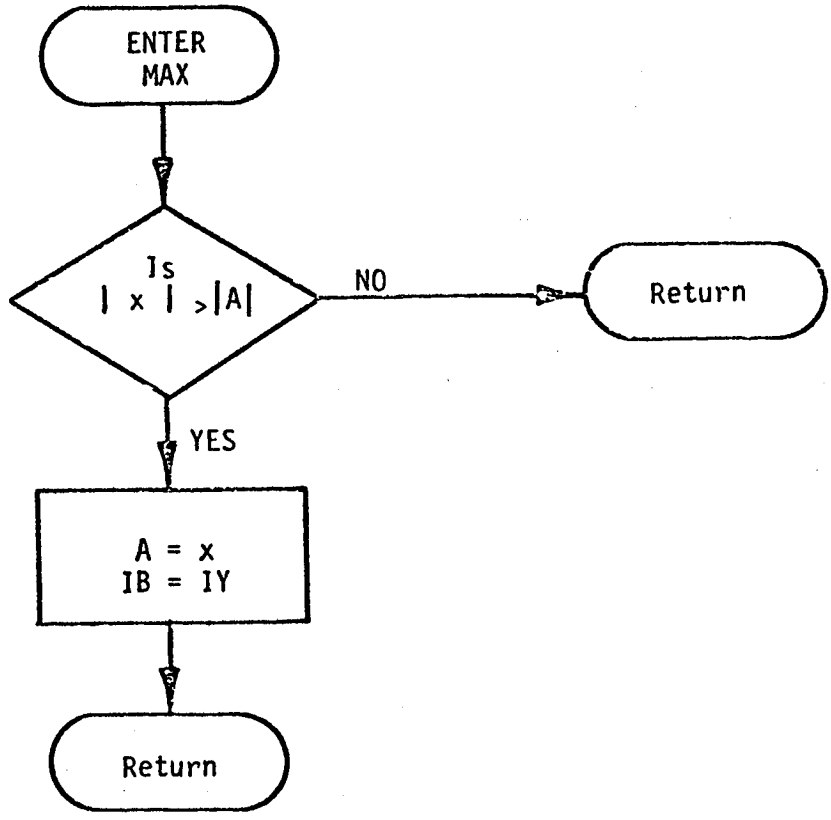


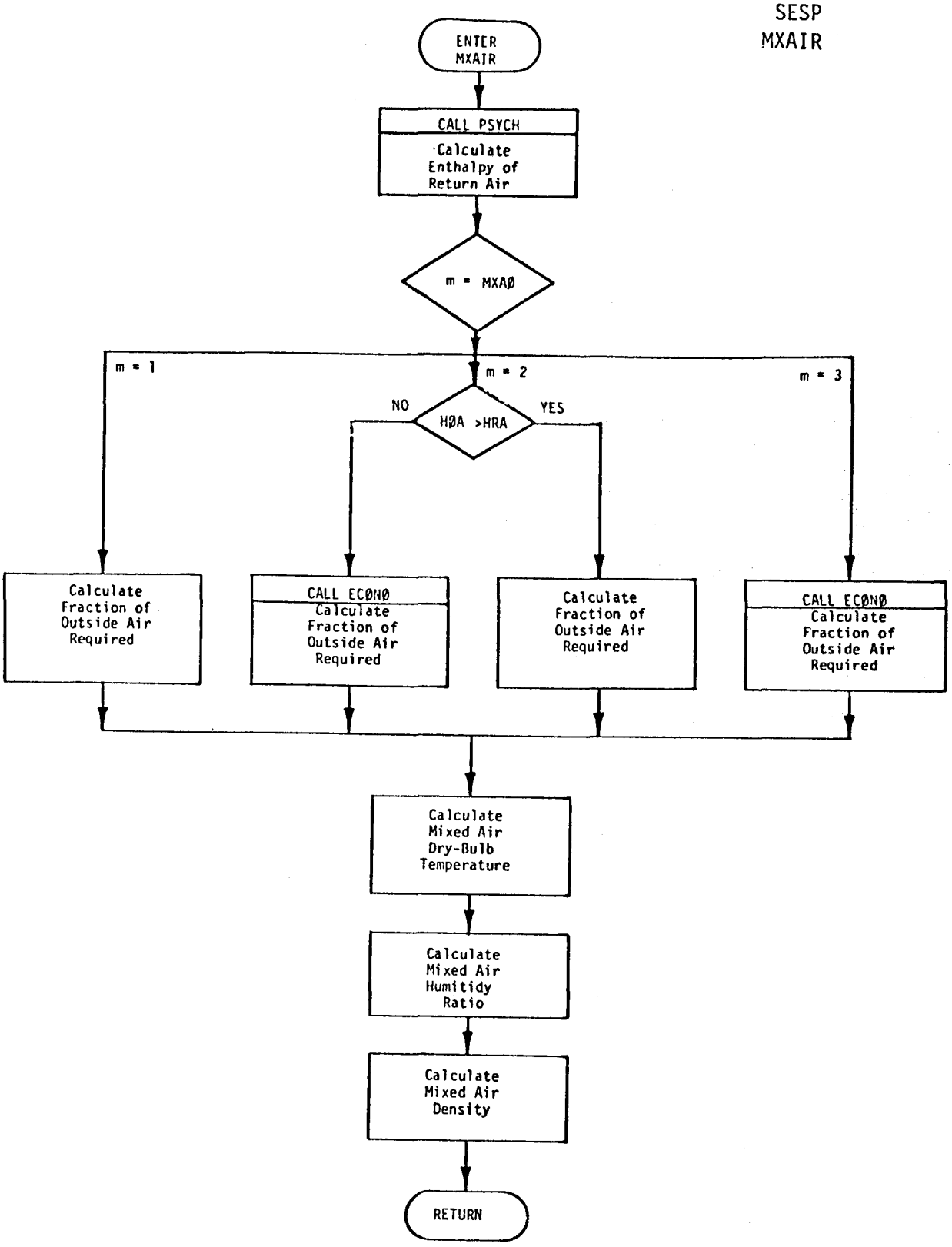
(B) To p. 3


B
From p. 2
Page 3
Calculate Temperature And Humidity Ratio Of Air Leaving Induction Unit
CALL WZNEW
Calculate Zone Humidity Ratio
Calculate Return Air Humidity Ratio And Density
2-Pipe Or 4-Pipe System ?
4-Pipe
RETURN
2-Pipe
Is Process Water In Changeover Mode ?
NO
RETURN
YES
Calculate Changeover Energy & Add To AHU Heating Or Cooling Load
RETURN

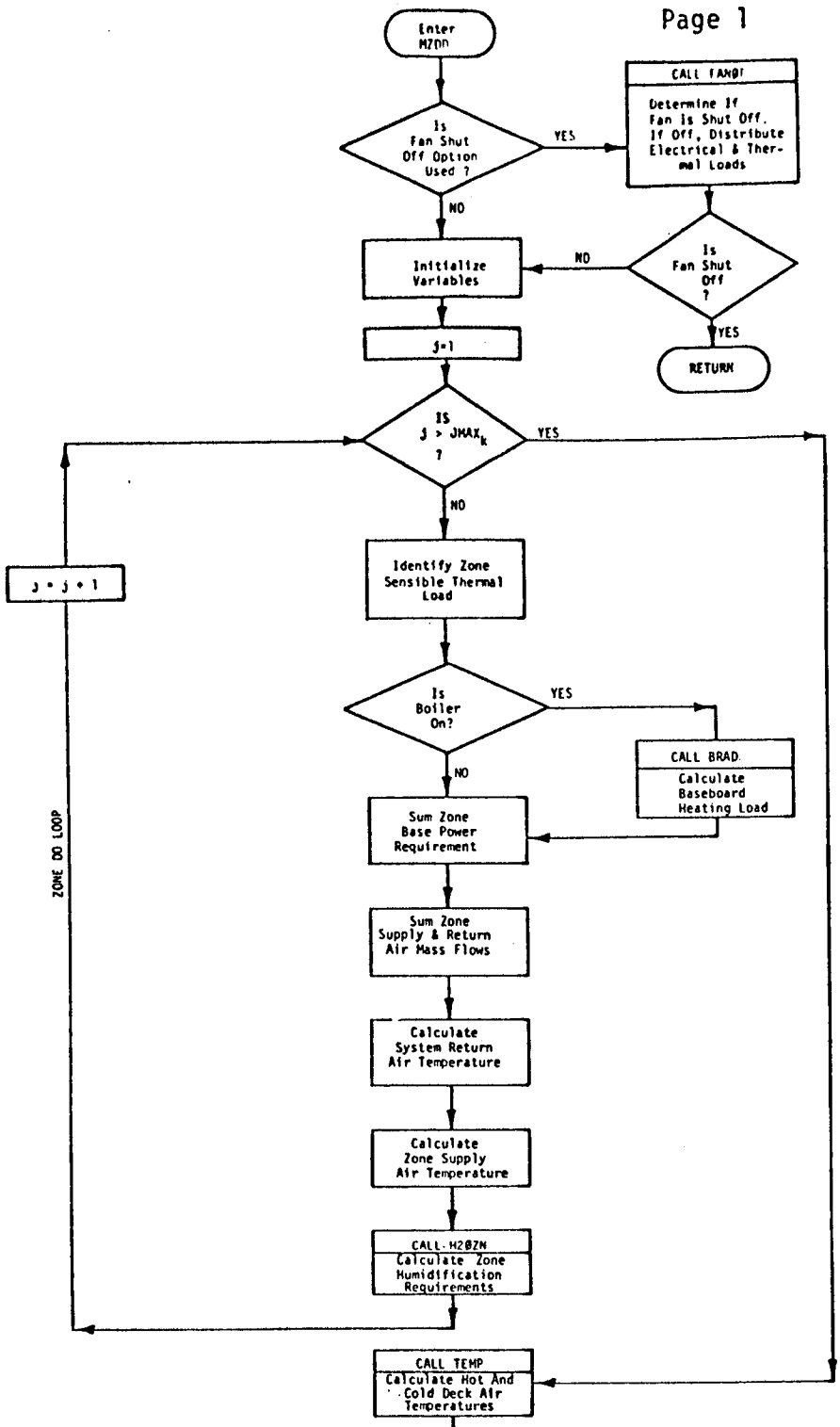

ENTER IUNI
NMI=N-1
J=1
DLEX=X(2)-X(1)
IORDER=0
YES
IERR=-1
NO
N<2
YES
IERR=-2
FOR NT=1,NTAB:SET
40(NT)=Y(1,NT)
RETURN
NO
DELX=0
YES
IERR=J+1
RETURN
NO
N=2
YES
NO
IS
INDEPENDENT
ARRAY STRICTLY
MONOTONIC
YES
NO
IPT=1
IPT > NMI
YES
IPT=NMI
NO
IN=SIGN(1.0,DELX*(XO-X(IPT))
A


A
P=X(IPT)-XO
P*(X(IPT+1)-XO)=0
YES
NO
FOR NT=1,WTAB:SET YO(NT)=Y(IPT,NT)
RETURN
P*(X(IPT+1)-XO)<0
YES
NO
IPT=IPT+IN
YES
IPT>0 AND IPT<N
NO
IERR=-4
IPT=IPT-IN
IURDER=1
PERFORM FIRST ORDER INTERPOLATION
RETURN
NO
PERFORM SECOND ORDER INTERPOLATION
RETURN

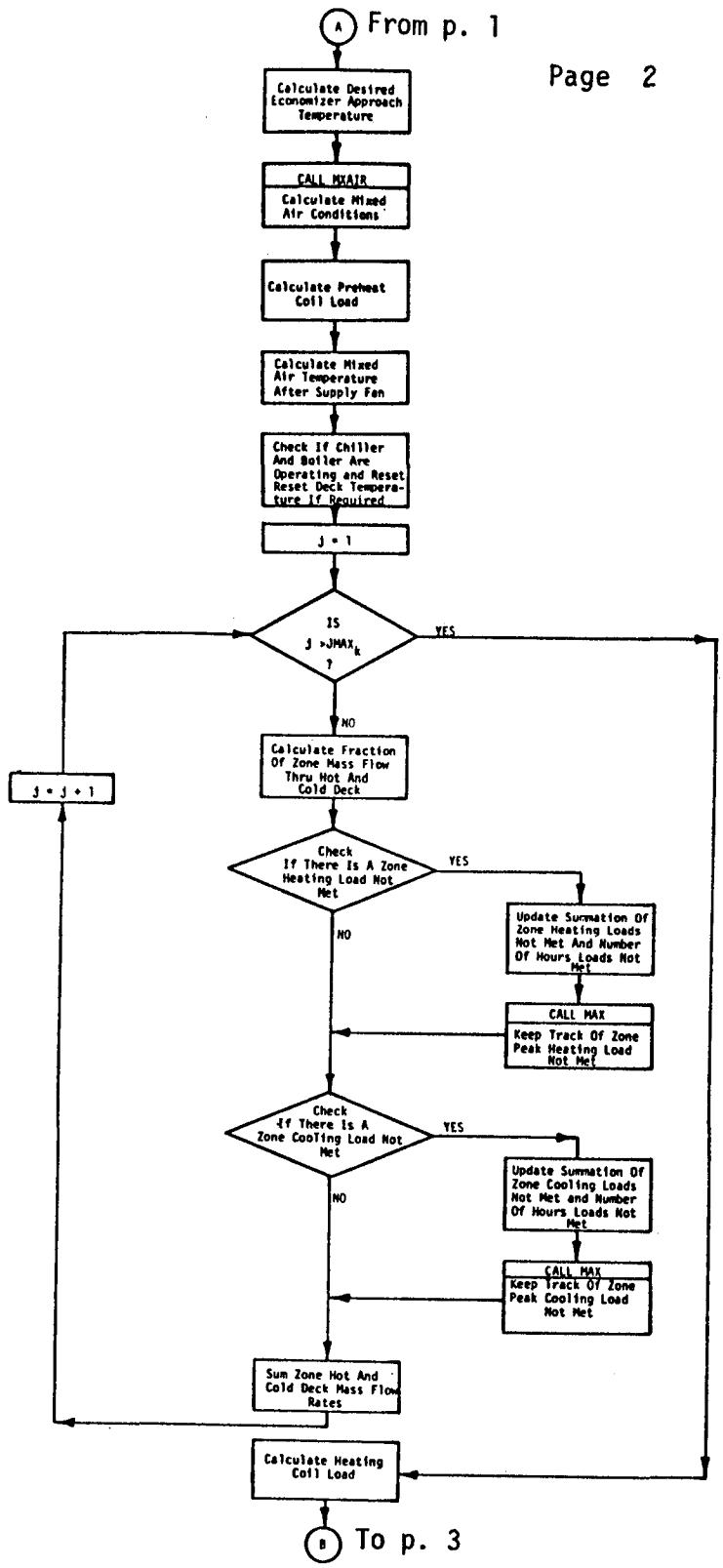

ENTER
MAX
Is
| x | >|A|
NO
Return
YES
A = x
IB = IY
Return

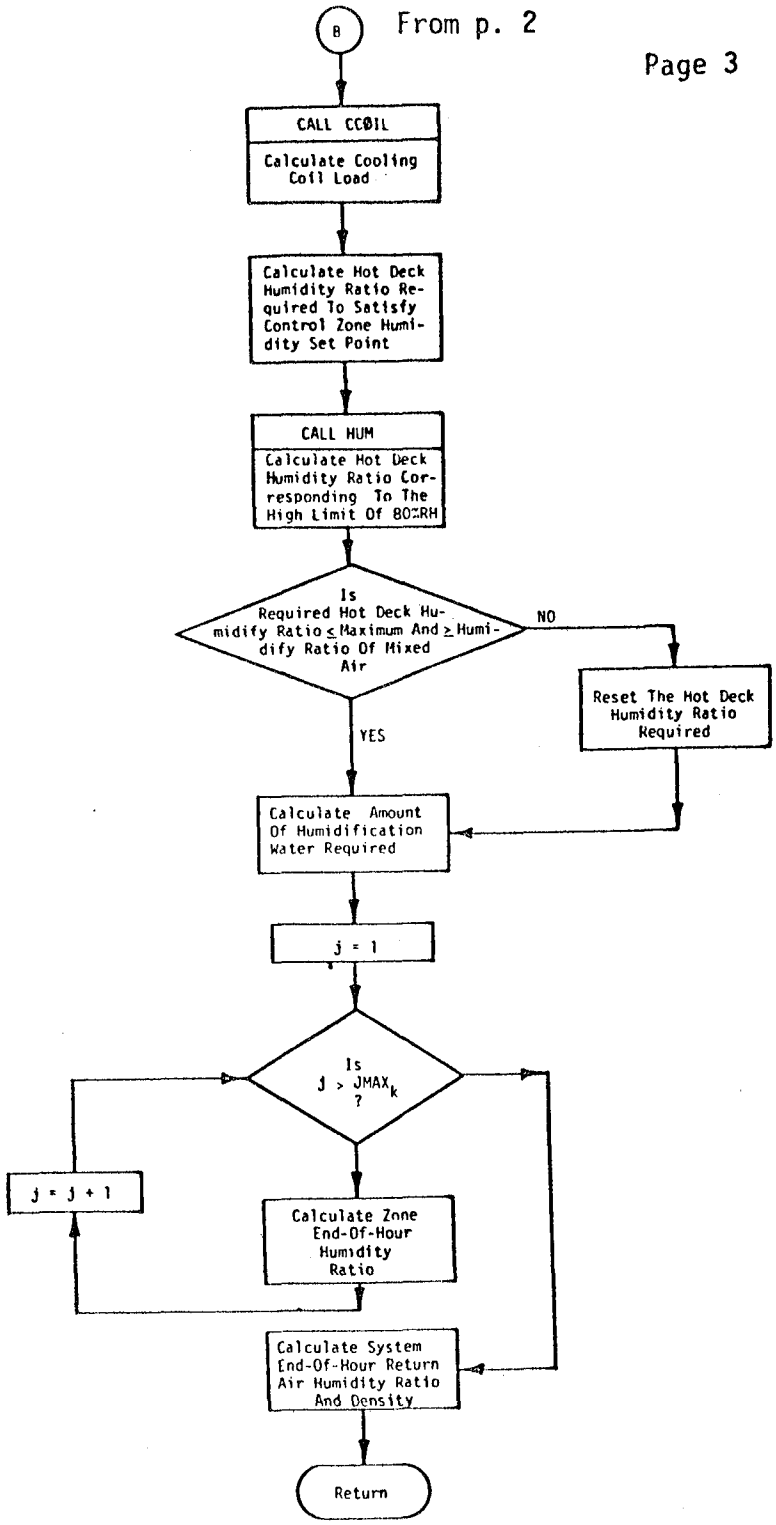

ENTER
MXAIR
CALL PSYCH
Calculate
Enthalpy of
Return Air
m = MXAØ
m = 1
m = 2
m = 3
NO
YES
HØA >HRA
Calculate
Fraction of
Outside Air
Required
CALL ECØNØ
Calculate
Fraction of
Outside Air
Required
Calculate
Fraction of
Outside Air
Required
CALL ECØNØ
Calculate
Fraction of
Outside Air
Required
Calculate
Mixed Air
Dry-Bulb
Temperature
Calculate
Mixed Air
Humitidy
Ratio
Calculate
Mixed Air
Density
RETURN

