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LABORATORY TECHNICAL REPORT

LTR - ST - 972

THE RATIO MAP:
A TECHNIQUE FOR HEADLAMP COMPARISON

ANN L. HARRISON

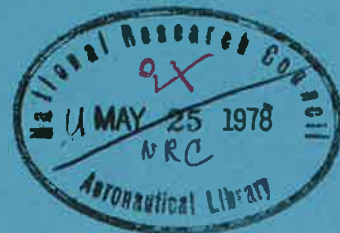
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TABLES _____
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Appendix A - 23
Appendix B - 19

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COMM. LAB. _____

FILE 4013-4
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FOR Internal and Ministry of Transport
POUR _____

REFERENCE Discussions with Dr. G. D. Campbell, of M.O.T.
RÉFÉRENCE _____

LTR - ST.972

THE RATIO MAP:
A TECHNIQUE FOR HEADLAMP COMPARISON

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INTRODUCTION

This report discusses the technique of ratio mapping as applied to headlamp intensity and illuminance maps and its use during the headlamp investigations currently being undertaken at the National Research Council of Canada.

In the first section of this report, the concept of the ratio map is discussed and the development of a ratio mapping procedure is described, while the following two sections describe two particular ratio mapping programs and their use. The first program, module ISC of the RATIO program library, constructs the ratio map for given pairs of headlamp intensity maps. The second program, module MAIN3 of the VIEW program library, constructs the ratio map for given pairs of headlamp illuminance maps, where the illuminance was mapped over a vertical plane situated at a fixed distance ahead of the vehicle in which the headlamps reside.

Two appendices have been included to provide source listings for the computer programs and their associated modules and to demonstrate typical output from a sample program in each case. A brief comparison of the two sample mappings is offered in order to illustrate the interpretation of the ratio map.

The computer programs described in this report were written in Fortran IV for use on the I.B.M. 360/67 T.S.S. system available at N.R.C. and make use of other programs previously developed during the course of the headlamp investigations. The ratio mapping programs were designed to accept input datasets in a form such as that produced by the intensity and illuminance mapping programs (described in References 1 and 2 respectively) and to store the resulting ratio maps in a form suitable to the plotting routines of the VIEW program library. In this latter form, the maps can be listed and plotted and certain of their surface statistics can be computed.

(1) THE RATIO MAP

The concept of a ratio map was introduced into the headlamp investigations at N.R.C. as a means of facilitating inter-headlamp comparisons.

Previously, it had been possible to create an intensity map for a particular headlamp and, using this intensity map, to map the headlamp illuminance on the road surface plane or on a vertical plane ahead of the vehicle in which the headlamp was mounted. In addition, the intensity or illuminance contours of such maps could be plotted to illustrate their position and hence to describe, in a limited fashion, the illuminance characteristics of the particular headlamp.

Until the ratio mapping procedure was introduced, however, it was not possible to compare the relative output from two headlamps or configurations on a given target surface without manually overlaying their contour plots. And it was quite difficult to demonstrate, for example, a 2:1 relationship between headlamps without computing ratios at each point in the mapping plane. Thus the ratio mapping technique was developed as a means of measuring relative headlamp performance for different types and groupings of headlamps.

Construction of the ratio map

The ratio map for any pair of maps defined over the same grid is constructed, quite simply, by obtaining the pair of maps, computing the ratio

$$z_{R_{i,j}} \leftarrow \frac{z_{1_{i,j}}}{z_{2_{i,j}}}$$

of their surface values for each point on the grid, and storing the resulting surface.

Intensity ratio map

The intensity ratio map is the ratio map constructed for a pair of intensity maps. The grid over which the ratio map is defined is the same as that employed for the intensity maps from which it was constructed. It is actually a spherical surface represented by a pseudo-rectangular grid and described in terms of the headlamp horizontal (azimuth) and vertical (elevation) angles, θ_h and θ_v .

This form of ratio map has the advantage that the surface may be defined over a rather large field of view, limited only by the range of the headlamp angles. Moreover, since the longitudinal distance for the original headlamp illuminance measurements has already been incorporated into the

intensity map values, the ratio map values are independent of distance. Unfortunately, the method is applicable strictly to single headlamp comparisons. The intensity maps for a group of headlamps may be combined only if the various headlamp origins are assumed to be co-incident, as sometimes may be done for convenience.

The ratio map for two intensity maps is constructed by the ISC computer program of the RATIO program library. This program and its use are described in section (2) of this report and a sample program is presented in Appendix A.

Illuminance ratio map

The illuminance ratio map is the ratio map constructed for a pair of illuminance maps. The form of these maps is that required by the VIEW program library in general for its illuminance maps. Thus the illuminance is mapped over a vertical plane situated at a fixed distance ahead of the vehicle and represented by a rectangular grid described in terms of the lateral and vertical displacements (width and height) with respect to the mapping origin, X_E and Z_E . The mapping origin in the case of the illuminance mapping programs is usually assumed to be either a point on the road centre line in a line laterally with the headlamps or the vehicle centre of gravity,

hence it will not be co-incident with the headlamp origin as in the case of the intensity map.

The vertical plane may be used to represent the field of view ahead of the driver and containing various target surfaces, just as in the real-world situation. The illuminance ratio mapping facility may then be used to demonstrate the effects of different illuminance distributions, relative to one another, over the particular mapping plane. In this way, it offers a relative measure of headlamp effectiveness under conditions of actual use, answering such questions as "How much more illuminance does headlamp A, on average, produce over the mapping plane than headlamp B?" and "Where does it produce less?" Generally it concerns itself with only a small range of headlamp angles, whereas the intensity ratio mapping procedure invokes the whole range of angles over which the intensity map was defined. In most visibility problems, moreover, a fixed mapping distance or a number of such distances may be specified for the headlamp comparisons.

The ratio map for two maps of the illuminance on a vertical plane is constructed by the MAIN3 computer program of the VIEW program library. This program and its use are described in section (3) of this report and a sample program is presented in Appendix B.

Use of the ratio map

As can be seen from the above discussion, the uses of the ratio map are as varied as the type of mappings available and the comparisons which one may wish to effect.