Page 1

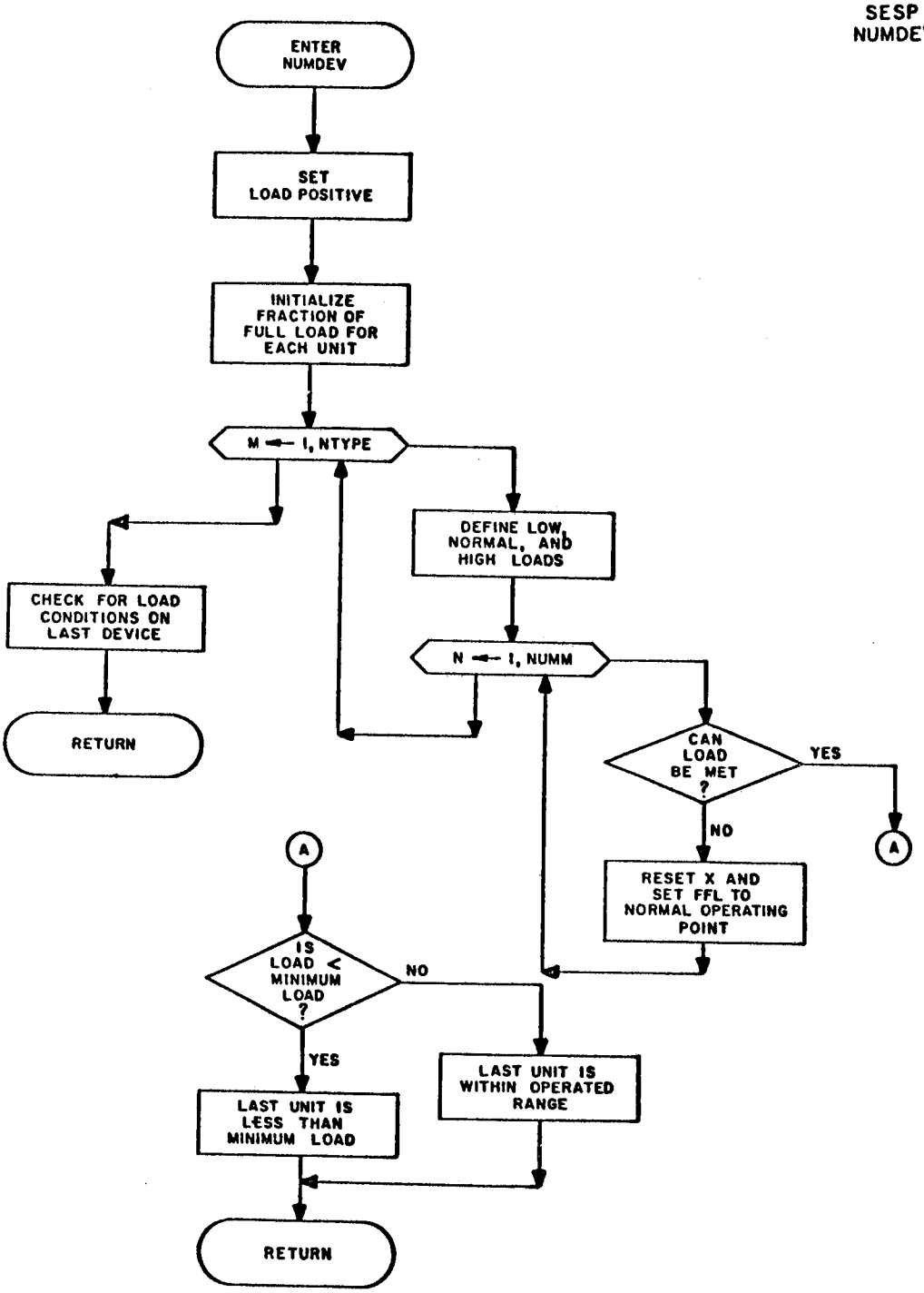

Enter MZDD
Is Fan Shut Off Option Used ?
YES
NO
CALL FANØT
Determine If Fan Is Shut Off. If Off, Distribute Electrical & Thermal Loads
Is Fan Shut Off ?
NO
YES
RETURN
Initialize Variables
j=1
IS j > JMAX_k ?
YES
NO
Identify Zone Sensible Thermal Load
Is Boiler On?
YES
NO
CALL BRAD
Calculate Baseboard Heating Load
Sum Zone Base Power Requirement
Sum Zone Supply & Return Air Mass Flows
Calculate System Return Air Temperature
Calculate Zone Supply Air Temperature
CALL H2ØZN
Calculate Zone Humidification Requirements
j = j + 1
ZONE DO LOOP
CALL TEMP
Calculate Hot And Cold Deck Air Temperatures
A

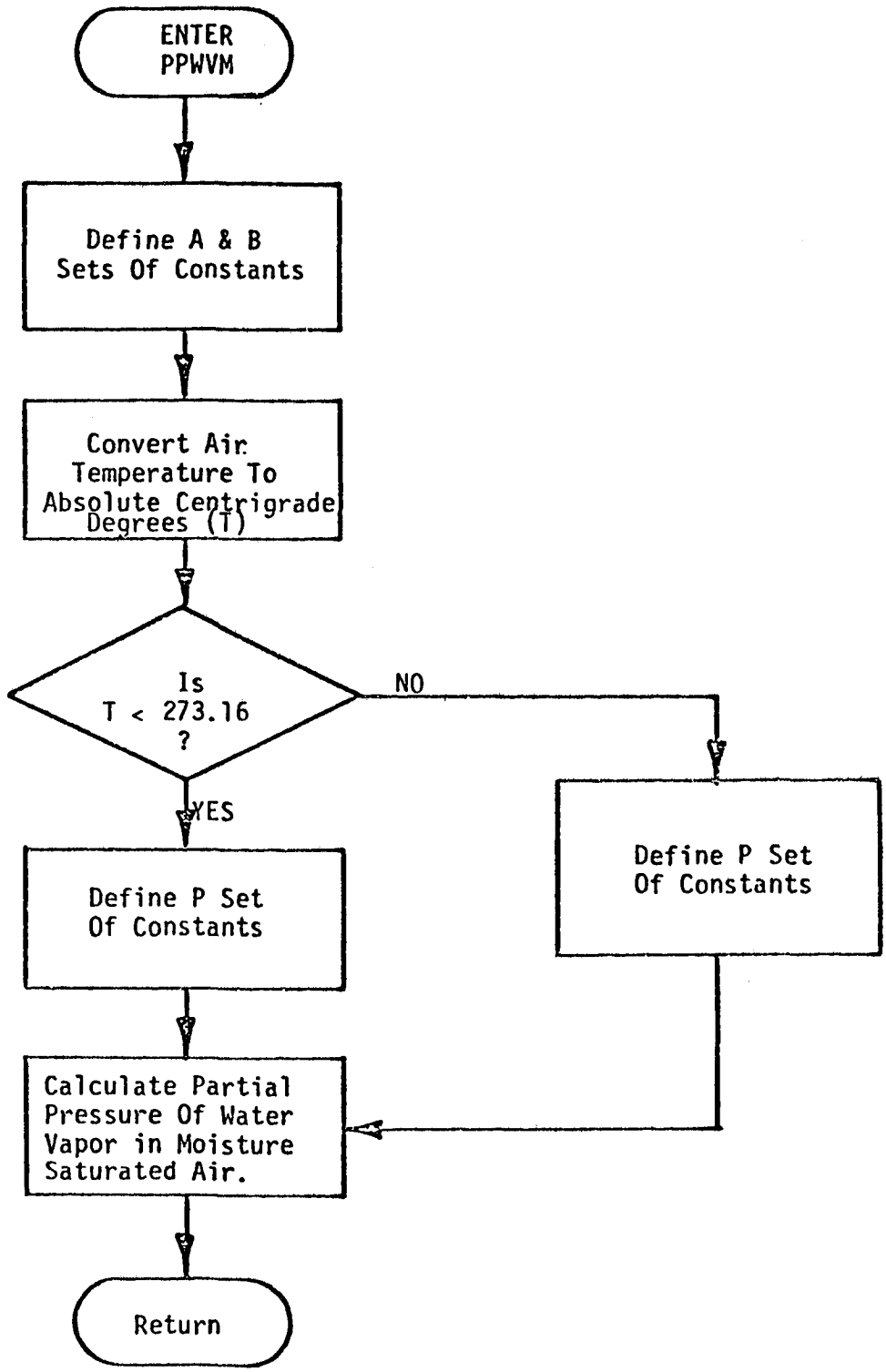
To p. 2

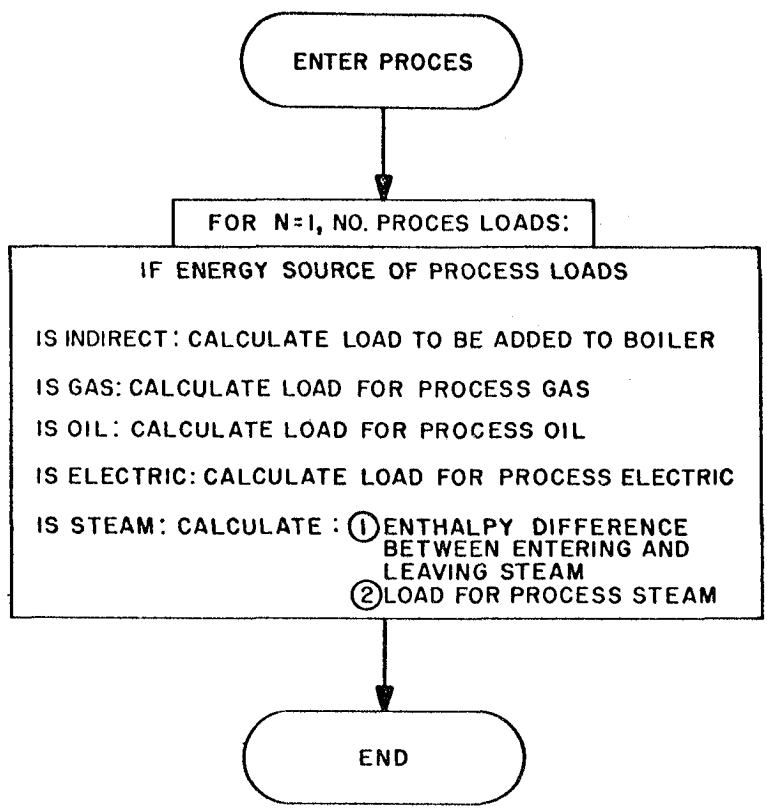

A
From p. 1
Page 2
Calculate Desired Economizer Approach Temperature
CALL MXAIR
Calculate Mixed Air Conditions
Calculate Preheat Coil Load
Calculate Mixed Air Temperature After Supply Fan
Check If Chiller And Boiler Are Operating and Reset Reset Deck Temperature If Required
J = 1
IS J >JMAX$_k$?
YES
NO
Calculate Fraction Of Zone Mass Flow Thru Hot And Cold Deck
J = J + 1
Check If There Is A Zone Heating Load Not Met
YES
NO
Update Summation Of Zone Heating Loads Not Met And Number Of Hours Loads Not Met
CALL MAX
Keep Track Of Zone Peak Heating Load Not Met
Check If There Is A Zone Cooling Load Not Met
YES
NO
Update Summation Of Zone Cooling Loads Not Met and Number Of Hours Loads Not Met
CALL MAX
Keep Track Of Zone Peak Cooling Load Not Met
Sum Zone Hot And Cold Deck Mass Flow Rates
Calculate Heating Coil Load
B
To p. 3

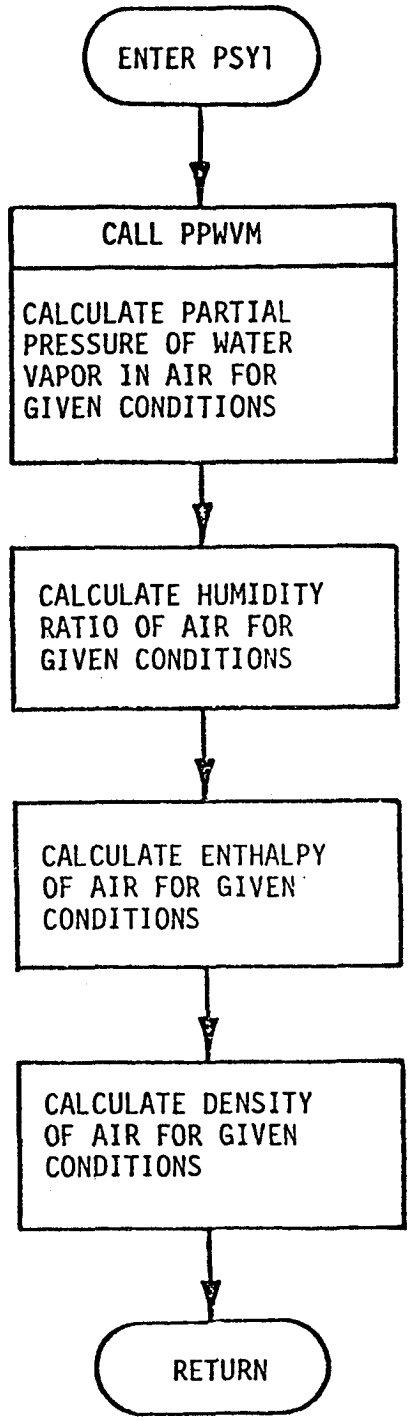

B
From p. 2
CALL CCØIL
Calculate Cooling Coil Load
Calculate Hot Deck Humidity Ratio Required To Satisfy Control Zone Humidity Set Point
CALL HUM
Calculate Hot Deck Humidity Ratio Corresponding To The High Limit Of 80%RH
Is Required Hot Deck Humidify Ratio ≤ Maximum And ≥ Humidify Ratio Of Mixed Air
NO
Reset The Hot Deck Humidity Ratio Required
YES
Calculate Amount Of Humidification Water Required
j = 1
Is j > JMAX_k ?
j = j + 1
Calculate Zone End-Of-Hour Humidity Ratio
Calculate System End-Of-Hour Return Air Humidity Ratio And Density
Return

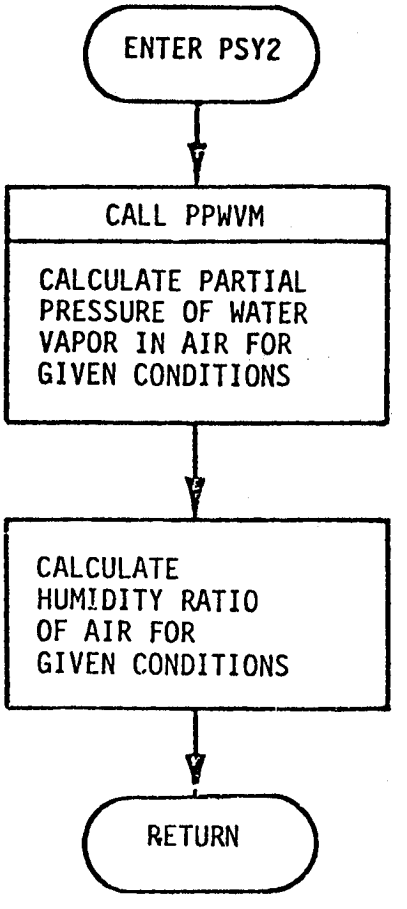
SESP
NUMDEV

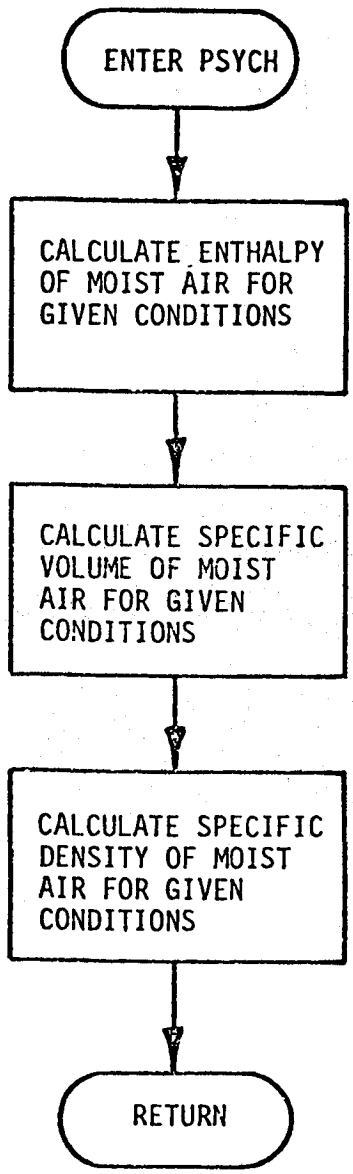

ENTER NUMDEV
SET LOAD POSITIVE
INITIALIZE FRACTION OF FULL LOAD FOR EACH UNIT
M ← 1, NTYPE
CHECK FOR LOAD CONDITIONS ON LAST DEVICE
RETURN
DEFINE LOW, NORMAL, AND HIGH LOADS
N ← 1, NUMM
CAN LOAD BE MET ?
YES
NO
A
RESET X AND SET FFL TO NORMAL OPERATING POINT
A
IS LOAD < MINIMUM LOAD ?
NO
YES
LAST UNIT IS WITHIN OPERATED RANGE
LAST UNIT IS LESS THAN MINIMUM LOAD
RETURN

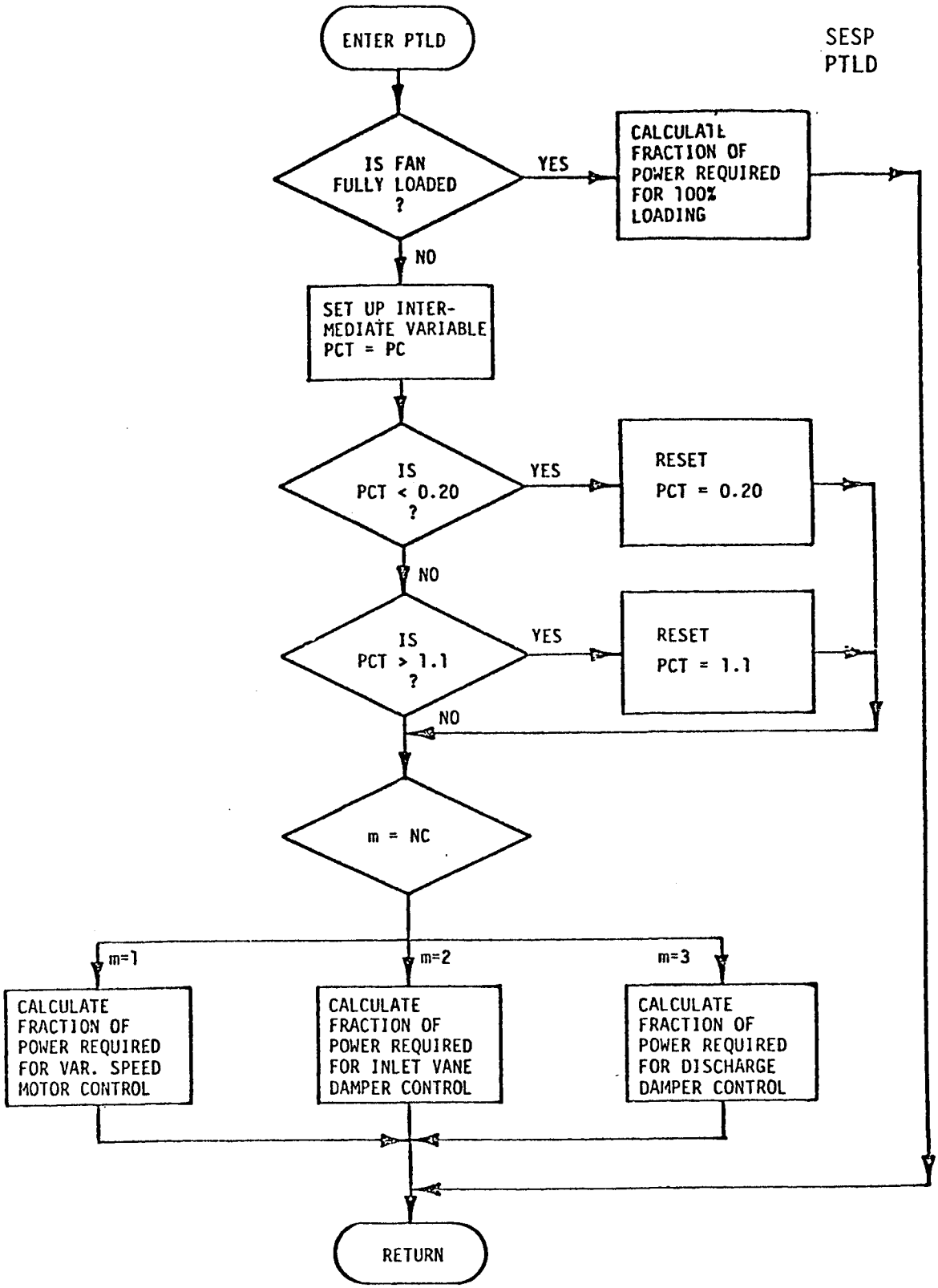

ENTER
PPWVM
Define A & B
Sets Of Constants
Convert Air
Temperature To
Absolute Centrigrade
Degrees (T)
Is
T < 273.16
?
NO
YES
Define P Set
Of Constants
Define P Set
Of Constants
Calculate Partial
Pressure Of Water
Vapor in Moisture
Saturated Air.
Return

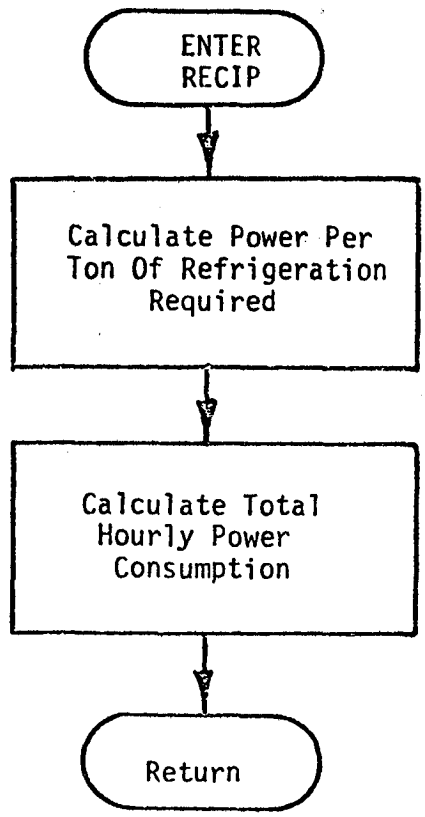

ENTER PROCES
FOR N=1, NO. PROCES LOADS:
IF ENERGY SOURCE OF PROCESS LOADS
IS INDIRECT: CALCULATE LOAD TO BE ADDED TO BOILER
IS GAS: CALCULATE LOAD FOR PROCESS GAS
IS OIL: CALCULATE LOAD FOR PROCESS OIL
IS ELECTRIC: CALCULATE LOAD FOR PROCESS ELECTRIC
IS STEAM: CALCULATE : 1 ENTHALPY DIFFERENCE BETWEEN ENTERING AND LEAVING STEAM
2 LOAD FOR PROCESS STEAM
END


ENTER PSY1
CALL PPWVM
CALCULATE PARTIAL PRESSURE OF WATER VAPOR IN AIR FOR GIVEN CONDITIONS
CALCULATE HUMIDITY RATIO OF AIR FOR GIVEN CONDITIONS
CALCULATE ENTHALPY OF AIR FOR GIVEN CONDITIONS
CALCULATE DENSITY OF AIR FOR GIVEN CONDITIONS
RETURN

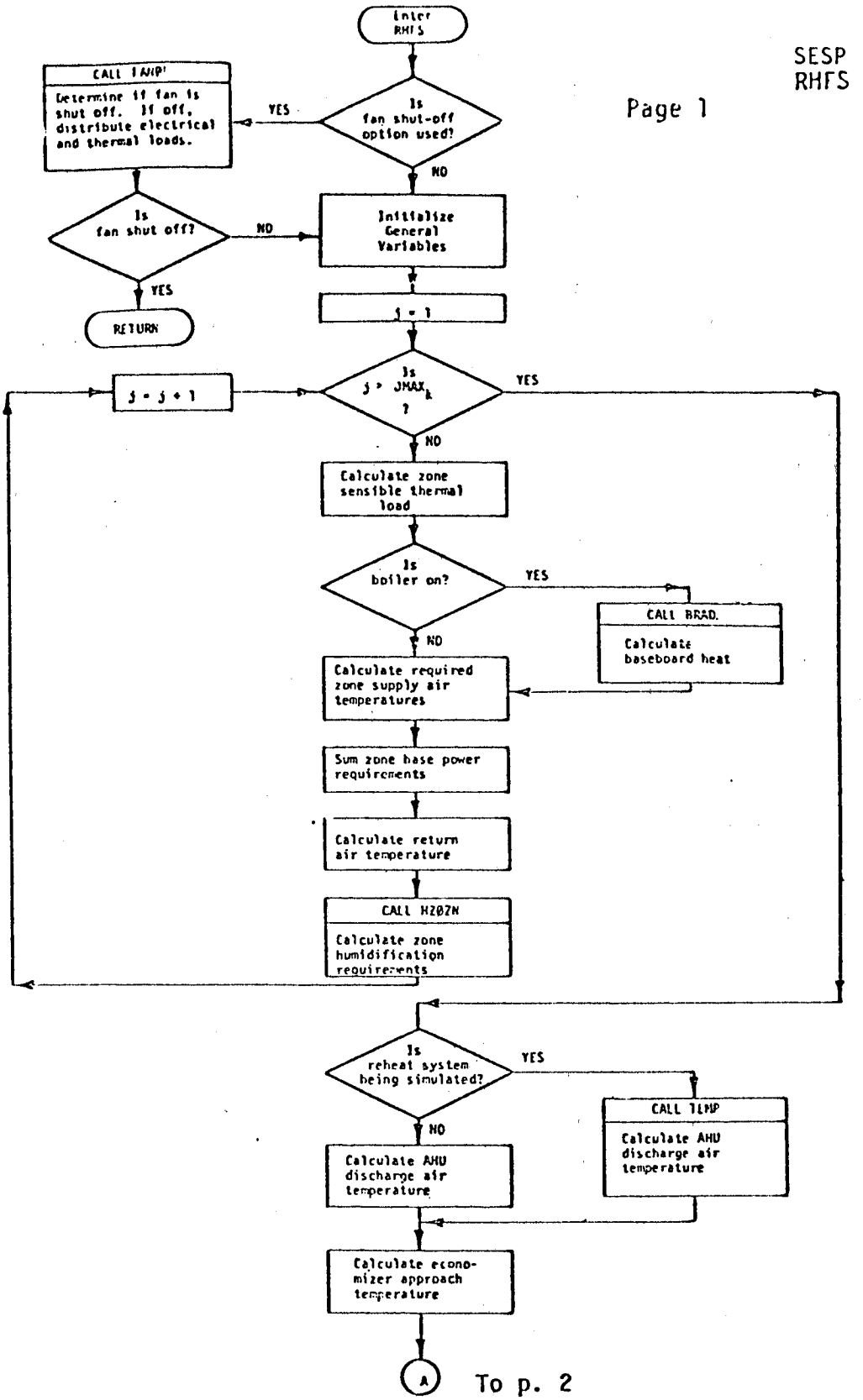

ENTER PSY2
CALL PPWVM
CALCULATE PARTIAL PRESSURE OF WATER VAPOR IN AIR FOR GIVEN CONDITIONS
CALCULATE HUMIDITY RATIO OF AIR FOR GIVEN CONDITIONS
RETURN


ENTER PSYCH
CALCULATE ENTHALPY OF MOIST AIR FOR GIVEN CONDITIONS
CALCULATE SPECIFIC VOLUME OF MOIST AIR FOR GIVEN CONDITIONS
CALCULATE SPECIFIC DENSITY OF MOIST AIR FOR GIVEN CONDITIONS
RETURN

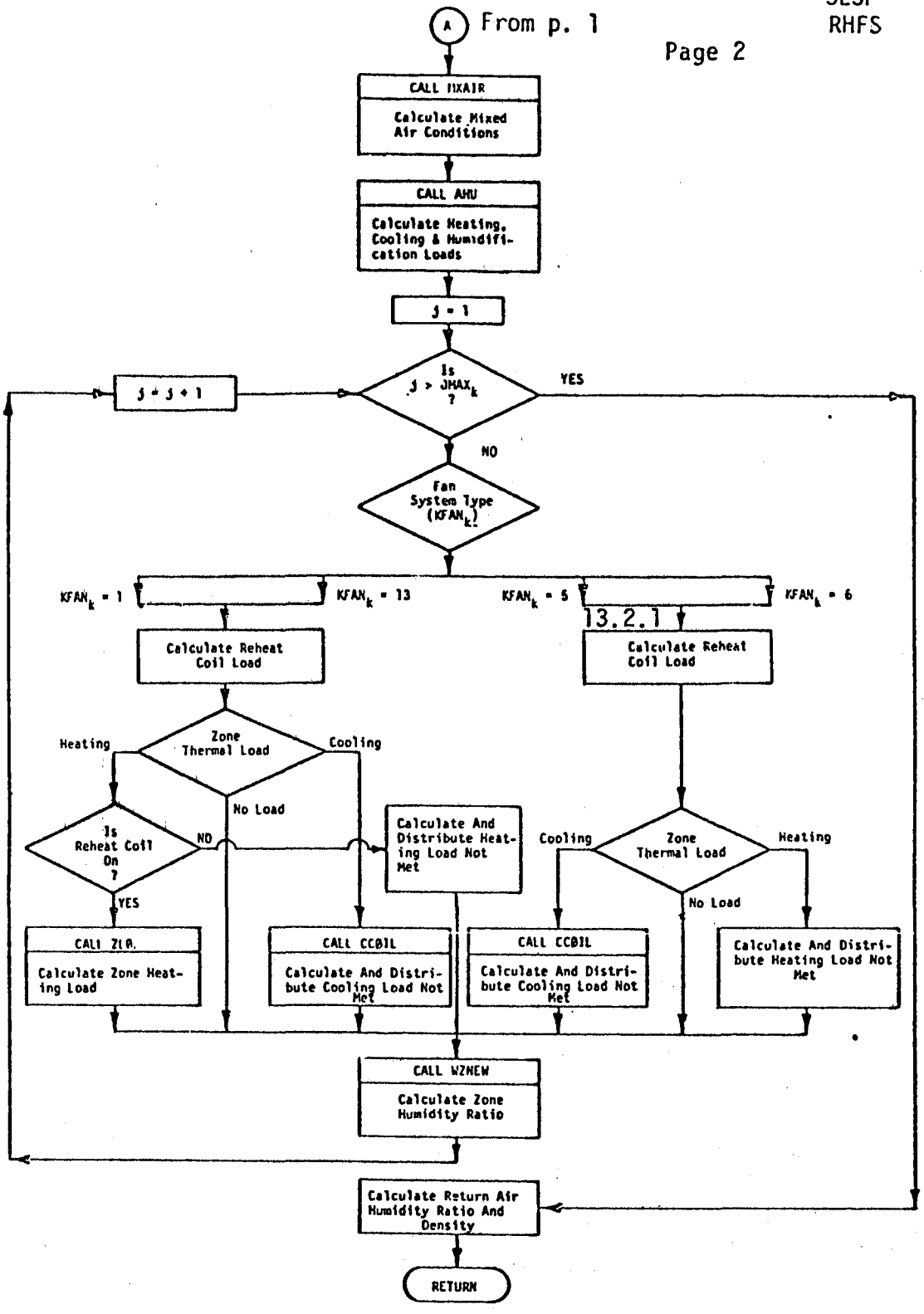

SESP
PTLD
ENTER PTLD
IS FAN FULLY LOADED ?
YES
CALCULATE FRACTION OF POWER REQUIRED FOR 100% LOADING
NO
SET UP INTER-MEDIATE VARIABLE PCT = PC
IS PCT < 0.20 ?
YES
RESET PCT = 0.20
NO
IS PCT > 1.1 ?
YES
RESET PCT = 1.1
NO
m = NC
m=1
m=2
m=3
CALCULATE FRACTION OF POWER REQUIRED FOR VAR. SPEED MOTOR CONTROL
CALCULATE FRACTION OF POWER REQUIRED FOR INLET VANE DAMPER CONTROL
CALCULATE FRACTION OF POWER REQUIRED FOR DISCHARGE DAMPER CONTROL
RETURN

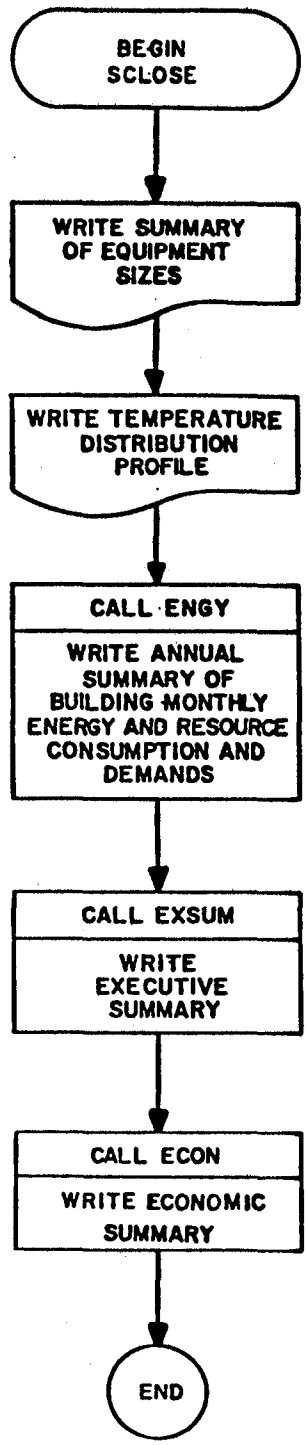

ENTER
RECIP
Calculate Power Per
Ton Of Refrigeration
Required
Calculate Total
Hourly Power
Consumption
Return

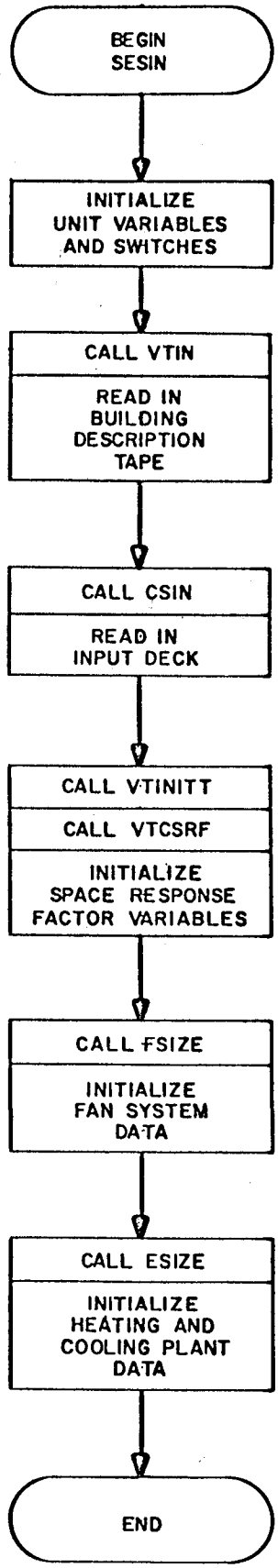
Page 1

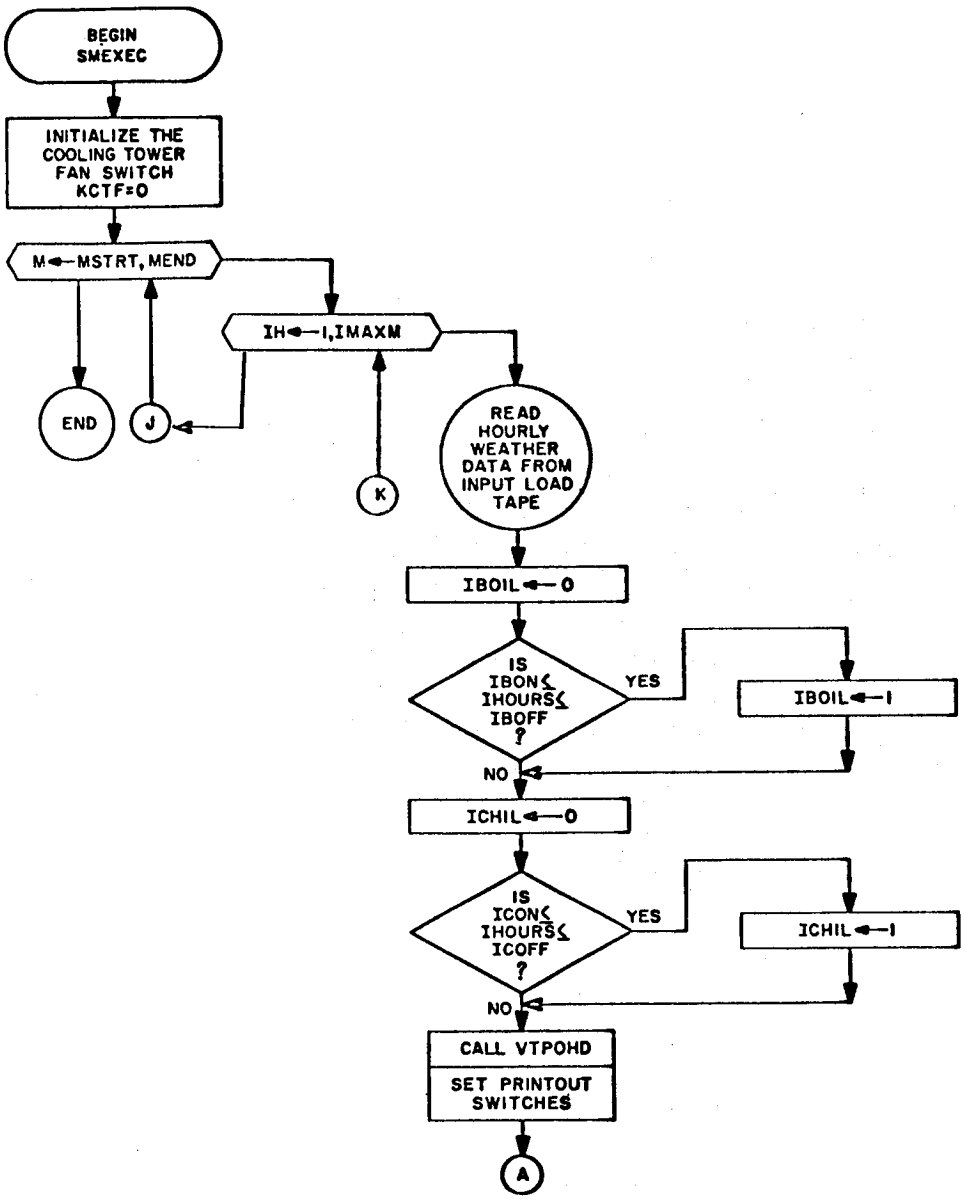

Enter RHFS
Is fan shut-off option used?
YES
NO
CALL FANP
Determine if fan is shut off. If off, distribute electrical and thermal loads.
Is fan shut off?
NO
YES
RETURN
Initialize General Variables
j = 1
Is j > JMAX_k ?
YES
NO
j = j + 1
Calculate zone sensible thermal load
Is boiler on?
YES
NO
CALL BRAD.
Calculate baseboard heat
Calculate required zone supply air temperatures
Sum zone base power requirements
Calculate return air temperature
CALL HZØZN
Calculate zone humidification requirements
Is reheat system being simulated?
YES
NO
CALL TLMP
Calculate AHU discharge air temperature
Calculate AHU discharge air temperature
Calculate economizer approach temperature
A

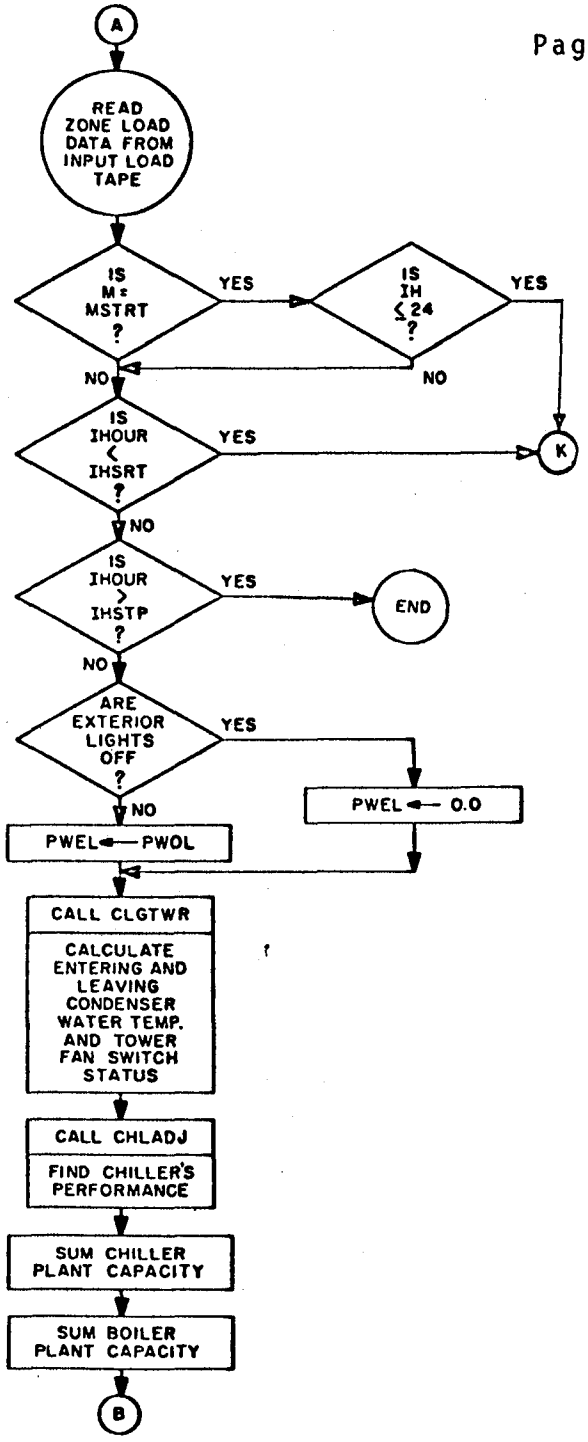
To p. 2

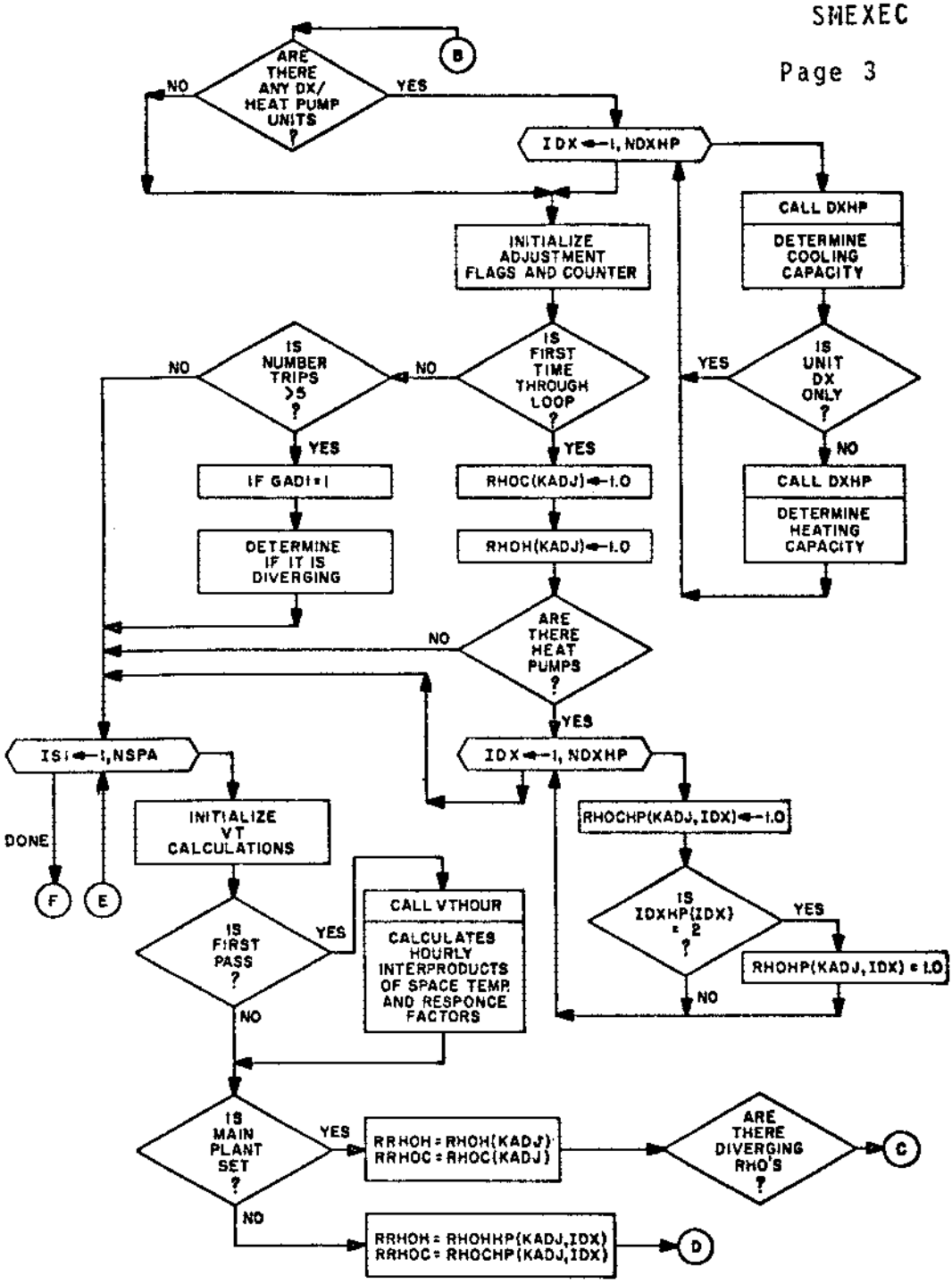

A
From p. 1
CALL MIXAIR
Calculate Mixed Air Conditions
CALL AHU
Calculate Heating, Cooling & Humidification Loads
J = 1
Is J > JMAX_k ?
YES
NO
J = J + 1
Fan System Type (KFAN_k)
KFAN_k = 1
KFAN_k = 13
KFAN_k = 5
KFAN_k = 6
13.2.1
Calculate Reheat Coil Load
Calculate Reheat Coil Load
Zone Thermal Load
Heating
Cooling
No Load
Is Reheat Coil On ?
NO
YES
Calculate And Distribute Heating Load Not Met
Zone Thermal Load
Cooling
Heating
No Load
CALL ZLR
Calculate Zone Heating Load
CALL CCØIL
Calculate And Distribute Cooling Load Not Met
CALL CCØIL
Calculate And Distribute Cooling Load Not Met
Calculate And Distribute Heating Load Not Met
CALL WZNEW
Calculate Zone Humidity Ratio
Calculate Return Air Humidity Ratio And Density
RETURN