An intensity ratio map may be used, for example, to compare two sets of basic illuminance measurements for the same headlamp. The location and range of the different ratio contours will then show whether the two sets of measurements are essentially the same or, if they are not, in what areas they appear to differ. Generally, a mean ratio value close to K coupled with a standard deviation close to zero indicates that there is a $K:1$ relationship between the two maps inherent throughout the mapping plane. A relatively large deviation, on the other hand, suggests that the $K:1$ trend is not consistent throughout the mapping plane. Closer examination of the mapping plane in such a case would probably reveal that one map was prominent in certain regions of the grid and the other map, in other areas ($K \rightarrow 1$) or that one map was distinctly more prominent in some areas of the grid than in others ($K \ll 1 \mid K \gg 1$).

In a similar fashion, using both intensity and illuminance forms of the ratio map, it is possible to effect a general comparison of two headlamp types: for example, a new headlamp design vs. an old design, as exemplified in the S.A.E.

types 4000 and 4002 low beams. Perhaps headlamps of the same type but from different manufacturers might be compared --- or prototype and conventional headlamps, or North American and European headlamp designs, etc. In any event, the ratio map is used to point out salient features of the various headlamps and to demonstrate both their similarities and their differences. The intensity ratio map, by the nature of its definition, will generally provide for a comparison over a fuller field of view; in particular, the total field defined by the range of the measured headlamp angles. For most practical purposes, however, such a complete definition is not necessary. The more restricted field of view defined for the illuminance maps and usually equivalent to the field of view of interest to the driver in most target detection/visibility situations is generally sufficient for the headlamp comparison.

Further applications of the ratio mapping procedure would include a contrast of different headlamp configurations according to their actual operating conditions. The illuminance maps constructed by the computer in this case should correspond to the actual values measured in field experiments. Thus the ratio map might be used to predict areas of interest for further study in subsequent field experiments. The effects of headlamp aim and orientation and atmospheric

phenomena on the illuminance projected onto the mapping plane, for example, might profitably be examined by using the ratio maps in this manner. A further possibility lies in the introduction of the pre-constructed ratio map values directly into illuminance calculations during the intercomparison of two headlamp systems. Employing ratio rather than basic intensity values thus permits the required calculations to be performed once for the ratio of the two systems, rather than calculating separately for each headlamp in each of the systems and only then determining ratios.

(2) THE RATIO OF TWO INTENSITY MAPS

The ISC program constructs and stores the ratio map for each pair of intensity maps presented to it, printing the various maps as required.

This program consists of the mainline control program (module ISC) and special print and store subroutines (modules ISCPRT and ISCSTO), for which source listings are presented in Appendix A. In addition, it employs the input routines (modules INDATA, et seq.) created as part of the SRCH program and subsequently stored in the general purpose library GEN1LIB.

Description of the main program ISC

Initially, the program sets the upper limits for the grid dimensions (MAXX and MAXY) and overall size (MAXZ) and sets the program counter (NSET) to zero.

For each iteration, a new page is generated on the SYSOUT dataset (unit 6) and the output dataset for the map listings is defined by reading its device number (IPRT) from unit 5. An end-of-file condition raised at this point terminates the program. Otherwise, the program counter is

incremented by 1 and page headings are written. Each of the intensity maps is defined, in turn, by obtaining its input device number (INPT) and the output storage device (IOUT) from unit 5, then invoking subroutine INPUT or its entry INPUT1 to read the intensity map data from unit INPT and subroutine PRINT or its entry PRINT1 as required to list the intensity map. If the i/o devices cannot be defined due to an end-of-file, the program terminates. Otherwise, the ratio map is constructed, point by point, from the two intensity maps, using the first-defined map as the numerator and the second-defined map as the denominator of the ratio values. New dataset descriptor labels (LAB1 and TEXT1) are read from unit 5. The completed ratio map is then printed as required by subroutine PRINT1 and, finally, is stored on unit IOUT by subroutine STORE.

Description of the input routines

Subroutine INPUT and its secondary entry INPUT1 obtain the intensity map data from the specified input file, invoking subroutine INXY as necessary to generate the grid and subroutine INGRID to read the surface values.

These routines were developed as part of the SRCH program and are described in detail in the discussion of

that program (Reference 1). They may, of course, be replaced in order to accommodate other data forms.

Description of the output routines

Subroutine PRINT and its secondary entry PRINT1 produce a listing of the particular grid surface, be it an intensity map, an illuminance map, or a ratio map, on the specified output device. The output device for the listing, the grid dimensions, and the grid reference vectors are transmitted to the subroutine at the main entry point. Subsequent entry at PRINT1, therefore, assumes the same grid specifications. The final listing has a graphical-type format, with 11 columns printed on each page.

Subroutine STORE stores the particular grid surface data on the specified output device in a format acceptable to the plotting routines of the VIEW program library. Thus a series of constant parameters are interspersed among the provided values so that the data organisation resembles that of the ratio map generated by the VIEW program and discussed in the following section of this report.

Execution of the ISC program

The object modules necessary for the execution of the ISC program include those for the main program and output routines, all stored in the RATIO job library, and those for the input routines, stored in the GENLIB library.

The input datasets include that for the program control data, in this case the SYSIN file on unit 5, and that for the various intensity maps to be processed by the program. Each intensity map dataset must be in a form acceptable to the input routines which, in this case, is that specified for the SRCH program and described in detail in Reference 1.

The output datasets include that for the various program progress messages and the like, assigned here to the SYSOUT file on unit 6, any listing datasets specified for the various map listings by subroutine PRINT, and the ratio map datasets created by subroutine STORE. Each listing dataset contains information which may be printed off-line by means of a PRINT command following completion of the main program. Each set of ratio map data is organised in a form suitable for the MAIN2 plotting option of the VIEW program and described in detail in Reference 2.

Execution of the ISC program, as presented here in this report, requires a total of 76K bytes of core storage, including 72,188 bytes for the ISC modules and 5,484 bytes for the input routines in GEN1LIB. For a reduced test case (a 41 by 18 grid containing only 738 surface points), the program required 14.5 seconds of CPU time for execution. For the sample program presented in this report, with an 81 by 41 grid (four and one-half times greater than that of the reduced case), only 18.5 seconds of CPU time were required (a 29% increase).

Sample program

A sample program to demonstrate the use of the ISC program is discussed in Appendix A.

The program obtained the intensity maps for two headlamps, constructed a ratio map of the intensity values, and stored the resulting ratio map. This map was subsequently listed and plotted and various statistics were computed for it.