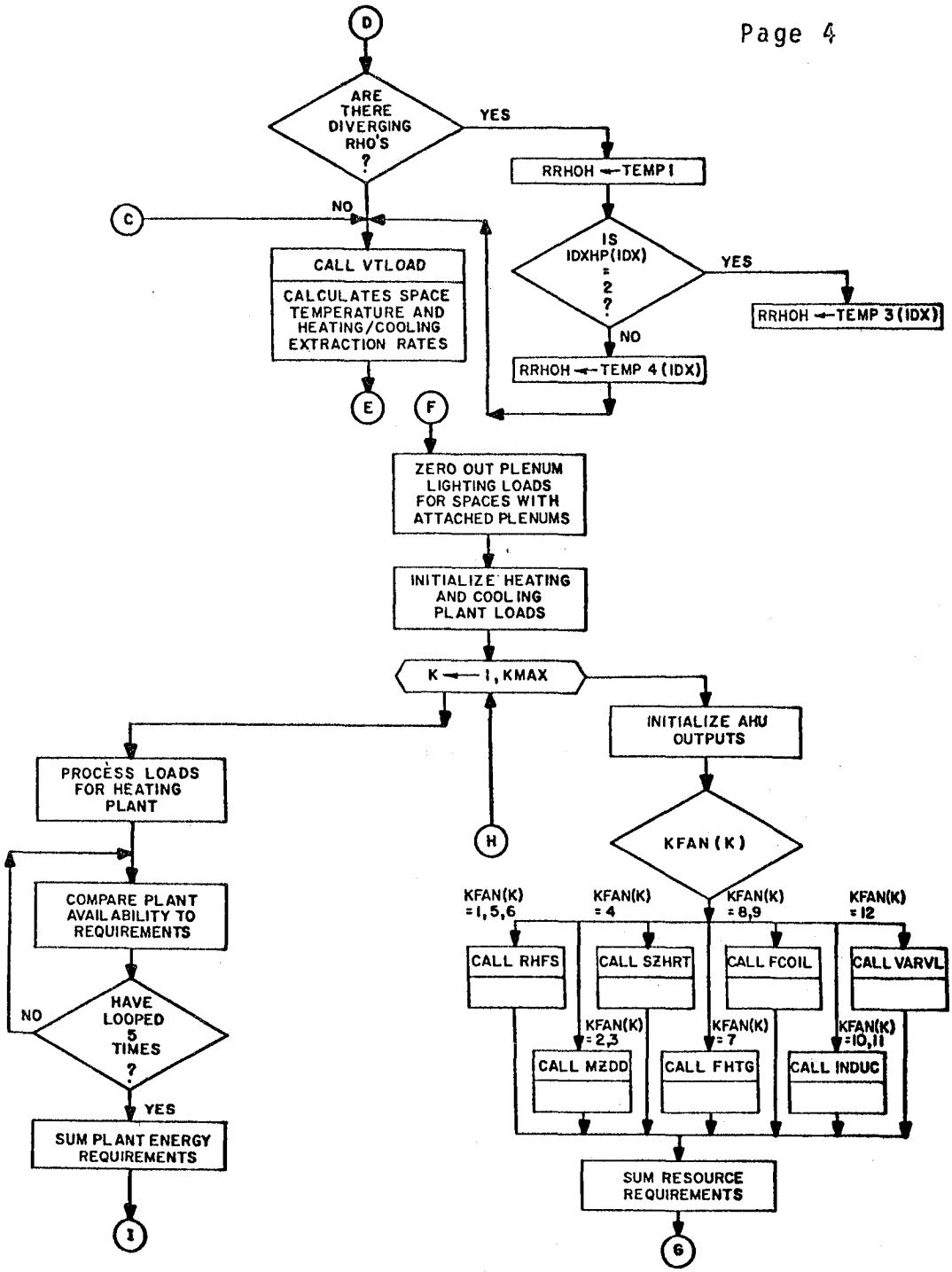

BEGIN
SCLOSE
WRITE SUMMARY OF EQUIPMENT SIZES
WRITE TEMPERATURE DISTRIBUTION PROFILE
CALL ENGY
WRITE ANNUAL SUMMARY OF BUILDING MONTHLY ENERGY AND RESOURCE CONSUMPTION AND DEMANDS
CALL EXSUM
WRITE EXECUTIVE SUMMARY
CALL ECON
WRITE ECONOMIC SUMMARY
END

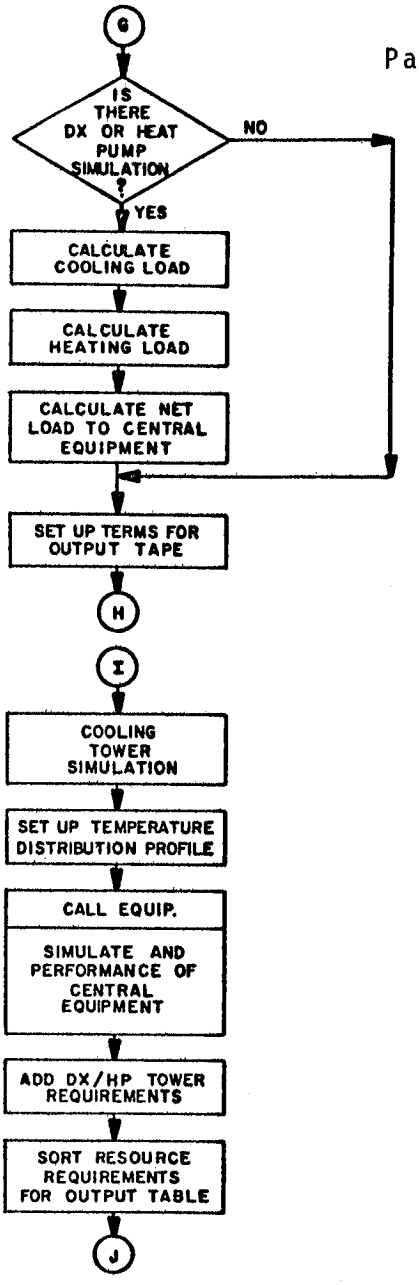

BEGIN
SESIN
INITIALIZE
UNIT VARIABLES
AND SWITCHES
CALL VTIN
READ IN
BUILDING
DESCRIPTION
TAPE
CALL CSIN
READ IN
INPUT DECK
CALL VTINITT
CALL VTCSRF
INITIALIZE
SPACE RESPONSE
FACTOR VARIABLES
CALL FSIZE
INITIALIZE
FAN SYSTEM
DATA
CALL ESIZE
INITIALIZE
HEATING AND
COOLING PLANT
DATA
END

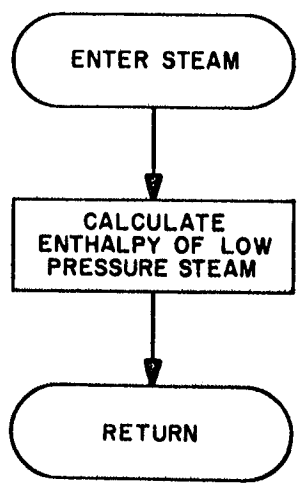

BEGIN SMEXEC
INITIALIZE THE COOLING TOWER FAN SWITCH KCTF=0
M←MSTRT, MEND
IH←1,IMAXM
END
J
K
READ HOURLY WEATHER DATA FROM INPUT LOAD TAPE
IBOIL←0
IS IBON≤ IHOURS≤ IBOFF ?
YES
IBOIL←1
NO
ICHIL←0
IS ICON≤ IHOURS≤ ICOFF ?
YES
ICHIL←1
NO
CALL VTPOHD
SET PRINTOUT SWITCHES
A

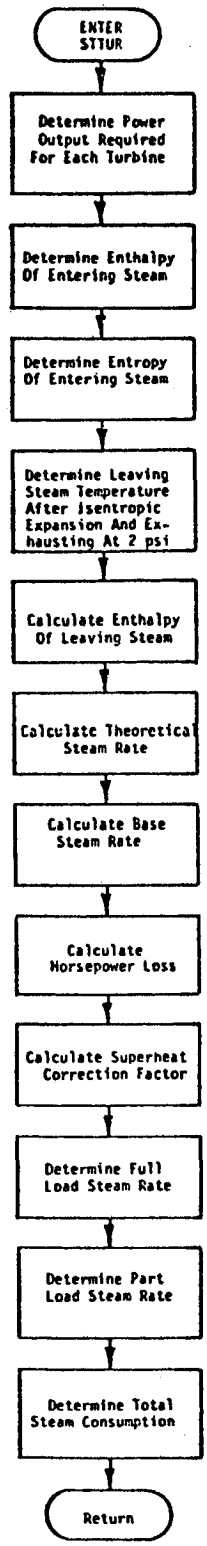

A
READ ZONE LOAD DATA FROM INPUT LOAD TAPE
IS M = MSTRT ?
YES
IS IH ≤ 24 ?
YES
NO
NO
IS IHOUR < IHSRT ?
YES
K
NO
IS IHOUR > IHSTP ?
YES
END
NO
ARE EXTERIOR LIGHTS OFF ?
YES
PWEL ← 0.0
NO
PWEL ← PWOL
CALL CLGTWR
CALCULATE ENTERING AND LEAVING CONDENSER WATER TEMP. AND TOWER FAN SWITCH STATUS
CALL CHLADJ
FIND CHILLER'S PERFORMANCE
SUM CHILLER PLANT CAPACITY
SUM BOILER PLANT CAPACITY
B

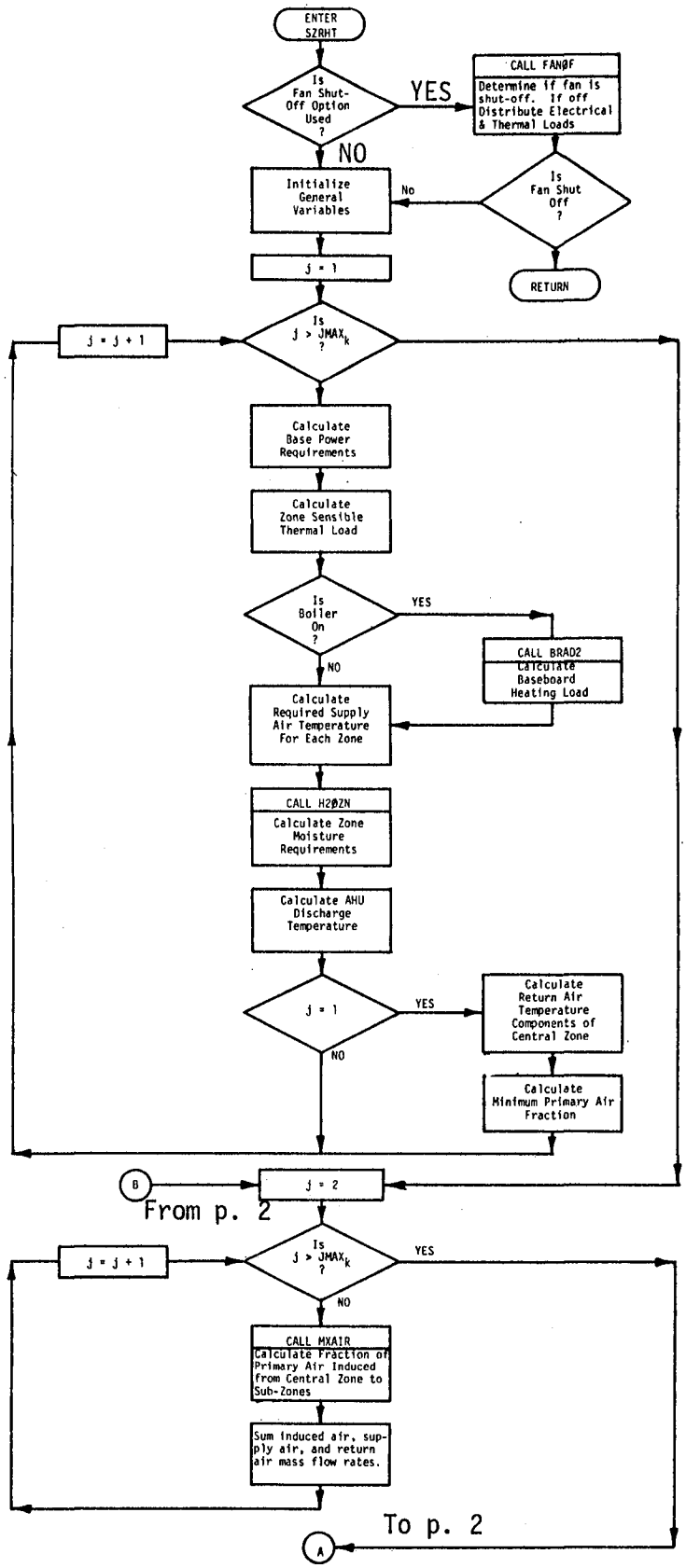

ARE THERE ANY DX/ HEAT PUMP UNITS ?
NO
YES
B
IDX ← 1, NDXHP
CALL DXHP
DETERMINE COOLING CAPACITY
INITIALIZE ADJUSTMENT FLAGS AND COUNTER
IS NUMBER TRIPS >5 ?
NO
IS FIRST TIME THROUGH LOOP ?
NO
YES
IS UNIT DX ONLY ?
YES
NO
YES
IF GADI = 1
RHOC(KADJ) ← 1.0
CALL DXHP
DETERMINE HEATING CAPACITY
DETERMINE IF IT IS DIVERGING
RHOH(KADJ) ← 1.0
ARE THERE HEAT PUMPS ?
NO
YES
IS1 ← 1, NSPA
IDX ← 1, NDXHP
DONE
F
E
INITIALIZE VT CALCULATIONS
RHOCHP(KADJ, IDX) ← 1.0
IS IDXHP(IDX) = 2 ?
YES
RHOHP(KADJ, IDX) = 1.0
NO
IS FIRST PASS ?
YES
NO
CALL VTHOUR
CALCULATES HOURLY INTERPRODUCTS OF SPACE TEMP AND RESPONCE FACTORS
IS MAIN PLANT SET ?
YES
RRHOH = RHOH(KADJ)
RRHOC = RHOC(KADJ)
ARE THERE DIVERGING RHO'S ?
C
NO
RRHOH = RHOHHP(KADJ,IDX)
RRHOC = RHOCHP(KADJ,IDX)
D

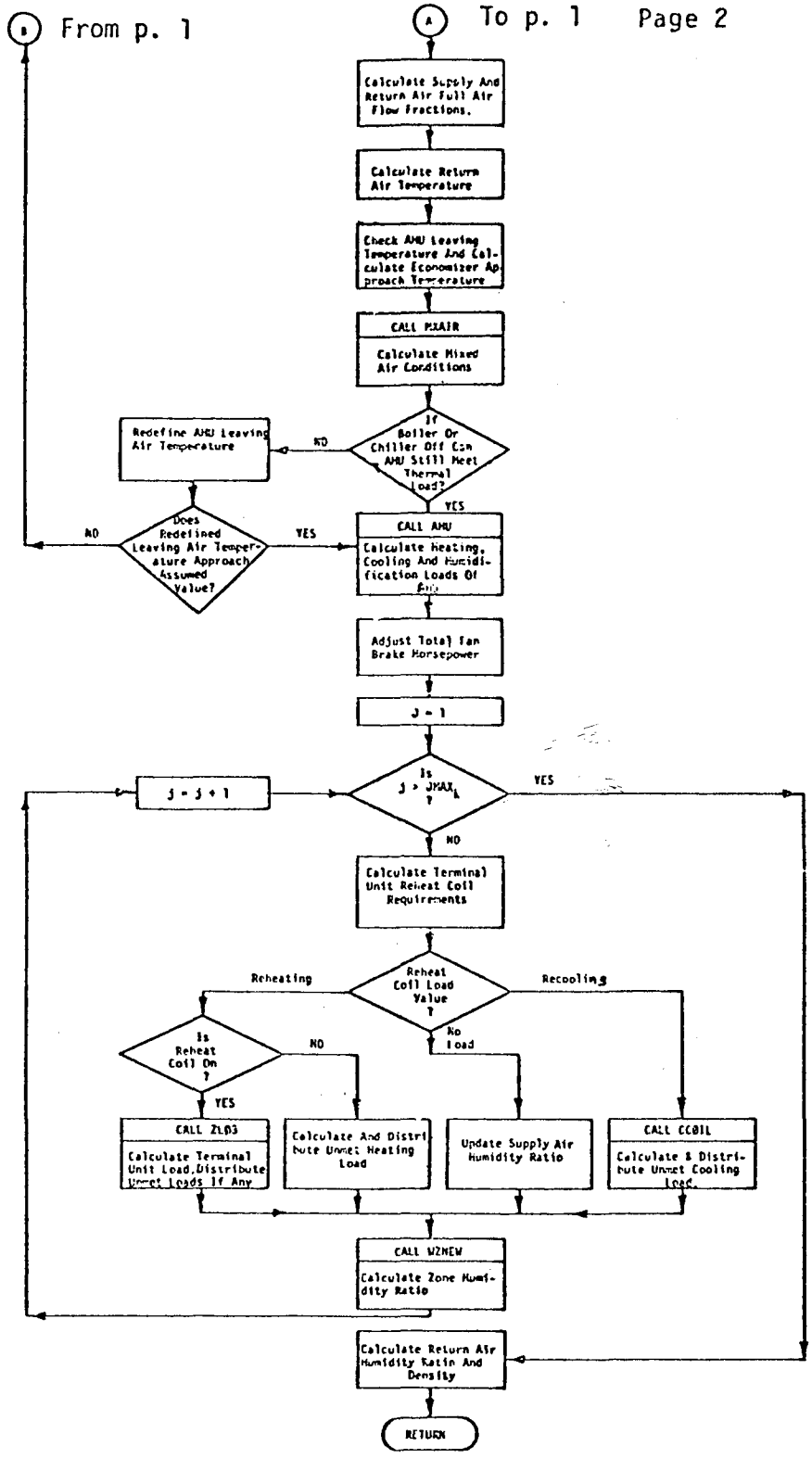

D
ARE THERE DIVERGING RHO'S ?
YES
NO
C
RRHOH ← TEMP 1
IS IDXHP(IDX) = 2 ?
YES
NO
RRHOH ← TEMP 3 (IDX)
RRHOH ← TEMP 4 (IDX)
CALL VTLOAD
CALCULATES SPACE TEMPERATURE AND HEATING/COOLING EXTRACTION RATES
E
F
ZERO OUT PLENUM LIGHTING LOADS FOR SPACES WITH ATTACHED PLENUMS
INITIALIZE HEATING AND COOLING PLANT LOADS
K ← 1, KMAX
INITIALIZE AHU OUTPUTS
PROCESS LOADS FOR HEATING PLANT
H
KFAN (K)
COMPARE PLANT AVAILABILITY TO REQUIREMENTS
NO
HAVE LOOPED 5 TIMES ?
YES
SUM PLANT ENERGY REQUIREMENTS
I
KFAN(K) = 1,5,6
KFAN(K) = 4
KFAN(K) = 8,9
KFAN(K) = 12
CALL RHFS
CALL SZHRT
CALL FCOIL
CALL VARVL
KFAN(K) = 2,3
KFAN(K) = 7
KFAN(K) = 10,11
CALL MZDD
CALL FHTG
CALL INDUC
SUM RESOURCE REQUIREMENTS
G

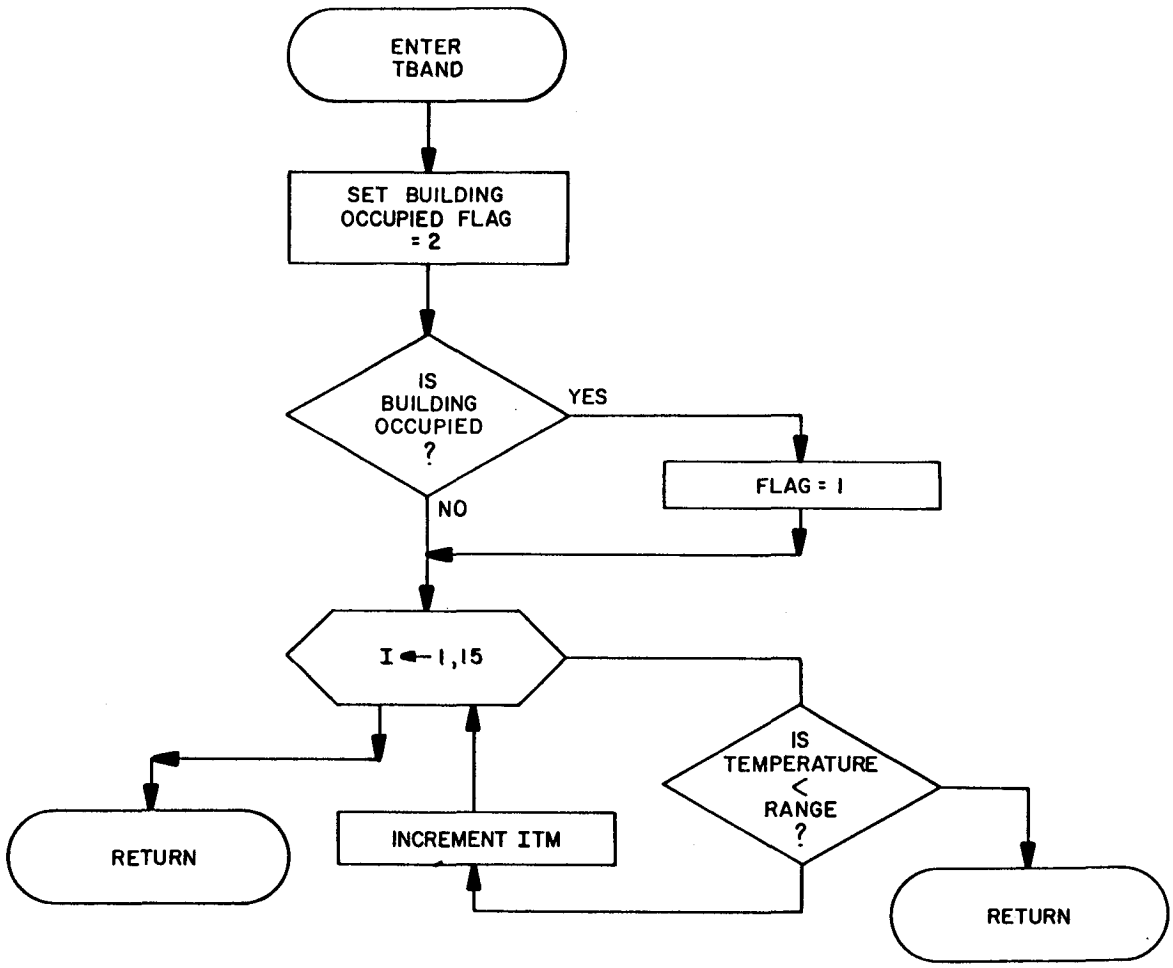

G
IS THERE DX OR HEAT PUMP SIMULATION ?
NO
YES
CALCULATE COOLING LOAD
CALCULATE HEATING LOAD
CALCULATE NET LOAD TO CENTRAL EQUIPMENT
SET UP TERMS FOR OUTPUT TAPE
H
I
COOLING TOWER SIMULATION
SET UP TEMPERATURE DISTRIBUTION PROFILE
CALL EQUIP.
SIMULATE AND PERFORMANCE OF CENTRAL EQUIPMENT
ADD DX/HP TOWER REQUIREMENTS
SORT RESOURCE REQUIREMENTS FOR OUTPUT TABLE
J

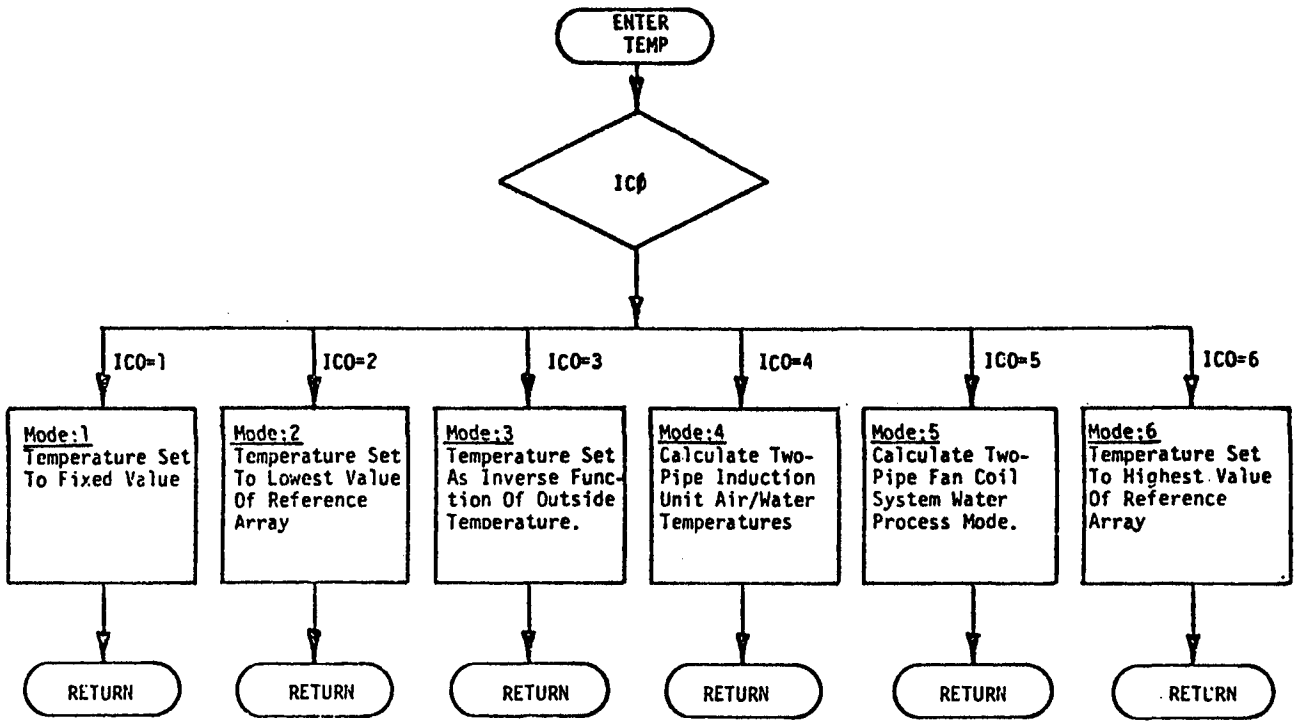

ENTER STEAM
CALCULATE ENTHALPY OF LOW PRESSURE STEAM
RETURN

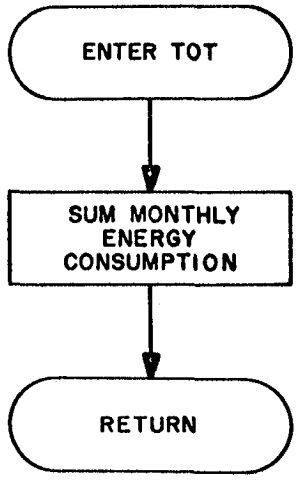

ENTER STTUR
Determine Power Output Required For Each Turbine
Determine Enthalpy Of Entering Steam
Determine Entropy Of Entering Steam
Determine Leaving Steam Temperature After Isentropic Expansion And Exhausting At 2 psi
Calculate Enthalpy Of Leaving Steam
Calculate Theoretical Steam Rate
Calculate Base Steam Rate
Calculate Horsepower Loss
Calculate Superheat Correction Factor
Determine Full Load Steam Rate
Determine Part Load Steam Rate
Determine Total Steam Consumption
Return

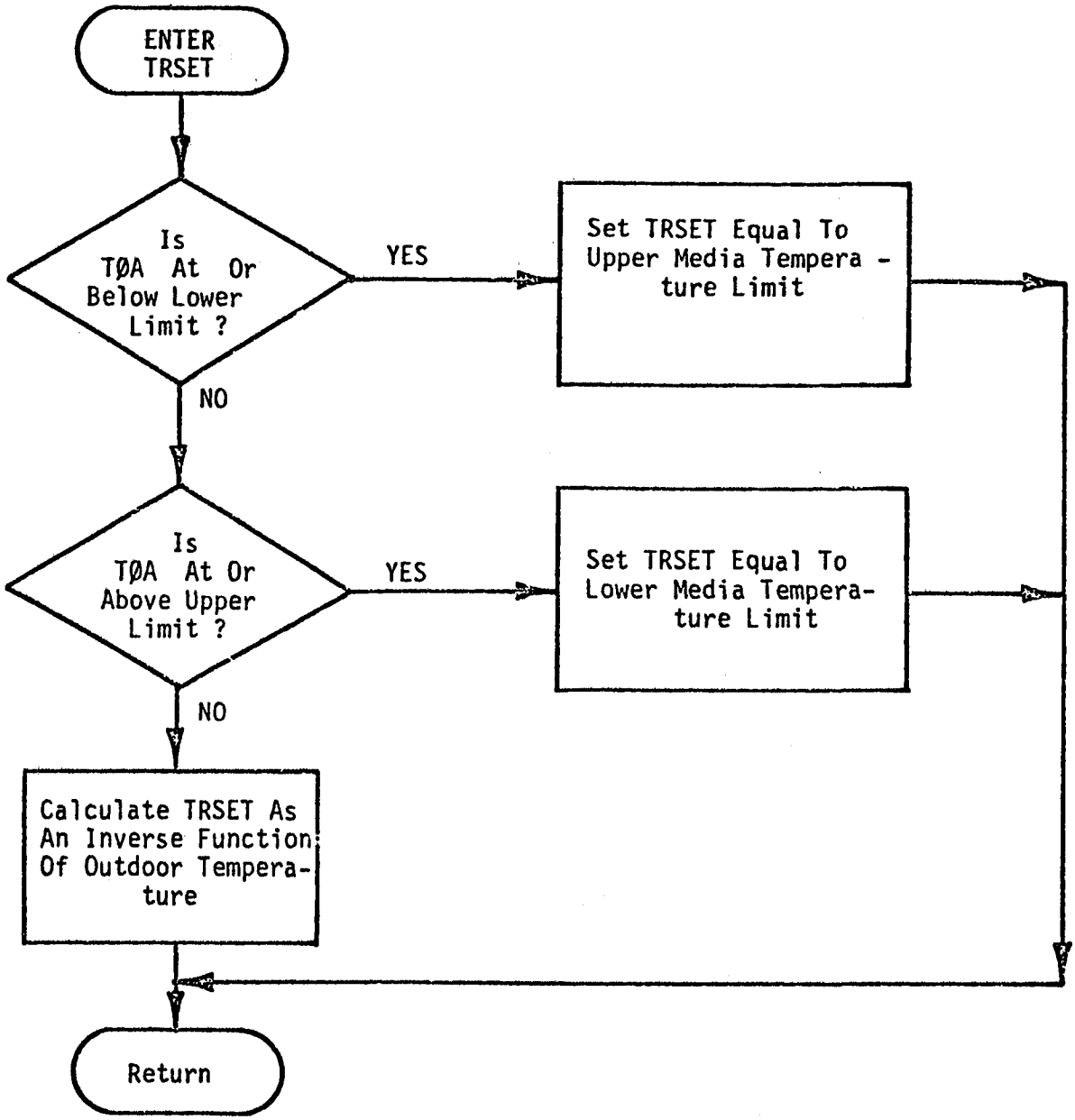

ENTER SZRHT
Is Fan Shut-Off Option Used ?
YES
NO
CALL FANØF
Determine if fan is shut-off. If off Distribute Electrical & Thermal Loads
Is Fan Shut Off ?
No
RETURN
Initialize General Variables
j = 1
j = j + 1
Is j > JMAXk ?
Calculate Base Power Requirements
Calculate Zone Sensible Thermal Load
Is Boiler On ?
YES
NO
CALL BRAD2
Calculate Baseboard Heating Load
Calculate Required Supply Air Temperature For Each Zone
CALL HØZN
Calculate Zone Moisture Requirements
Calculate AHU Discharge Temperature
j = 1
YES
NO
Calculate Return Air Temperature Components of Central Zone
Calculate Minimum Primary Air Fraction
B
From p. 2
j = 2
j = j + 1
Is j > JMAXk ?
YES
NO
CALL MXAIR
Calculate Fraction of Primary Air Induced from Central Zone to Sub-Zones
Sum induced air, supply air, and return air mass flow rates.
To p. 2
A

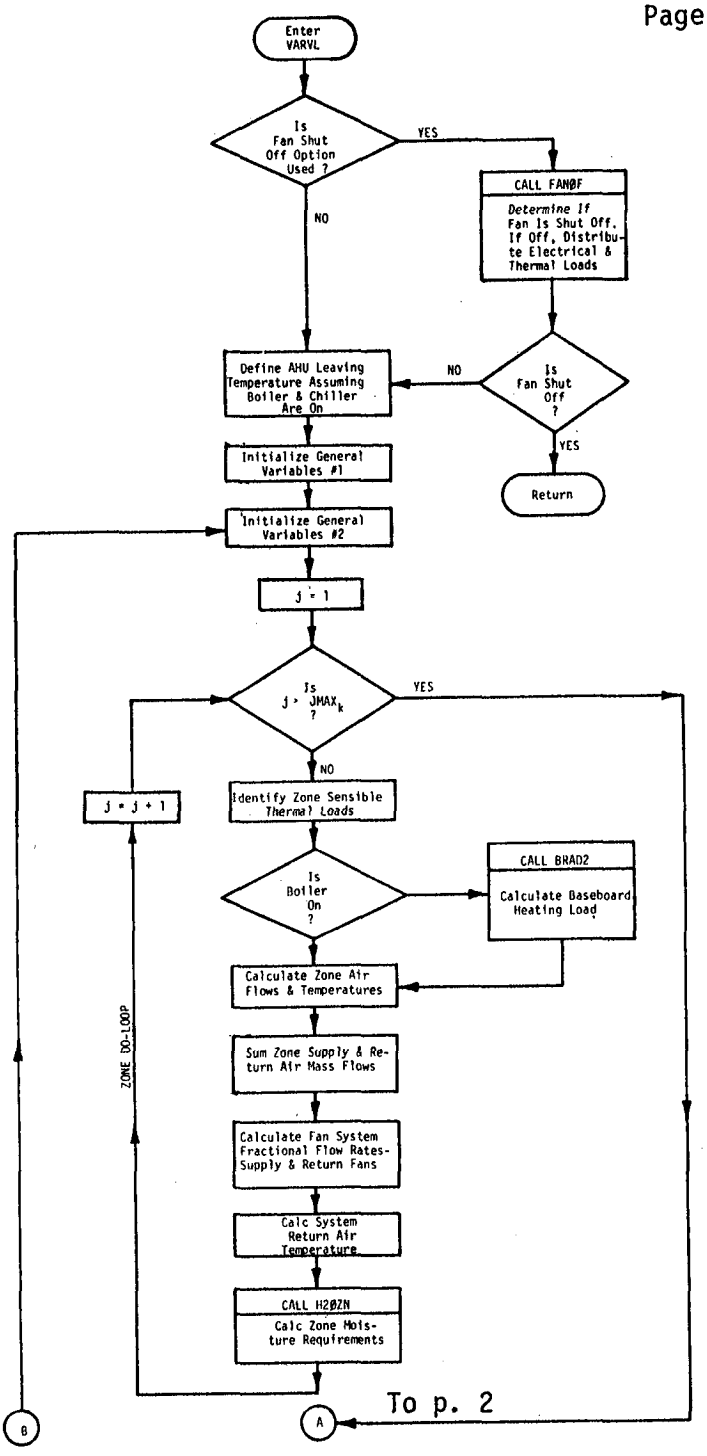

From p. 1
To p. 1
Page 2
Calculate Supply And Return Air Full Air Flow Fractions.
Calculate Return Air Temperature
Check AHU Leaving Temperature And Calculate Economizer Approach Temperature
CALL MXAIR
Calculate Mixed Air Conditions
If Boiler Or Chiller Off Can AHU Still Meet Thermal Load?
NO
Redefine AHU Leaving Air Temperature
YES
Does Redefined Leaving Air Temperature Approach Assumed Value?
NO
YES
CALL AHU
Calculate Heating, Cooling And Humidification Loads Of Fan
Adjust Total Fan Brake Horsepower
J = 1
Is J > JMAX ?
YES
NO
J = J + 1
Calculate Terminal Unit Reheat Coil Requirements
Reheat Coil Load Value ?
Reheating
Recooling
No Load
Is Reheat Coil On ?
NO
YES
CALL ZLO3
Calculate Terminal Unit Load, Distribute Unmet Loads If Any
Calculate And Distribute Unmet Heating Load
Update Supply Air Humidity Ratio
CALL CCOIL
Calculate & Distribute Unmet Cooling Load.
CALL WZNEW
Calculate Zone Humidity Ratio
Calculate Return Air Humidity Ratio And Density
RETURN


ENTER
TBAND
SET BUILDING
OCCUPIED FLAG
= 2
IS
BUILDING
OCCUPIED
?
YES
FLAG = 1
NO
I ← 1,15
IS
TEMPERATURE
<
RANGE
?
RETURN
INCREMENT ITM
RETURN


ENTER TEMP
ICØ
ICO=1
ICO=2
ICO=3
ICO=4
ICO=5
ICO=6
Mode:1 Temperature Set To Fixed Value
Mode:2 Temperature Set To Lowest Value Of Reference Array
Mode:3 Temperature Set As Inverse Function Of Outside Temperature.
Mode:4 Calculate Two-Pipe Induction Unit Air/Water Temperatures
Mode:5 Calculate Two-Pipe Fan Coil System Water Process Mode.
Mode:6 Temperature Set To Highest Value Of Reference Array
RETURN
RETURN
RETURN
RETURN
RETURN
RETURN