Both intensity maps and their resulting ratio map were defined over an 81 by 41 grid corresponding to that of the original headlamp illumination measurements and described in terms of the headlamp horizontal and vertical angles (θ_h, θ_v).

The grid extents in this case were

$$\theta_h \in [-19.2^\circ, +19.2^\circ]$$

$$\theta_v \in [-11.52^\circ, +7.68^\circ]$$

$$\text{with } \Delta_h = \Delta_v = .48^\circ .$$

(3) THE RATIO OF TWO ILLUMINANCE MAPS

The MAIN3 option of the VIEW program constructs and stores the ratio map for each pair of illuminance maps presented to it.

This program consists solely of the mainline program (MAIN3), for which the source listing is presented in Appendix B. Because the program controls directly the i/o operations performed on the various mappings, such mappings must be in a form compatible with that produced by the MAIN1 program of the VIEW library. To vary the input map form, for example, would entail the replacement of the relevant input commands in the MAIN3 program so as to accommodate the new form.

Description of the main program MAIN3

At the start of the program, various counters are initially set to zero, including the task counter (NSET), the output page counter (NPAGE), and the mapping number for the two input files (M1 and M2).

Data are then obtained for each pair of files containing the sequence of illuminance maps to be compared. When the end of the input file is reached on unit 5, the program ends.

Otherwise, it reads values for the two input devices for the illuminance mappings (IN1 and IN2) and for the output device onto which their ratio mapping will be stored (IOUT). The task and page counters are immediately incremented and the i/o specifications are listed on unit 6. The mapping flag (MSTOP) is set initially to -1, indicating that no value has yet been defined for it.

Each pair of illuminance mappings on the input files are then considered in turn. For all mappings after the first on the files ($M1 > 0$), a new output page is generated on unit 6. Values are read from the first input file (unit IN1) defining the next mapping number and distance ($M1$ and $TEMP1$). In the case of an end-of-file condition at this point, the mapping flag is set to the current value of the second file's map number ($M2$). The corresponding map and distance values ($M2$ and $TEMP2$) are read next from the second input file (unit IN2). In the event of an end-of-file condition, then either both input files ended simultaneously ($MSTOP \geq 0$) or the second file ended prematurely ($MSTOP < 0$), in which case an error message is written on unit 6. The program then turns to the next problem by seeking new i/o specifications on unit 5. If the map and distance data were read successfully from the second input file, on the other hand,

the mapping flag must be similarly checked for a premature end of the first input file ($MSTOP \geq 0$). Otherwise, the map and distance values for the two mappings are compared to ensure that they are identical and are then copied onto the output file (unit IOUT).

The headlamp specifications are retrieved next from the input files. Values read for the number of headlamps employed in the particular configuration (NL1 and NL2) are checked before being copied onto the output file. The headlamp location co-ordinates and angles of aim (XYZ and AIM) are read first for the NL1 headlamps of the first input file and are copied onto the output file. The corresponding values for the second group of NL2 headlamps are similarly transferred.

The mapping plane is defined in terms of its horizontal (x_E) and vertical (z_E) reference vectors, which describe its lateral extents and height with respect to the particular mapping origin. The reference vectors are read from both input files in turn and their extents are compared so as to ensure that both maps were defined over the same grid. If they were not, the current sequence of maps is abandoned. Otherwise, the grid specifications are copied onto the output file.

Once the size of the mapping plane (K) has been

determined from the grid specifications, the surface values for the two illuminance maps (E1SUM and E2SUM) are read column by column from their respective input files. The ratio map is then constructed using the first map as numerator and the second map as denominator. The completed ratio map is stored on the output file and, in the case of the first mapping in the sequence (M1=1), is followed by a dummy record describing the non-existent target fields and necessary for the plotting routines. If a zero-divide condition was raised during the ratio mapping process (flag J > 0), then the number of such conditions is listed on unit 6. Finally, a note is written on unit 6 concerning completion of the construction and storage of the particular ratio map and the next set of mappings in the input sequence may be considered.

Execution of the MAIN3 program

The sole object module necessary for the execution of the MAIN3 program is that for the main program itself and is kept in the VIEW job library.

The input datasets include that for the program control data, in this case the SYSIN file on unit 5, and that for the various illuminance maps to be preprocessed by the program. Each of the pairs of illuminance datasets may contain a sequence of illuminance mappings, all of which are in the form produced

by the MAIN1 option of the VIEW program and described in detail in Reference 2. This form is also acceptable to the MAIN2 plotting option.

The output datasets include that for the various program progress and error messages, here relegated to the SYSOUT file on unit 6, and that receiving the sequence of ratio maps produced for each pair of input files. Each ratio map dataset is in a form suitable for input to the MAIN2 plotting routines. For each mapping in the given file, it contains the following information:

- (i) the mapping number and distance;
- (ii) the number of headlamp aim combinations (set to 1);
- (iii) the number of headlamps in each of the configurations;
- (iv) the expected number of target surfaces within the mapping plane (set to 0);
- (v) the headlamp location co-ordinates and aim angles for the first map, followed by those for the second map;
- (vi) the mapping plane x-dimension and reference vector (width), followed by its z-dimension and reference vector (height);
- (vii) the ratio map values;
- (viii) the target data flag (set to 0).

Execution of the MAIN3 ratio mapping program

from the VIEW library required 74,432 bytes of core storage to accommodate the object module for the main program. For the sample program presented in this report and operating on a 13 by 23 grid, 4.5 seconds of CPU time were required. This performance appears similar to that of the intensity ratio mapping procedure discussed in the previous section of this report.

Sample program

A sample program to demonstrate the use of the MAIN3 program is discussed in Appendix B.

The program obtained two illuminance maps previously generated by the MAIN1 program of the VIEW library, constructed a ratio map of the illuminance values, and stored the resulting ratio map. This map was subsequently listed and plotted and various statistics were computed for it.

The mapping plane selected for the illuminance maps and hence retained for their ratio map was a vertical plane as determined for the VIEW family of programs. It was described in terms of the lateral displacement with respect to the road centre line (x_E) and the height above the road surface (z_E). One constraint upon the definition of the mapping plane was that the vertical plane should cover the width of a standard roadbed

laterally and the vertical area from road level to the region of overhead signs. A further constraint was that all points within the mapping plane could be located in terms of headlamp angles that were within the bounds of the intensity maps for the various headlamps in use.

In the particular example presented in this report, the mapping origin was chosen to be that point on the road surface centre line in a line laterally with the headlamps, where the test vehicle in which they were mounted was assumed centred in the driving lane of a two-lane roadway. The vertical mapping plane was defined at a distance of 150 feet ahead of the vehicle and over a 13 by 23 grid. The grid extents in this case were

$$x_E \in [-12, +12]$$

$$z_E \in [0, +22]$$

$$\text{with } \Delta_{x_E} = 2 \text{ ft and } \Delta_{z_E} = 1 \text{ ft .}$$

REFERENCES

- (1) "SRCH: A Headlamp Research Program for the extrapolation/
interpolation of surface values from a predefined grid"
A.L. Harrison
N.R.C./N.A.E. report LTR-ST.602, June, 1972.
- (2) "VIEW: A Headlight Research Program for producing an
illumination map on the vertical plane about the eye
(or some other) axis"
A.L. Harrison
N.R.C./N.A.E. report LTR-ST.608, January, 1973.

APPENDIX A

This appendix contains the source listings for the various modules associated with the ISC ratio mapping program and the program output for a sample run illustrating its use.

Source listings

The source listings for the ISC ratio mapping program, presented on pages A.5 through A.9, are preceded by a block diagram indicating the basic structure of the program.

The primary modules include ISC, the mainline program which effects the construction of the ratio mapping for each pair of intensity maps, ISCPRT (subroutine PRINT), which produces a printed listing of a grid surface, and ISCSTO (subroutine STORE), which stores the resulting ratio map in a form acceptable to the VIEW program plotting routines. These modules have been stored, for convenience, in source form in the library SRC.RATIO and in object form in the library OBJ.RATIO.

Subroutine INPUT and the associated subservient routines which obtain the intensity map data are those originally developed for the SRCH program. Since they have been discussed in detail previously (Reference 1), they have been omitted here.

Sample program

The sample program examined the basic differences between two particular headlamps as illustrated by the ratio of their intensity maps.

The two headlamps, selected from the N.R.C. headlamp population, were labelled headlamp A and headlamp B. Their intensity maps are depicted on pages A.10 and A.11 respectively. As is evident from these plots, headlamp A was an S.A.E. type low beam, while headlamp B was an E.C.E. type low beam. Illumination measurements for both were performed using the coarse grid scan. Headlamp A achieved its maximum intensity value of 16,297 candela at the grid location $(+2.88^\circ, -1.92^\circ)$, while headlamp B achieved its maximum of 12,730 candela at the grid location $(+3.36^\circ, -.96^\circ)$. Minimum intensity values observed for the particular grid were 11 candela for headlamp A and 28 candela for headlamp B.

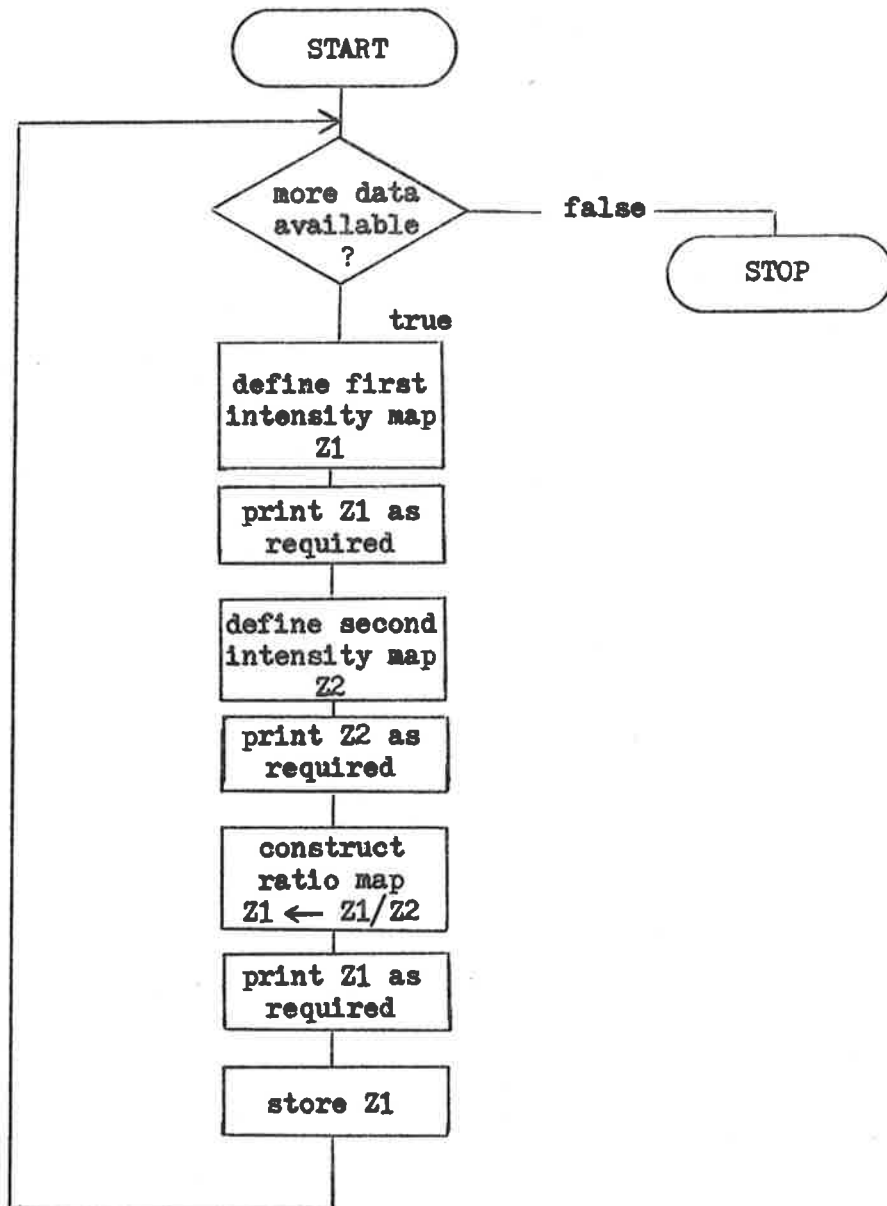
The card deck employed for the sample ratio mapping program is shown on page A.12 and the actual program output is included as the following page. Note that listings of the intensity maps and their associated ratio map were not generated in this case.