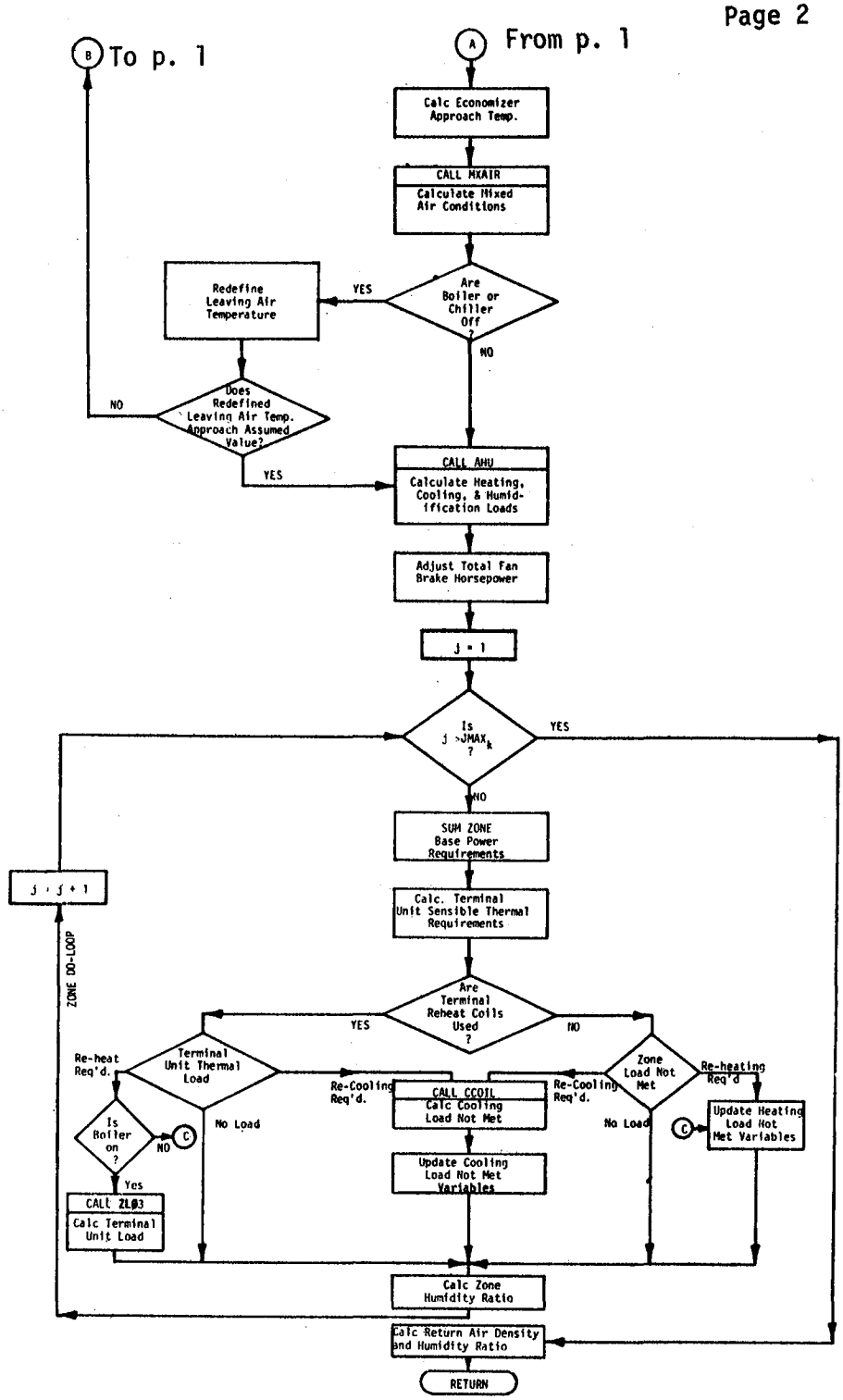

ENTER TOT
SUM MONTHLY ENERGY CONSUMPTION
RETURN

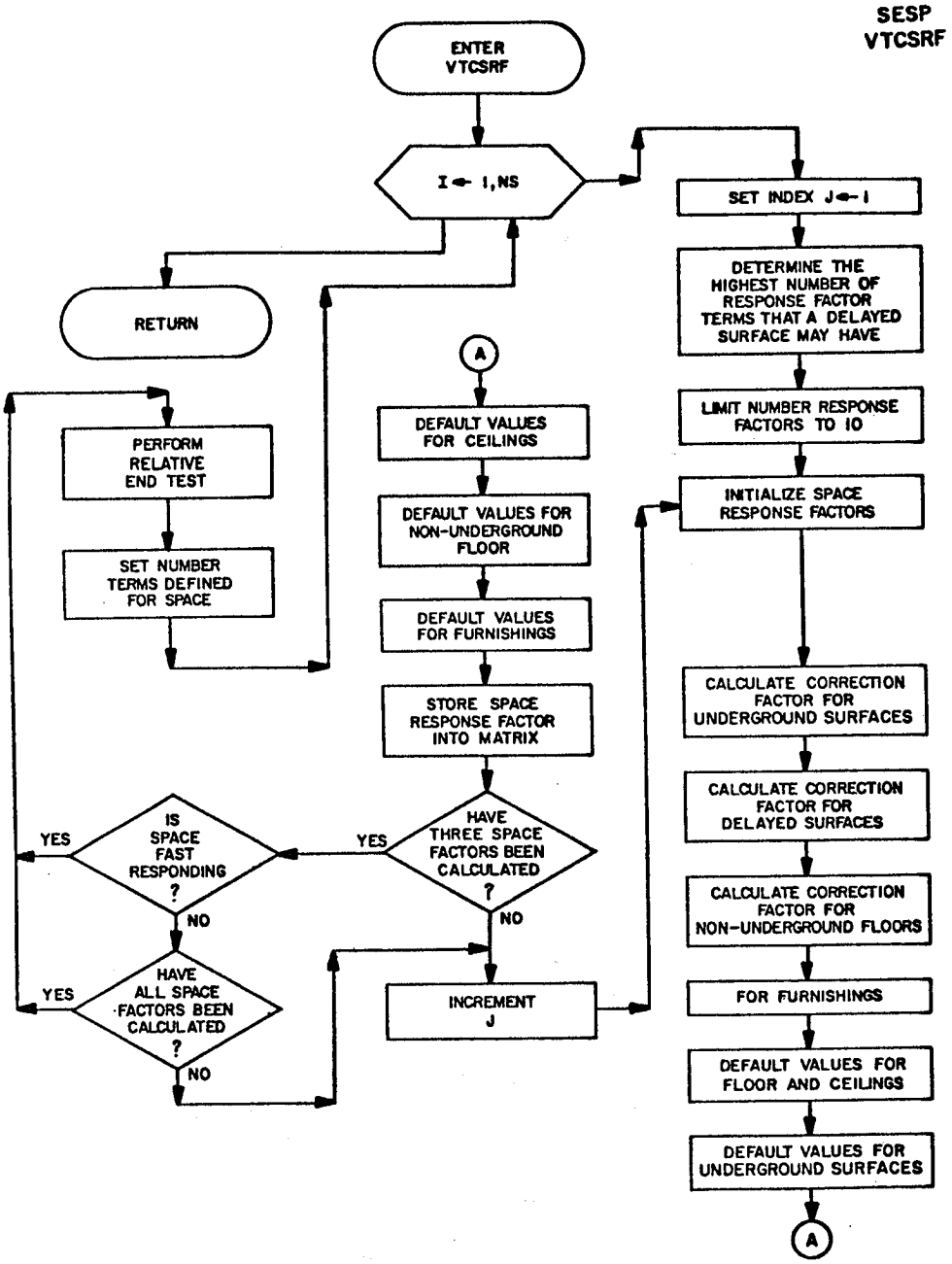

ENTER TRSET
Is TØA At Or Below Lower Limit ?
YES
Set TRSET Equal To Upper Media Tempera - ture Limit
NO
Is TØA At Or Above Upper Limit ?
YES
Set TRSET Equal To Lower Media Tempera- ture Limit
NO
Calculate TRSET As An Inverse Function Of Outdoor Tempera- ture
Return

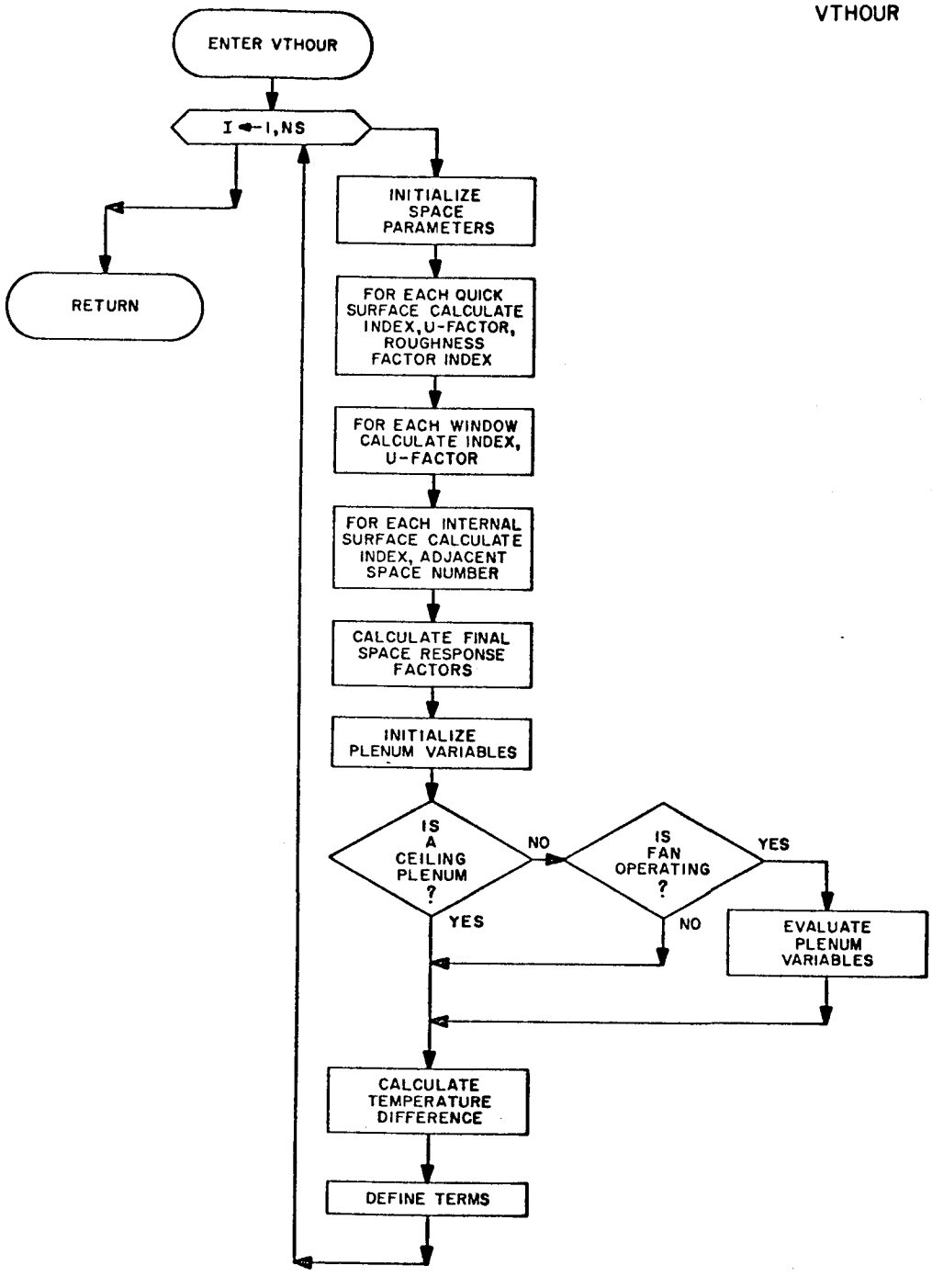

Enter VARVL
Is Fan Shut Off Option Used ?
YES
NO
CALL FANØF
Determine If Fan Is Shut Off. If Off, Distribute Electrical & Thermal Loads
Is Fan Shut Off ?
NO
YES
Return
Define AHU Leaving Temperature Assuming Boiler & Chiller Are On
Initialize General Variables #1
Initialize General Variables #2
j = 1
Is j > JMAXk ?
YES
NO
j = j + 1
Identify Zone Sensible Thermal Loads
Is Boiler On ?
CALL BRAD2
Calculate Baseboard Heating Load
Calculate Zone Air Flows & Temperatures
Sum Zone Supply & Return Air Mass Flows
Calculate Fan System Fractional Flow Rates-Supply & Return Fans
Calc System Return Air Temperature
CALL HØZN
Calc Zone Moisture Requirements
ZONE DO-LOOP
B
A

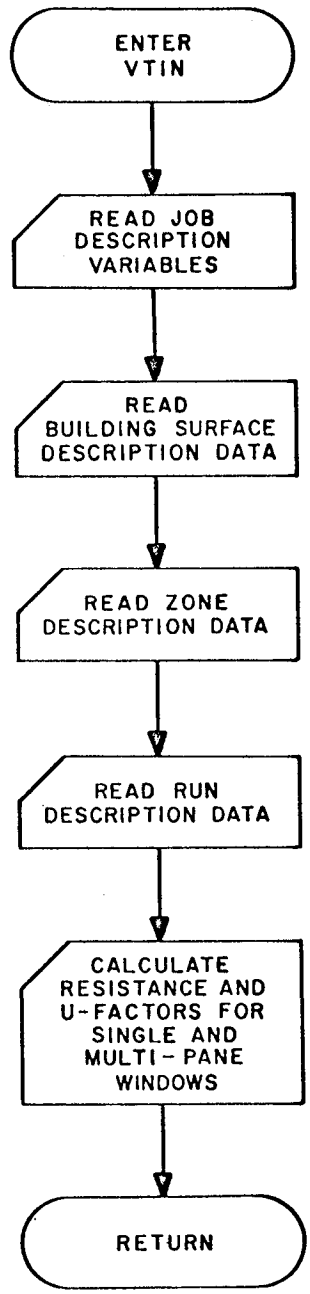
From p. 2

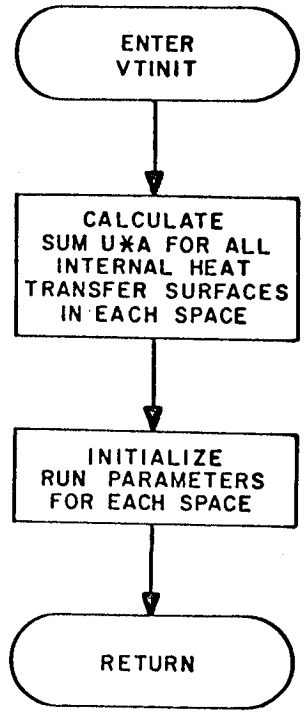
To p. 2

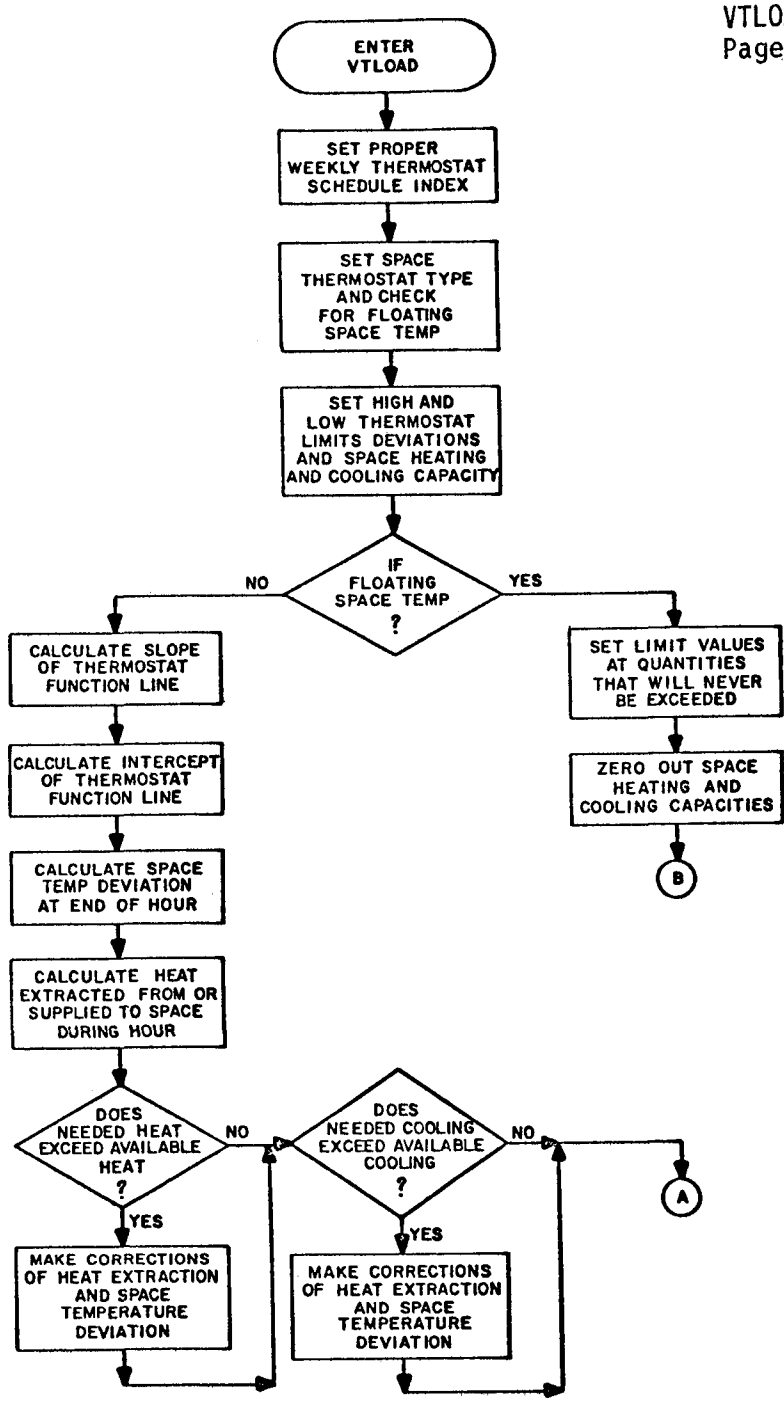

B To p. 1
A From p. 1
Calc Economizer Approach Temp.
CALL MXAIR
Calculate Mixed Air Conditions
Are Boiler or Chiller Off ?
YES
NO
Redefine Leaving Air Temperature
Does Redefined Leaving Air Temp. Approach Assumed Value?
NO
YES
CALL AHU
Calculate Heating, Cooling, & Humidification Loads
Adjust Total Fan Brake Horsepower
J = 1
Is J >JMAX$_k$?
YES
NO
SUM ZONE Base Power Requirements
J = J + 1
ZONE DO-LOOP
Calc. Terminal Unit Sensible Thermal Requirements
Are Terminal Reheat Coils Used ?
YES
NO
Terminal Unit Thermal Load
Re-heat Req'd.
Re-Cooling Req'd.
No Load
Is Boiler on ?
NO
C
Yes
CALL ZL03
Calc Terminal Unit Load
CALL CCOIL
Calc Cooling Load Not Met
Update Cooling Load Not Met Variables
Zone Load Not Met
Re-heating Req'd
Re-Cooling Req'd.
No Load
C
Update Heating Load Not Met Variables
Calc Zone Humidity Ratio
Calc Return Air Density and Humidity Ratio
RETURN

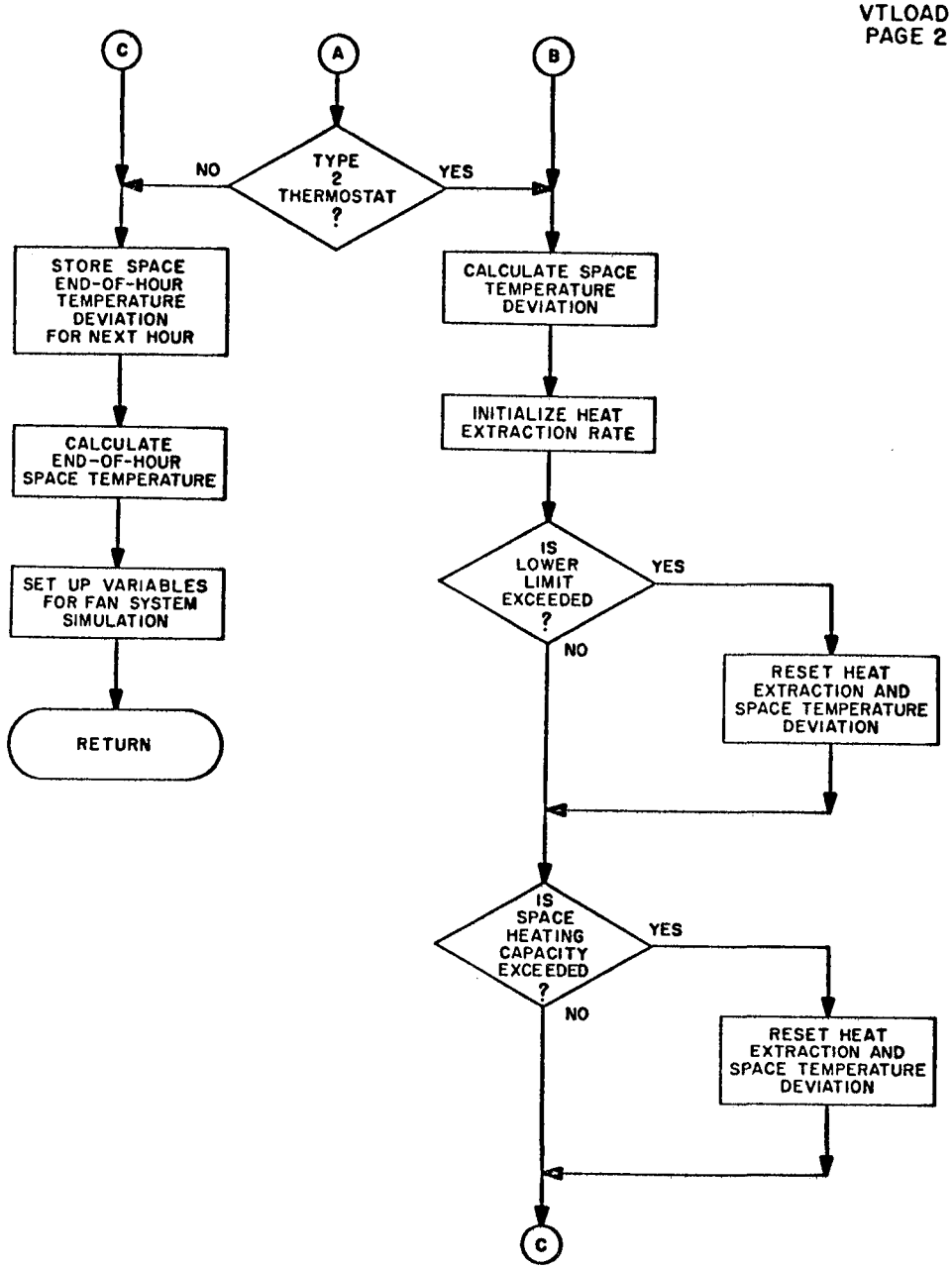

ENTER VTCSRF
I ← 1,NS
RETURN
PERFORM RELATIVE END TEST
SET NUMBER TERMS DEFINED FOR SPACE
A
DEFAULT VALUES FOR CEILINGS
DEFAULT VALUES FOR NON-UNDERGROUND FLOOR
DEFAULT VALUES FOR FURNISHINGS
STORE SPACE RESPONSE FACTOR INTO MATRIX
HAVE THREE SPACE FACTORS BEEN CALCULATED ?
YES
NO
IS SPACE FAST RESPONDING ?
YES
NO
HAVE ALL SPACE FACTORS BEEN CALCULATED ?
YES
NO
INCREMENT J
SET INDEX J ← I
DETERMINE THE HIGHEST NUMBER OF RESPONSE FACTOR TERMS THAT A DELAYED SURFACE MAY HAVE
LIMIT NUMBER RESPONSE FACTORS TO 10
INITIALIZE SPACE RESPONSE FACTORS
CALCULATE CORRECTION FACTOR FOR UNDERGROUND SURFACES
CALCULATE CORRECTION FACTOR FOR DELAYED SURFACES
CALCULATE CORRECTION FACTOR FOR NON-UNDERGROUND FLOORS
FOR FURNISHINGS
DEFAULT VALUES FOR FLOOR AND CEILINGS
DEFAULT VALUES FOR UNDERGROUND SURFACES
A