The resulting ratio map was subsequently plotted using the VIEW program plotting routines and the printed output from this program was then edited in order to provide a listing of

the ratio map. The plot of the ratio contours for the two headlamp intensity maps is shown on page A.14, while the listing of the ratio map has been reproduced on pages A.15 through A.22. The mapping of headlamp A with respect to headlamp B produced ratio values ranging from .098 to 8.250, with the maximum situated at $(+19.2^\circ, -1.92^\circ)$. The mean ratio value was 1.012, with a standard deviation of .997.

The ratio map in this particular case, especially as represented by its contour plot, suggested that headlamp A would generally offer greater illumination in the upper portion of the grid and headlamp B, in the lower portion. An interesting feature of this ratio map plot was the location of the unity ratio contour in accordance with the E.C.E. low beam illumination cut-off. It paralleled closely the headlamp horizontal axis on the left side of the grid, while its upper portion on the right side of the grid clearly showed the 15° elbow above the horizontal axis. The mean ratio value close to 1, together with a relatively large deviation (99% of the mean), indicated that the headlamp differences appeared to balance over the entire mapping plane, with neither producing a significantly greater output throughout.

It should be noted, once again, that the headlamps examined for this sample program were employed merely to demonstrate the use of the ISC ratio mapping program. They were not intended to represent the S.A.E. or E.C.E. headlamp populations, nor was their comparison intended to portray differences between the two headlamp types in general.



Block diagram of the ISC program structure

CC

***** "ISC" PROGRAM *****

```
C
C
C      THIS PROGRAM OBTAINS TWO INTENSITY MAPS, COMPUTES THEIR
C      RATIO AT EACH POINT ON THE GRID SURFACE, AND STORES THE
C      RESULTING RATIO MAP.
C
C      REAL X(200), Y(200), Z1(8192), TEXT1(22), Z2(8192), TEXT2(22)
C      INTEGER MAXX/200/, MAXY/200/, MAXZ/8192/
C
C      NSET = 0
C
C      100 WRITE (6,110)
C      110 FORMAT (1H1, ///)
C
C      READ (5,200,END=400) IPRT
C      NSET = NSET + 1
C      WRITE (6,120) NSET
C      120 FORMAT (' DATASET PAIR #', I2, ' .....')
C
C      (1) PAIRED INTENSITY MAPS ---
C
C      DO 220 MAP=1,2
C
C      READ (5,200,END=400) INPT, IDUT
C      200 FORMAT (I2, 1X, I2)
C
C      IF (MAP.GT.1) GO TO 210
C      CALL INPUT (Z1,MAXZ,X,MAXX,Y,MAXY,INPT,6,LAB1,TEXT1,I,NX,NY)
C      IF (IPRT.GT.0) CALL PRINT (IPRT,NX,X,NY,Y,Z1,LAB1,TEXT1,1)
C      GO TO 220
C      210 CALL INPUT1 (Z2,X,Y,INPT,LAB2,TEXT2,I,NX,NY)
C      IF (IPRT.GT.0) CALL PRINT1 (Z2,LAB2,TEXT2,1)
C
C      220 CONTINUE
C
C      (2) RATIO MAP ---
C
C      MAP = NX * NY
C      DO 300 I=1,MAP
C      300 Z1(I) = Z1(I) / Z2(I)
C
C      READ (5,310) LAB1, TEXT1
C      310 FORMAT (A4, 1X, 22A1)
C      WRITE (6,320) LAB1, TEXT1
```

APPENDIX A

page A.5

CC

***** "ISC" PROGRAM *****

```
320 FORMAT (//, ' RATIO MAPPING', /, 11X, ' PRODUCED FOR THE ABOVE ',  
1      ' PAIR OF DATASETS, ', /, 11X, ' THE RATIO MAP WAS ',  
2      ' IDENTIFIED AS: ', A4, 1X, 22A1)
```

C

```
IF (IPRT.GT.0) CALL PRINT1 (Z1,LAB1,TEXT1,3)  
CALL STORE (IOUT,NSET,NX,NY,X,Y,Z1,LAB1,TEXT1,6)
```

C

```
GO TO 100
```

C

C

```
400 WRITE (6,110)
```

C

```
STOP  
END
```

APPENDIX A

page A.6

CC

***** SUBROUTINE "PRINT" *****

```

C
C SUBROUTINE PRINT (IPRT,NX,X,NY,Y,Z,LABL,TEXT,IOPT)
C
C REAL X(NX), Y(NY), Z(NX,NY), TEXT(22)
C
C THIS SUBROUTINE LISTS THE GIVEN GRID SURFACE ON THE
C SPECIFIED OUTPUT DEVICE.
C
C IPRT = O/P DEVICE FOR THE LISTING;
C NX, NY = GRID HORIZONTAL & VERTICAL DIMENSIONS;
C X(NX), Y(NY) = GRID HORIZONTAL & VERTICAL REFERENCE
C VECTORS;
C Z(NX,NY) = GRID SURFACE VALUES;
C LABL, TEXT(22) = MAP DESCRIPTOR STRINGS;
C IOPT = MAP TYPE, WHERE:
C 1 --> INTENSITY MAP,
C 2 --> ILLUMINANCE MAP,
C 3 --> RATIO MAP.
C
C ENTRY PRINT1 (Z,LABL,TEXT,IOPT)
C
C REAL*8 TITLES(5,3) /' INTEN', 'SITY MAP', ' (VALUES', ' IN CAND',
1 'ELA) ', ' ILLUMINA', ' NCE MAP ', '(VALUES ',
2 'IN LUMEN', ' S/FT**2)', ' ', ' R',
3 'ATIO MAP', ' ', ' /'
C
C NC2 = 0
C
100 NC1 = NC2 + 1
IF (NC1.GT.NX) GO TO 600
NC2 = NC1 + 10
IF (NC2.GT.NX) NC2 = NX
C
WRITE (IPRT,200) (TITLES(I,IOPT),I=1,5), LABL, TEXT, NC1, NC2,
1 (X(I),I=NC1,NC2)
200 FORMAT (1H1, ///, 41X, 5A8, /, 44X, 'FDR ', A4, 1X, 22A1, ///,
1 ' VERTICAL', 39X, 'HORIZONTAL EXTENTS, COLUMNS ', I2,
2 ' TO ', I2, /, ' EXTENTS ', 11F10.3)
WRITE (IPRT,300)
300 FORMAT (/)
C

```

CC

***** SUBROUTINE "PRINT" *****

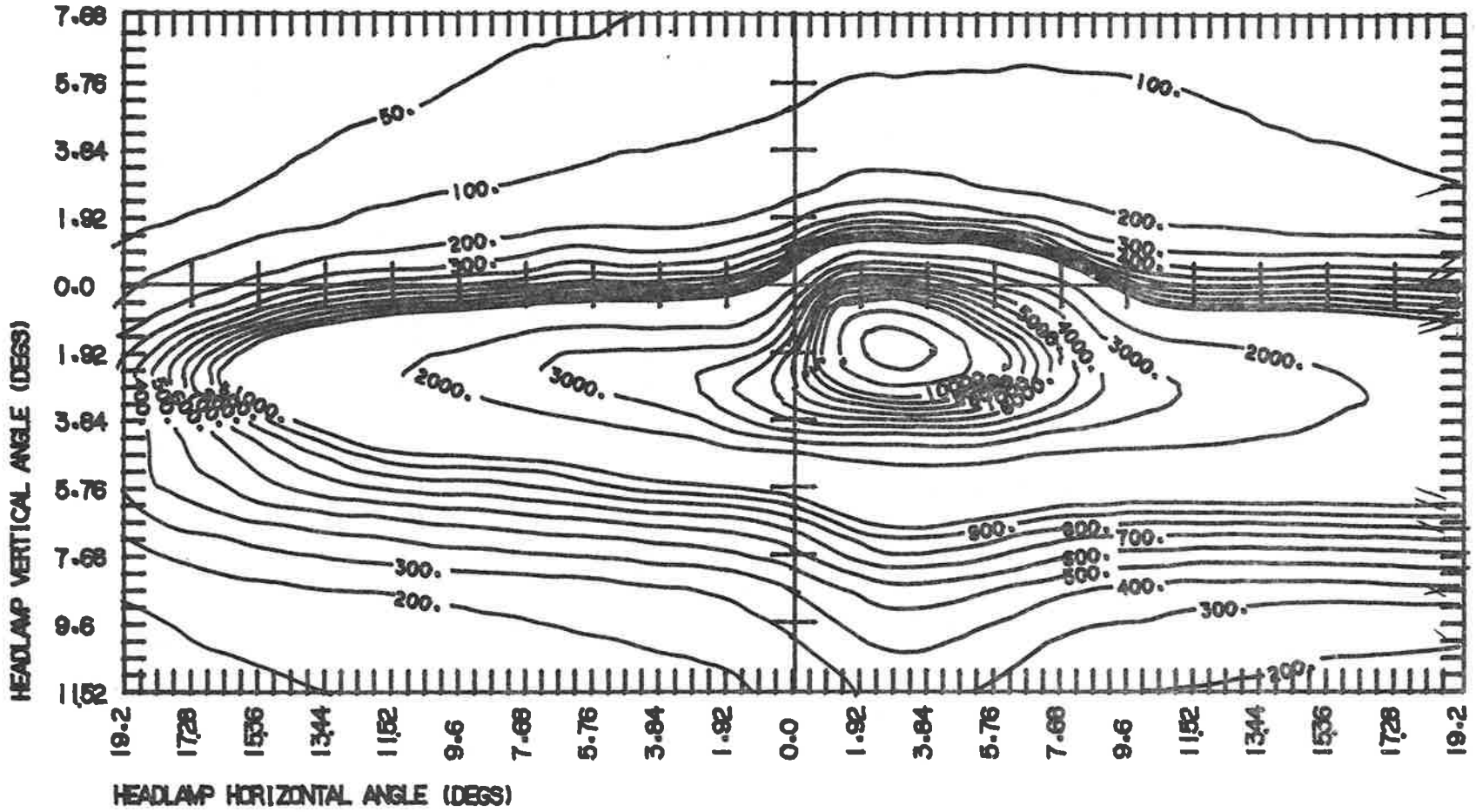
```
J1 = NY + 1
DO 400 J=1,NY
J1 = J1 - 1
400 WRITE (IPRT,500) Y(J1), (Z(I,J1),I=NC1,NC2)
500 FORMAT (1X, F8.3, 2X, 11F10.3)
C
GO TO 100
C
C
600 RETURN
END
```