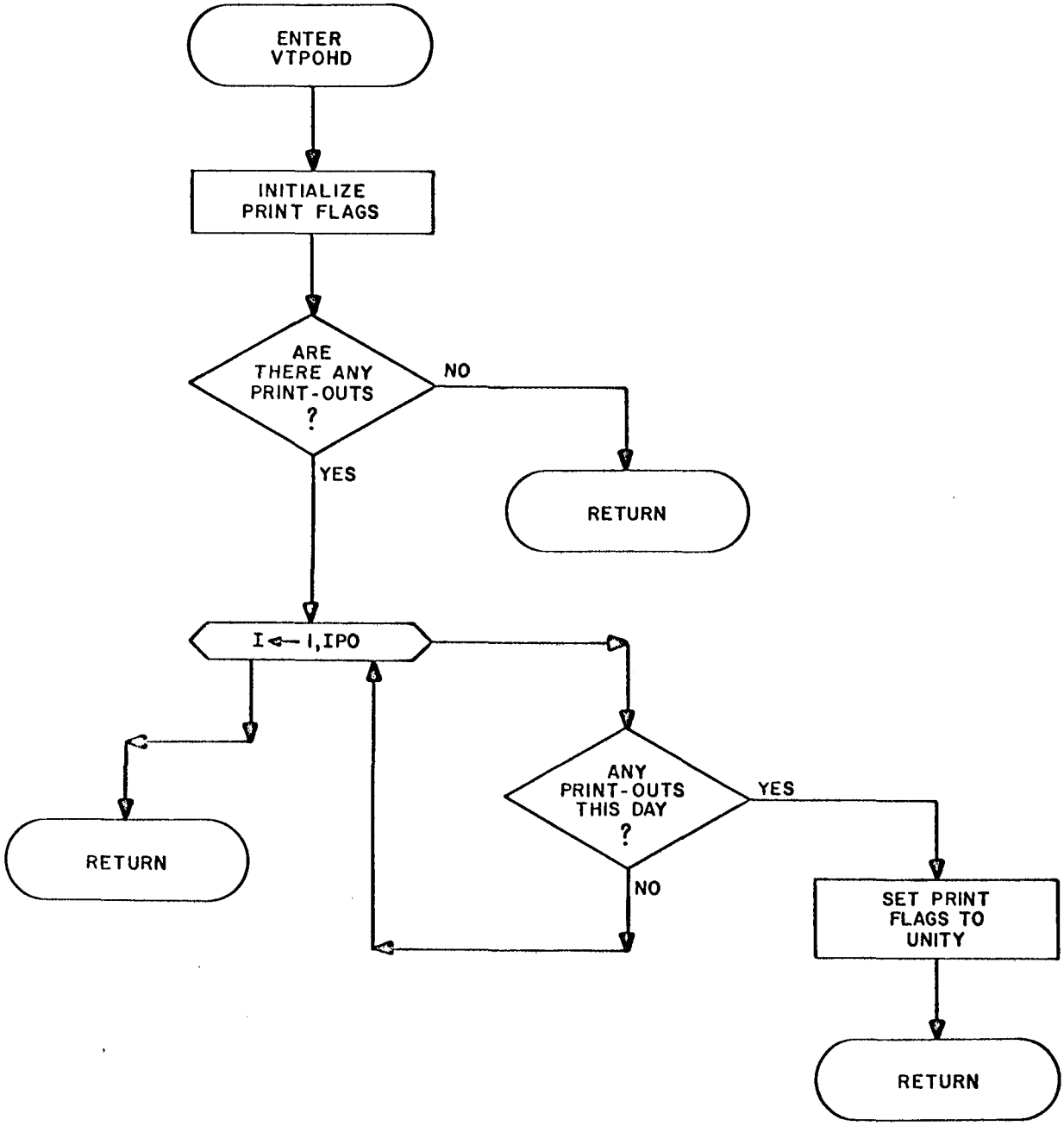

ENTER VTHOUR
I ← 1,NS
RETURN
INITIALIZE SPACE PARAMETERS
FOR EACH QUICK SURFACE CALCULATE INDEX, U-FACTOR, ROUGHNESS FACTOR INDEX
FOR EACH WINDOW CALCULATE INDEX, U-FACTOR
FOR EACH INTERNAL SURFACE CALCULATE INDEX, ADJACENT SPACE NUMBER
CALCULATE FINAL SPACE RESPONSE FACTORS
INITIALIZE PLENUM VARIABLES
IS A CEILING PLENUM ?
NO
IS FAN OPERATING ?
YES
YES
NO
EVALUATE PLENUM VARIABLES
CALCULATE TEMPERATURE DIFFERENCE
DEFINE TERMS

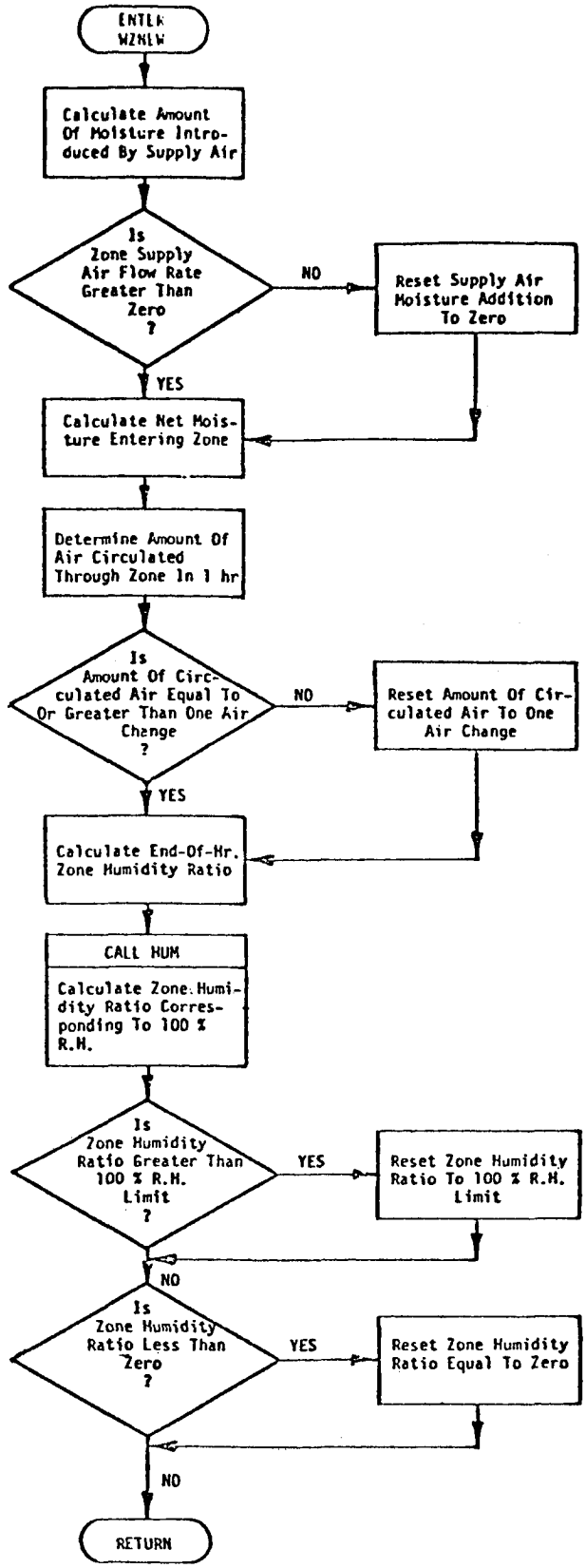

ENTER
VTIN
READ JOB
DESCRIPTION
VARIABLES
READ
BUILDING SURFACE
DESCRIPTION DATA
READ ZONE
DESCRIPTION DATA
READ RUN
DESCRIPTION DATA
CALCULATE
RESISTANCE AND
U-FACTORS FOR
SINGLE AND
MULTI-PANE
WINDOWS
RETURN


ENTER
VTINIT
CALCULATE
SUM U*A FOR ALL
INTERNAL HEAT
TRANSFER SURFACES
IN EACH SPACE
INITIALIZE
RUN PARAMETERS
FOR EACH SPACE
RETURN

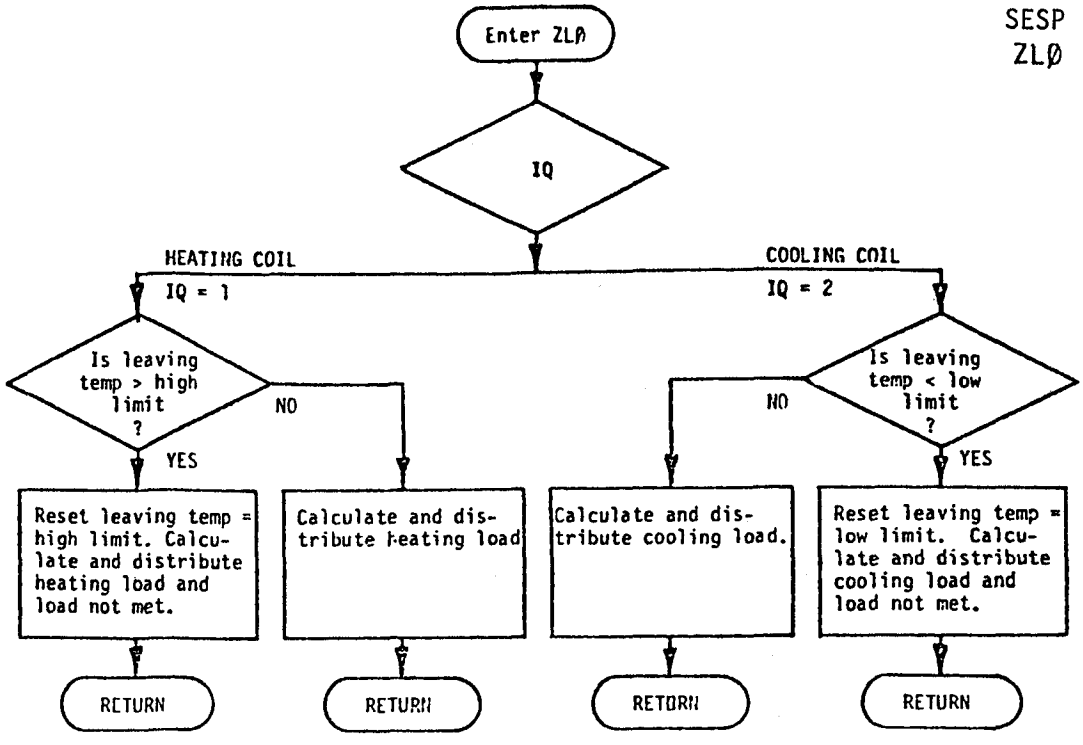

ENTER VTLOAD
SET PROPER WEEKLY THERMOSTAT SCHEDULE INDEX
SET SPACE THERMOSTAT TYPE AND CHECK FOR FLOATING SPACE TEMP
SET HIGH AND LOW THERMOSTAT LIMITS DEVIATIONS AND SPACE HEATING AND COOLING CAPACITY
IF FLOATING SPACE TEMP ?
NO
YES
CALCULATE SLOPE OF THERMOSTAT FUNCTION LINE
CALCULATE INTERCEPT OF THERMOSTAT FUNCTION LINE
CALCULATE SPACE TEMP DEVIATION AT END OF HOUR
CALCULATE HEAT EXTRACTED FROM OR SUPPLIED TO SPACE DURING HOUR
SET LIMIT VALUES AT QUANTITIES THAT WILL NEVER BE EXCEEDED
ZERO OUT SPACE HEATING AND COOLING CAPACITIES
B
DOES NEEDED HEAT EXCEED AVAILABLE HEAT ?
NO
YES
MAKE CORRECTIONS OF HEAT EXTRACTION AND SPACE TEMPERATURE DEVIATION
DOES NEEDED COOLING EXCEED AVAILABLE COOLING ?
NO
YES
MAKE CORRECTIONS OF HEAT EXTRACTION AND SPACE TEMPERATURE DEVIATION
A


C
A
B
TYPE 2 THERMOSTAT ?
NO
YES
STORE SPACE END-OF-HOUR TEMPERATURE DEVIATION FOR NEXT HOUR
CALCULATE SPACE TEMPERATURE DEVIATION
CALCULATE END-OF-HOUR SPACE TEMPERATURE
INITIALIZE HEAT EXTRACTION RATE
SET UP VARIABLES FOR FAN SYSTEM SIMULATION
IS LOWER LIMIT EXCEEDED ?
YES
NO
RETURN
RESET HEAT EXTRACTION AND SPACE TEMPERATURE DEVIATION
IS SPACE HEATING CAPACITY EXCEEDED ?
YES
NO
RESET HEAT EXTRACTION AND SPACE TEMPERATURE DEVIATION
C


ENTER
VTPOHD
INITIALIZE
PRINT FLAGS
ARE
THERE ANY
PRINT-OUTS
?
NO
YES
RETURN
I ← 1,IPO
RETURN
ANY
PRINT-OUTS
THIS DAY
?
YES
NO
SET PRINT
FLAGS TO
UNITY
RETURN

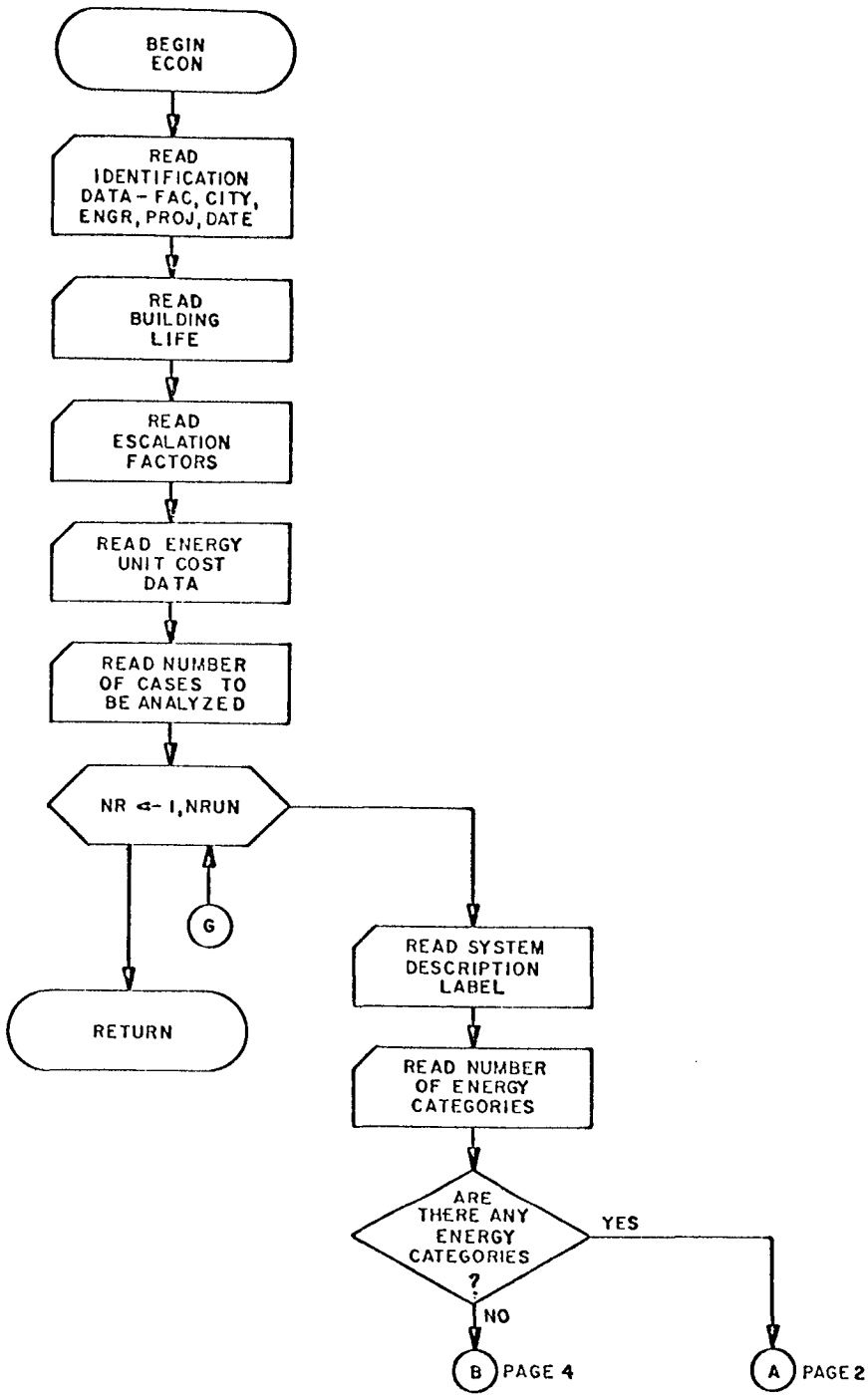

ENTER WZNEW
Calculate Amount Of Moisture Introduced By Supply Air
Is Zone Supply Air Flow Rate Greater Than Zero ?
NO
Reset Supply Air Moisture Addition To Zero
YES
Calculate Net Moisture Entering Zone
Determine Amount Of Air Circulated Through Zone In 1 hr
Is Amount Of Circulated Air Equal To Or Greater Than One Air Change ?
NO
Reset Amount Of Circulated Air To One Air Change
YES
Calculate End-Of-Hr. Zone Humidity Ratio
CALL HUM
Calculate Zone Humidity Ratio Corresponding To 100 % R.H.
Is Zone Humidity Ratio Greater Than 100 % R.H. Limit ?
YES
Reset Zone Humidity Ratio To 100 % R.H. Limit
NO
Is Zone Humidity Ratio Less Than Zero ?
YES
Reset Zone Humidity Ratio Equal To Zero
NO
RETURN