APPENDIX A

page A.8

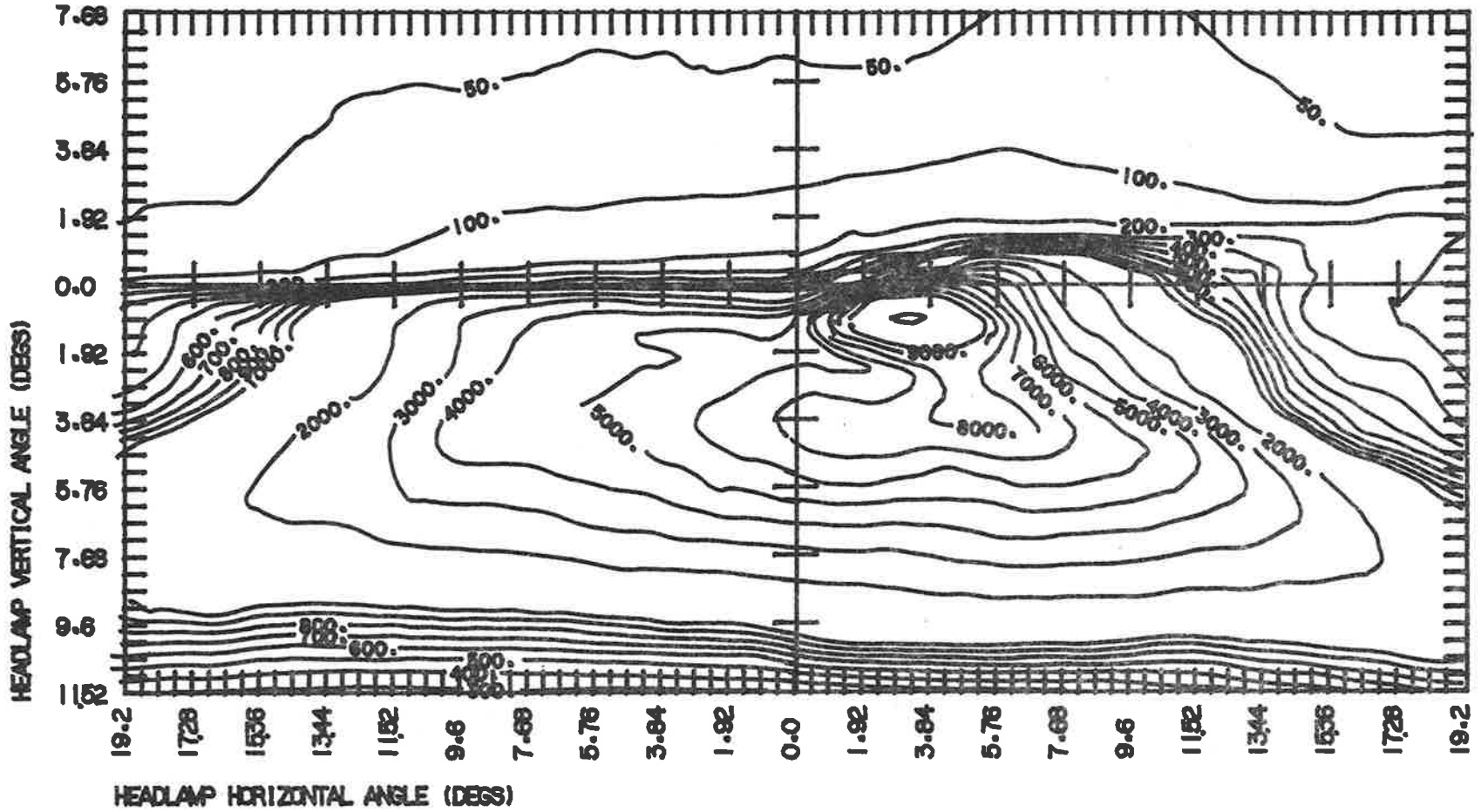
HL-A HEADLAMP A

INTENSITY MAP (VALUES IN CD)



HL-B HEADLAMP B

INTENSITY MAP (VALUES IN CD)



```
LOGON ALH,DEFER=N,RESTART=Y
ERASE RISC.AVSB
DDEF DD2,VP,GEN1LIB,OPTION=JOB LIB;DDEF DD1,VP,OBJ.RATIO,OPTION=JOB LIB
DDEF FT50F001,VS,ISOMAP.HLA;DDEF FT51F001,VS,ISOMAP.HLB
DDEF FT60F001,VS,RISC.AVSB,DCB=(RECFM=F,LRECL=80)
ISC
0
5C
51 60
RISC INTENSITY MAP A VS. B
%END
UNLOAD ISC;RELEASE DD1;RELEASE DD2
RELEASE FT50F001;RELEASE FT51F001;RELEASE FT60F001
ERASE (ISOMAP.HLA,ISOMAP.HLB)
LOGOFF
```

DATASET PAIR # 1

SUBROUTINE INPUT
I/P DATA ON UNIT 50 FOR THE MAP HL.A HEADLAMP A
MAP TYPE 3 AND DIMENSIONS 81 BY 41

SUBROUTINE INPUT
I/P DATA ON UNIT 51 FOR THE MAP HL.E HEADLAMP B
MAP TYPE 3 AND DIMENSIONS 81 BY 41

RATIO MAPPING
PRODUCED FOR THE ABOVE PAIR OF DATASETS,
THE RATIO MAP WAS IDENTIFIED AS: RISC INTENSITY MAP A VS. B

SUBROUTINE STORE
MAP # 1, A 81 BY 41 GRID SURFACE, IDENTIFIED
AS RISC INTENSITY MAP A VS. B WAS STORED ON UNIT 60

HEADLAMP RATIO MAP A:B
FOR THE INTENSITY MAPS

COLUMNS 1 TO 11 (VALUES AS RATIOS)

VERTICAL ANGLE (DEGS)	-19.200	-18.720	-18.240	HORIZONTAL ANGLE -17.280	-16.300	-15.320 (DEGS)	-15.840	-15.360	-14.880	-14.400
7.680	0.436	0.410	0.431	0.468	0.498	0.524	0.561	0.583	0.613	0.615
7.200	0.412	0.423	0.443	0.482	0.515	0.538	0.586	0.622	0.643	0.649
6.720	0.398	0.437	0.480	0.499	0.533	0.547	0.632	0.656	0.681	0.700
6.240	0.438	0.447	0.466	0.499	0.530	0.547	0.661	0.699	0.724	0.767
5.760	0.454	0.482	0.517	0.548	0.580	0.580	0.761	0.793	0.811	0.842
5.280	0.490	0.504	0.517	0.575	0.580	0.548	0.780	0.820	0.833	0.884
4.800	0.524	0.564	0.583	0.601	0.647	0.731	0.817	0.831	0.845	0.932
4.320	0.554	0.584	0.608	0.633	0.647	0.775	0.837	0.866	0.943	0.903
3.840	0.582	0.614	0.624	0.709	0.725	0.821	0.875	0.889	0.947	0.985
3.360	0.616	0.688	0.714	0.766	0.832	0.877	0.950	1.001	0.981	1.069
2.880	0.695	0.737	0.777	0.820	0.875	0.922	1.049	1.032	1.075	1.069
2.400	0.739	0.797	0.799	0.862	0.926	0.990	1.148	1.194	1.228	1.224
1.920	0.791	0.846	0.941	1.017	1.109	1.206	1.399	1.475	1.524	1.559
1.440	0.870	0.990	1.100	1.209	1.300	1.398	1.655	1.773	1.849	1.891
0.960	0.908	1.042	1.173	1.283	1.399	1.498	1.821	1.953	2.025	2.131
0.480	0.955	1.060	1.230	1.333	1.429	1.536	1.470	1.593	1.579	1.532
-0.000	0.978	0.414	0.452	0.478	0.513	0.546	0.516	0.673	0.698	0.672
-0.480	0.920	0.470	0.522	0.563	0.617	0.679	0.748	0.809	0.838	0.819
-0.960	0.876	0.654	0.729	0.811	0.910	0.985	1.078	1.135	1.153	1.126
-1.440	0.702	0.822	0.913	1.020	1.144	1.177	1.262	1.306	1.290	1.243
-1.920	0.543	0.879	0.973	1.068	1.144	1.114	1.311	1.306	1.262	1.243
-2.400	0.404	0.808	0.923	1.001	1.053	0.850	1.135	1.105	1.090	1.066
-2.880	0.279	0.687	0.825	0.872	0.823	0.591	0.860	0.854	0.847	0.829
-3.360	0.179	0.521	0.652	0.570	0.534	0.435	0.523	0.521	0.583	0.422
-3.840	0.104	0.390	0.481	0.381	0.348	0.351	0.350	0.350	0.425	0.350
-4.320	0.039	0.342	0.356	0.342	0.345	0.357	0.352	0.350	0.379	0.307
-4.800	0.000	0.284	0.297	0.298	0.291	0.291	0.272	0.269	0.274	0.273
-5.280	0.024	0.242	0.246	0.253	0.244	0.244	0.235	0.240	0.240	0.241
-5.760	0.031	0.207	0.214	0.216	0.208	0.208	0.203	0.208	0.208	0.212
-6.240	0.013	0.170	0.173	0.176	0.167	0.167	0.173	0.173	0.181	0.193
-6.720	0.063	0.147	0.151	0.151	0.149	0.149	0.153	0.147	0.169	0.180
-7.200	0.138	0.128	0.132	0.133	0.133	0.133	0.141	0.141	0.160	0.170
-7.680	0.123	0.112	0.115	0.117	0.120	0.120	0.132	0.144	0.150	0.161
-8.160	0.098	0.104	0.105	0.113	0.124	0.124	0.139	0.144	0.153	0.160
-8.640	0.098	0.101	0.108	0.116	0.126	0.126	0.139	0.144	0.153	0.160
-9.120	0.088	0.109	0.115	0.121	0.131	0.131	0.145	0.149	0.158	0.170
-9.600	0.083	0.109	0.117	0.124	0.131	0.131	0.145	0.149	0.158	0.170
-10.080	0.073	0.120	0.127	0.134	0.142	0.142	0.158	0.163	0.171	0.231
-10.560	0.043	0.130	0.143	0.155	0.164	0.164	0.188	0.201	0.217	0.267
-11.040	0.019	0.157	0.170	0.185	0.195	0.203	0.231	0.237	0.251	0.324
-11.520	0.019	0.195	0.212	0.228	0.245	0.258	0.281	0.294	0.311	0.324