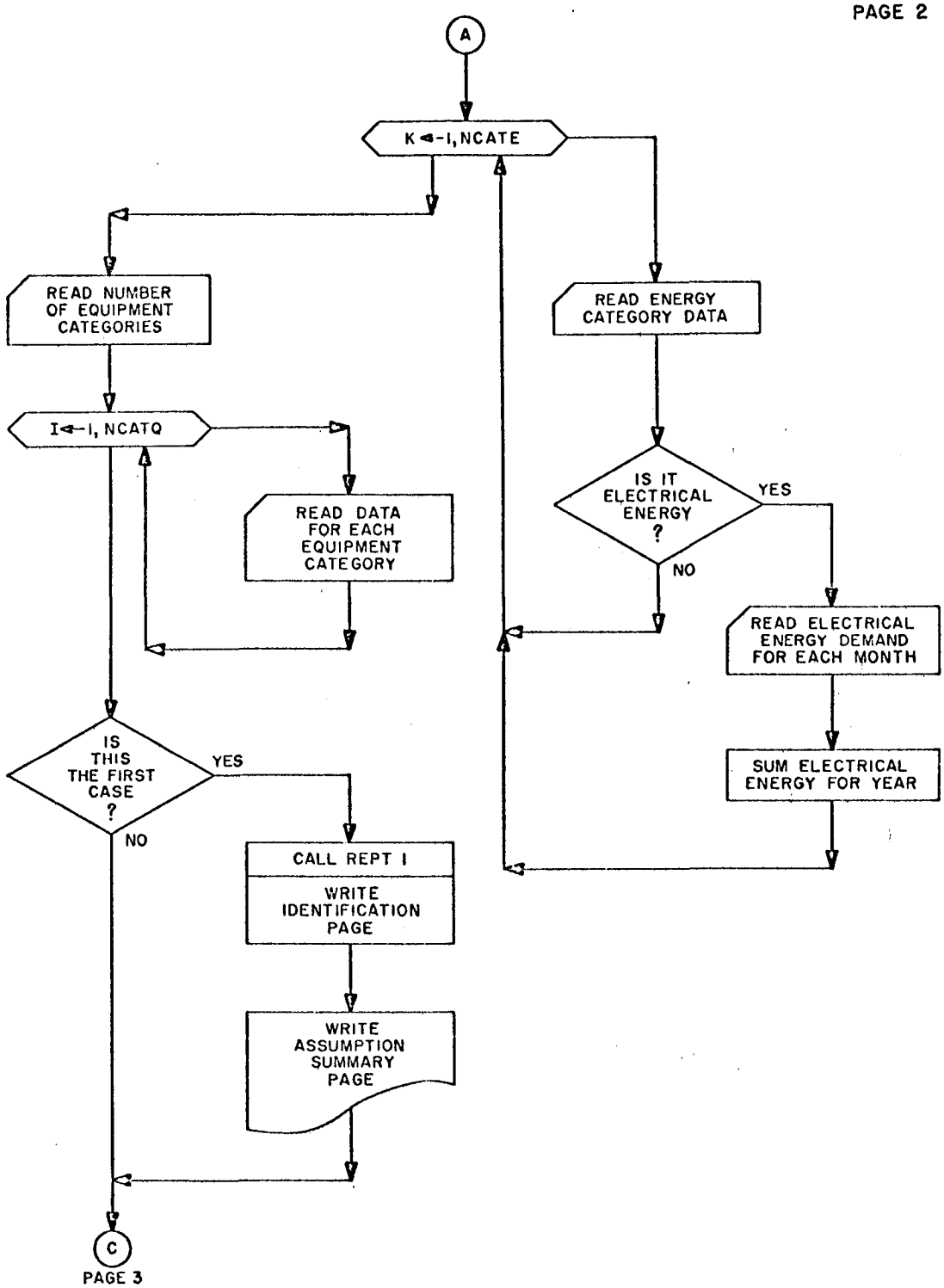
SESP
ZLØ

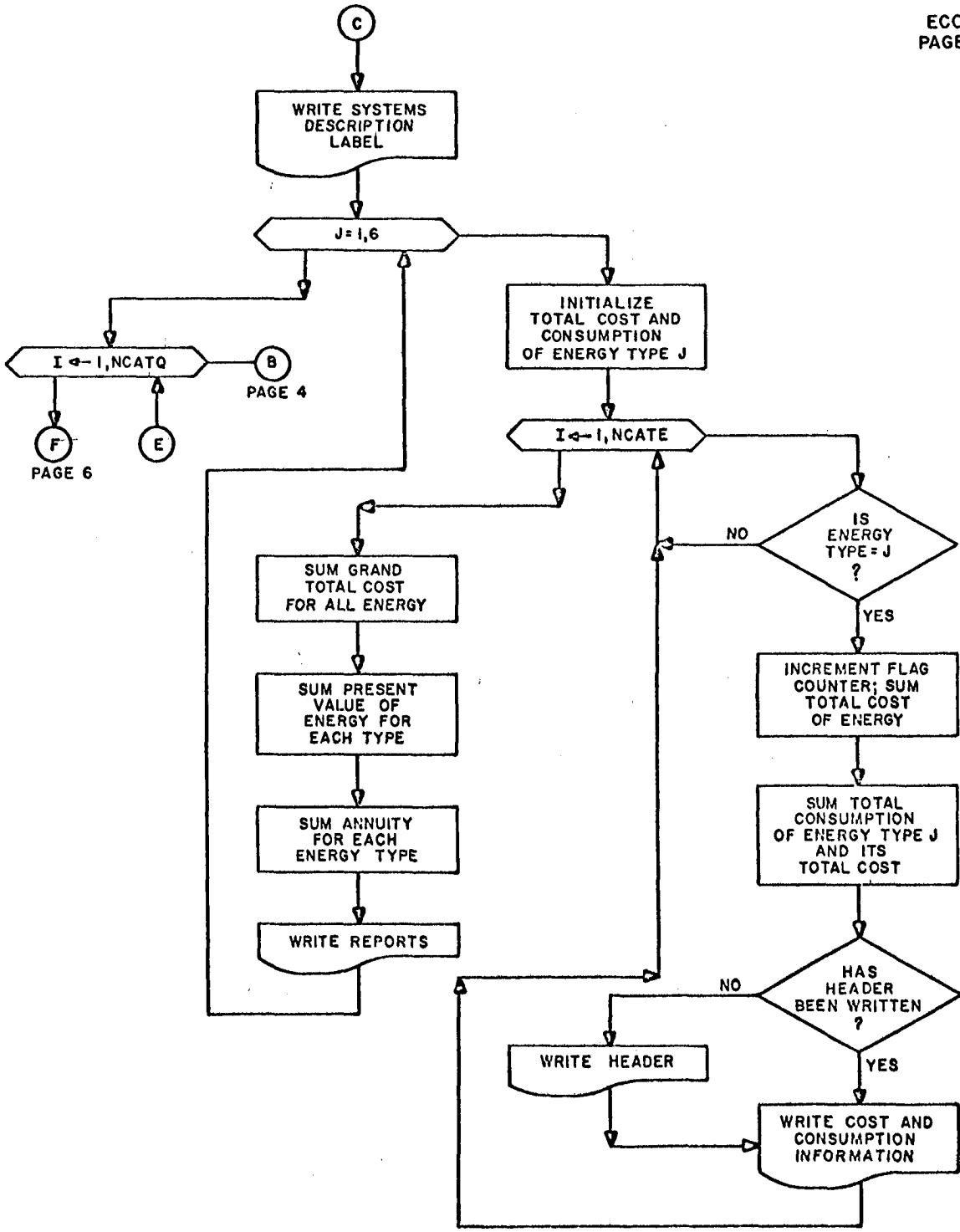

Enter ZLØ
IQ
HEATING COIL
IQ = 1
COOLING COIL
IQ = 2
Is leaving temp > high limit ?
NO
YES
Is leaving temp < low limit ?
NO
YES
Reset leaving temp = high limit. Calculate and distribute heating load and load not met.
Calculate and distribute heating load
Calculate and distribute cooling load.
Reset leaving temp = low limit. Calculate and distribute cooling load and load not met.
RETURN
RETURN
RETURN
RETURN

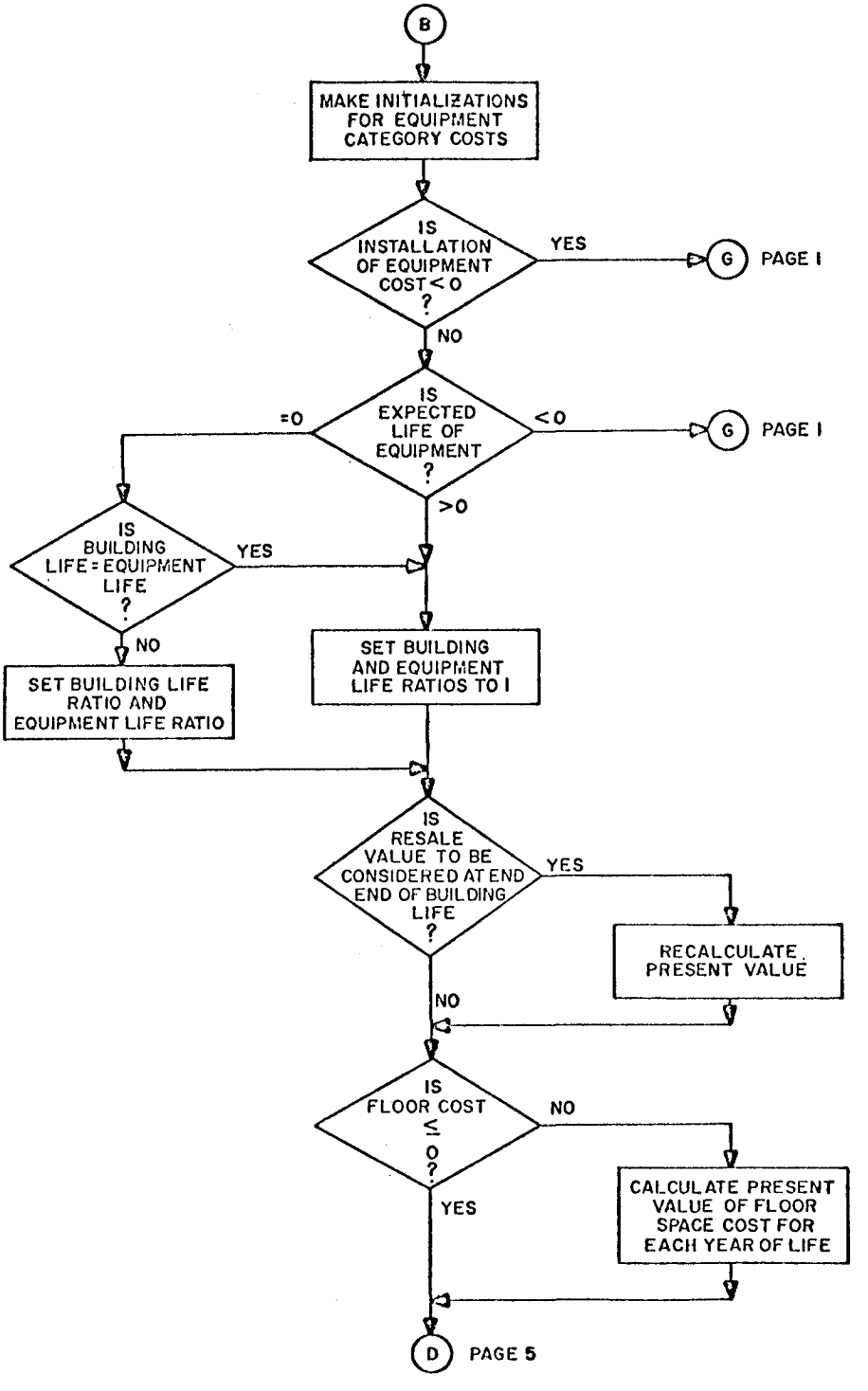
Section 5

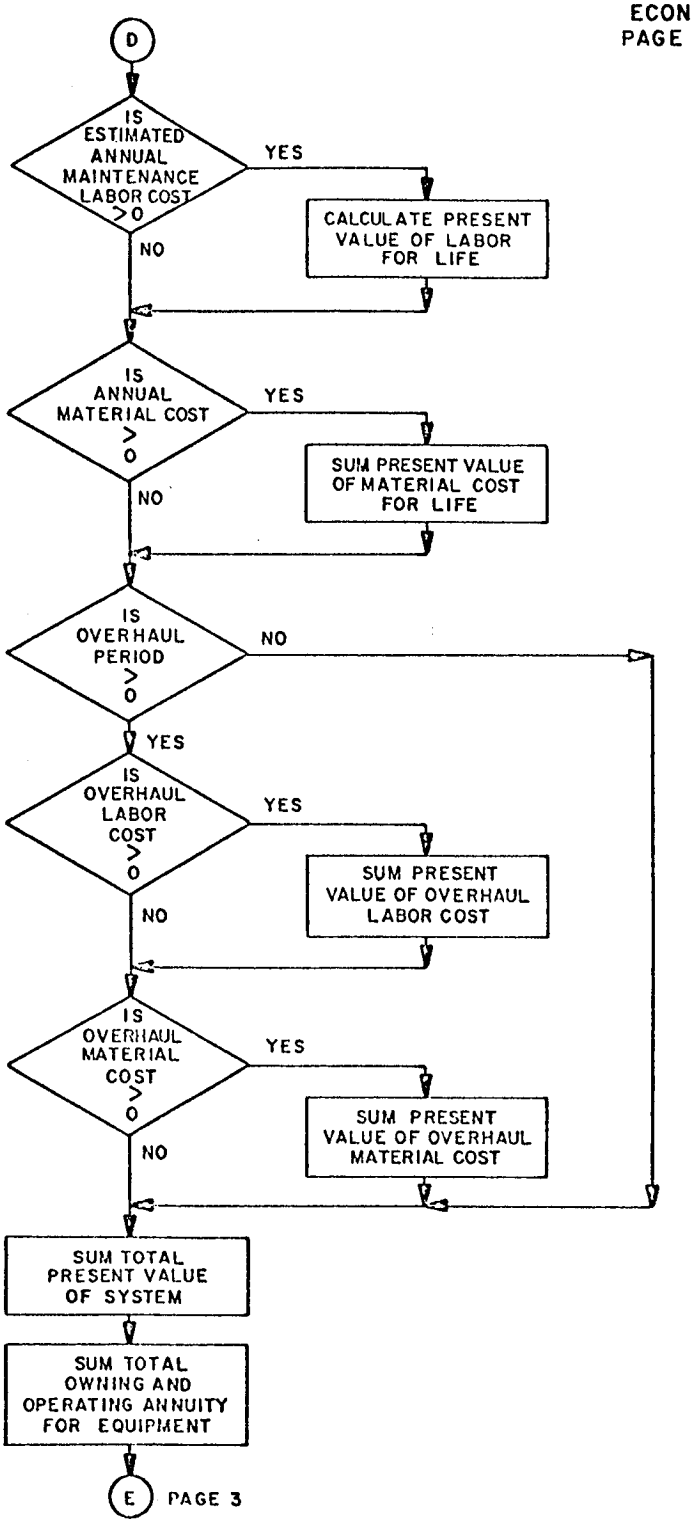
OWNING AND OPERATING COST PROGRAM

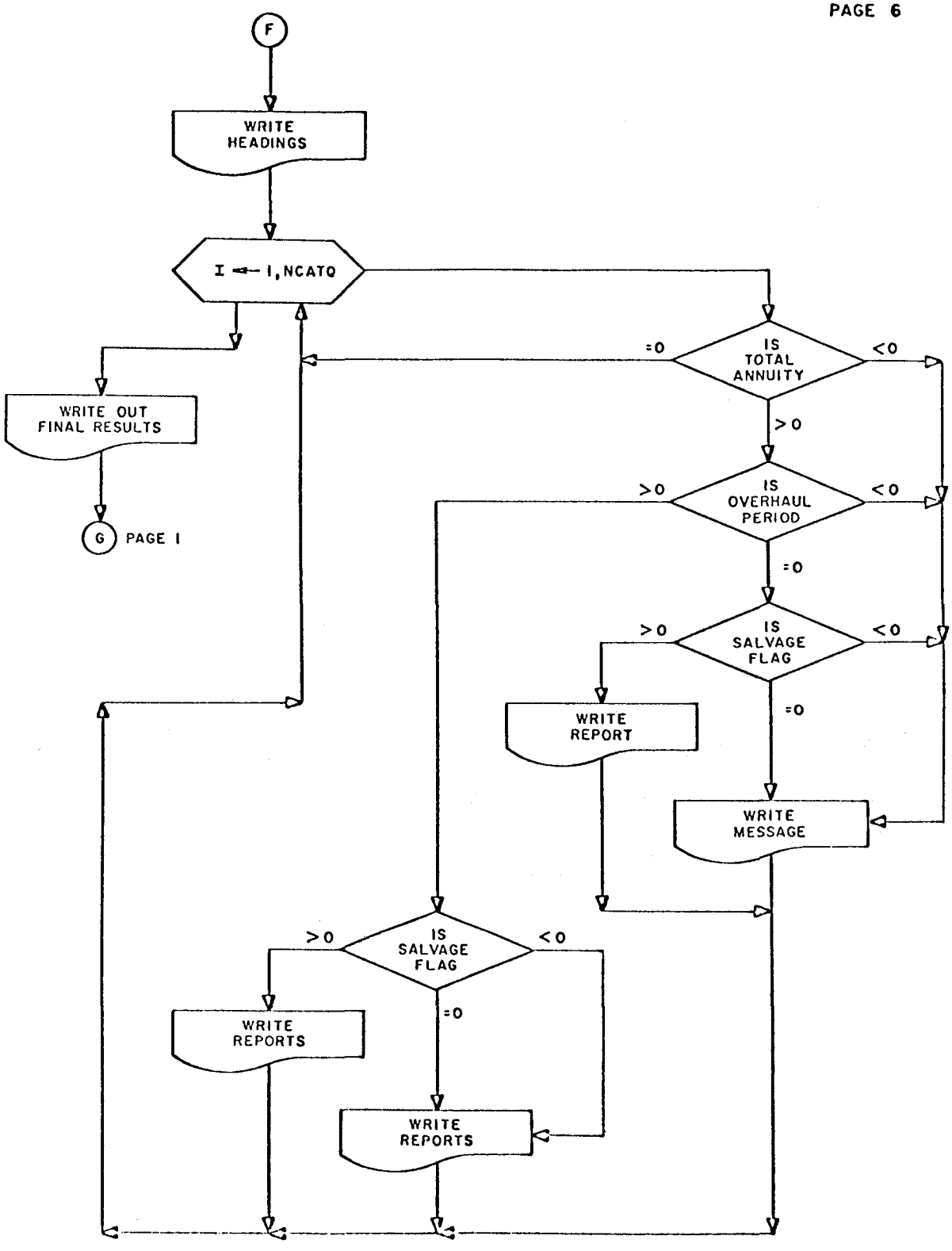

BEGIN ECON
READ IDENTIFICATION DATA - FAC, CITY, ENGR, PROJ, DATE
READ BUILDING LIFE
READ ESCALATION FACTORS
READ ENERGY UNIT COST DATA
READ NUMBER OF CASES TO BE ANALYZED
NR <- 1,NRUN
G
RETURN
READ SYSTEM DESCRIPTION LABEL
READ NUMBER OF ENERGY CATEGORIES
ARE THERE ANY ENERGY CATEGORIES ?
YES
NO
B PAGE 4
A PAGE 2


A
K ← 1, NCATE
READ NUMBER OF EQUIPMENT CATEGORIES
I ← 1, NCATQ
READ DATA FOR EACH EQUIPMENT CATEGORY
IS THIS THE FIRST CASE ?
YES
NO
CALL REPT I
WRITE IDENTIFICATION PAGE
WRITE ASSUMPTION SUMMARY PAGE
C
PAGE 3
READ ENERGY CATEGORY DATA
IS IT ELECTRICAL ENERGY ?
YES
NO
READ ELECTRICAL ENERGY DEMAND FOR EACH MONTH
SUM ELECTRICAL ENERGY FOR YEAR


C
WRITE SYSTEMS DESCRIPTION LABEL
J=1,6
I ← 1,NCATQ
B
PAGE 4
F
PAGE 6
E
INITIALIZE TOTAL COST AND CONSUMPTION OF ENERGY TYPE J
I ← 1,NCATE
IS ENERGY TYPE = J ?
NO
YES
INCREMENT FLAG COUNTER; SUM TOTAL COST OF ENERGY
SUM TOTAL CONSUMPTION OF ENERGY TYPE J AND ITS TOTAL COST
HAS HEADER BEEN WRITTEN ?
NO
YES
WRITE HEADER
WRITE COST AND CONSUMPTION INFORMATION
SUM GRAND TOTAL COST FOR ALL ENERGY
SUM PRESENT VALUE OF ENERGY FOR EACH TYPE
SUM ANNUITY FOR EACH ENERGY TYPE
WRITE REPORTS


B
MAKE INITIALIZATIONS FOR EQUIPMENT CATEGORY COSTS
IS INSTALLATION OF EQUIPMENT COST < 0 ?
YES
G
PAGE I
NO
IS EXPECTED LIFE OF EQUIPMENT ?
=0
< 0
G
PAGE I
>0
IS BUILDING LIFE = EQUIPMENT LIFE ?
YES
NO
SET BUILDING LIFE RATIO AND EQUIPMENT LIFE RATIO
SET BUILDING AND EQUIPMENT LIFE RATIOS TO I
IS RESALE VALUE TO BE CONSIDERED AT END END OF BUILDING LIFE ?
YES
RECALCULATE PRESENT VALUE
NO
IS FLOOR COST ≤ 0 ?
NO
CALCULATE PRESENT VALUE OF FLOOR SPACE COST FOR EACH YEAR OF LIFE
YES
D
PAGE 5


D
IS ESTIMATED ANNUAL MAINTENANCE LABOR COST >0
YES
CALCULATE PRESENT VALUE OF LABOR FOR LIFE
NO
IS ANNUAL MATERIAL COST > 0
YES
SUM PRESENT VALUE OF MATERIAL COST FOR LIFE
NO
IS OVERHAUL PERIOD > 0
NO
YES
IS OVERHAUL LABOR COST > 0
YES
SUM PRESENT VALUE OF OVERHAUL LABOR COST
NO
IS OVERHAUL MATERIAL COST > 0
YES
SUM PRESENT VALUE OF OVERHAUL MATERIAL COST
NO
SUM TOTAL PRESENT VALUE OF SYSTEM
SUM TOTAL OWNING AND OPERATING ANNUITY FOR EQUIPMENT
E
PAGE 3


F
WRITE HEADINGS
I ← 1,NCATO
WRITE OUT FINAL RESULTS
G PAGE 1
IS TOTAL ANNUITY
=0
<0
>0
IS OVERHAUL PERIOD
>0
<0
=0
IS SALVAGE FLAG
>0
<0
=0
WRITE REPORT
WRITE MESSAGE
IS SALVAGE FLAG
>0
<0
=0
WRITE REPORTS
WRITE REPORTS

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA TM-83242		

4. Title and Subtitle	5. Report Date
NECAP 4.1 - NASA'S ENERGY-COST ANALYSIS PROGRAM ENGINEERING FLOW CHART	May 1982
	6. Performing Organization Code: 992-24-01-01
7. Author(s): Ronald N. Jensen	8. Performing Organization Report No.
	10. Work Unit No.
9. Performing Organization Name and Address: NASA Langley Research Center, Hampton, VA 23665	11. Contract or Grant No.
	13. Type of Report and Period Covered: Technical Memorandum
12. Sponsoring Agency Name and Address: National Aeronautics and Space Administration, Washington, DC 20546	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

NASA's Energy-Cost Analysis Program (NECAP) is a powerful computerized method to determine and to minimize building energy consumption. The program calculates hourly heat gain or losses taking into account the building thermal resistance and mass, using hourly weather and a "response factor" method. Internal temperatures are allowed to vary in accordance with thermostat setting and equipment capacity.

NECAP 4.1 is a updated version of NECAP published in 1975 (see CR2590, Parts I and II). It has a simplified input procedure and numerous other technical improvements. Documentation consist of a Users Manual, Engineering Manual, Input Manual, Fast Input Manual and Example, Engineering Flow Chart Manual and an Operations Manuals (specifically for LaRC's Computer System).

This manual supports the "Engineering Manual" (TM 832340) by providing flow charts for the program.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Energy Energy Conservation Energy Analysis Air Conditioning and Heating	Unclassified - Unlimited Subject Category 44

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	181	A09

N-305

For sale by the National Technical Information Service, Springfield, Virginia 22161

*U.S. GOVERNMENT PRINTING OFFICE: 1982 539-007/12 1-3