HEADLAMP RATIO MAP A:B
FOR THE INTENSITY MAPS

VERTICAL ANGLE (DEGS)	COLUMNS 12 TO 22 (VALUES AS RATIOS)										
	-13.92C	-13.440	-12.960	-12.480	-12.000	-11.520	-11.040	-10.560	-10.080	-9.600	-9.120
7.680	0.645	0.673	0.697	0.772	0.822	0.867	0.921	0.956	0.992	1.031	1.062
7.500	0.686	0.702	0.758	0.817	0.841	0.886	0.903	0.935	0.973	1.013	1.057
6.120	0.703	0.766	0.786	0.804	0.831	0.850	0.905	0.939	0.948	1.013	1.054
5.760	0.778	0.806	0.801	0.838	0.844	0.859	0.901	0.950	0.967	1.032	1.041
5.280	0.814	0.830	0.834	0.858	0.871	0.858	0.868	0.885	0.981	1.032	1.000
4.800	0.867	0.876	0.889	0.848	0.853	0.892	0.910	0.947	0.979	1.014	1.016
4.320	0.915	0.913	0.871	0.915	0.925	0.937	0.944	0.990	1.032	1.023	1.059
3.840	0.889	0.891	0.899	0.917	0.998	1.019	1.044	1.064	1.069	1.088	1.107
3.360	0.933	0.951	0.961	1.014	1.089	1.019	1.256	1.271	1.182	1.166	1.169
2.880	1.085	1.005	1.038	1.178	1.226	1.260	1.454	1.433	1.291	1.406	1.248
2.400	1.227	1.217	1.254	1.332	1.408	1.444	1.735	1.693	1.651	1.607	1.604
1.920	1.520	1.515	1.570	1.641	1.696	1.720	1.980	1.945	1.910	1.863	1.837
1.440	1.917	1.948	1.962	2.000	2.012	2.045	2.164	2.075	2.019	1.954	1.897
0.960	2.156	2.197	2.256	2.288	2.245	2.255	2.452	2.326	2.098	1.963	1.831
0.480	1.514	1.517	1.573	1.532	1.491	1.480	1.454	1.421	1.444	1.354	1.328
0.000	0.784	0.618	0.695	0.899	0.823	0.589	0.564	0.536	0.487	0.446	0.414
-0.480	0.092	0.738	0.959	0.899	0.842	0.799	0.760	0.725	0.650	0.597	0.557
-1.040	1.092	1.013	1.085	1.024	0.971	0.912	0.842	0.805	0.737	0.684	0.635
-1.600	1.230	1.142	1.085	1.013	0.964	0.912	0.842	0.805	0.737	0.684	0.635
-2.160	1.042	0.999	0.943	0.902	0.864	0.811	0.741	0.709	0.635	0.584	0.540
-2.720	0.796	0.742	0.706	0.686	0.664	0.631	0.579	0.522	0.489	0.449	0.424
-3.280	0.540	0.521	0.511	0.507	0.498	0.477	0.443	0.408	0.376	0.355	0.328
-3.840	0.416	0.405	0.399	0.397	0.396	0.383	0.358	0.325	0.298	0.283	0.278
-4.400	0.347	0.339	0.335	0.340	0.341	0.322	0.298	0.273	0.254	0.244	0.244
-4.960	0.306	0.302	0.306	0.309	0.300	0.283	0.262	0.244	0.223	0.220	0.220
-5.520	0.274	0.279	0.280	0.280	0.271	0.254	0.236	0.213	0.212	0.219	0.212
-6.080	0.242	0.252	0.255	0.248	0.238	0.224	0.216	0.201	0.202	0.211	0.201
-6.640	0.218	0.222	0.226	0.218	0.208	0.205	0.203	0.198	0.202	0.200	0.196
-7.200	0.199	0.201	0.205	0.201	0.197	0.195	0.197	0.195	0.196	0.194	0.191
-7.760	0.185	0.193	0.193	0.185	0.187	0.185	0.186	0.182	0.183	0.186	0.187
-8.320	0.176	0.182	0.187	0.176	0.174	0.176	0.176	0.172	0.177	0.183	0.187
-8.880	0.157	0.175	0.175	0.157	0.157	0.158	0.163	0.152	0.157	0.163	0.167
-9.440	0.119	0.189	0.177	0.159	0.148	0.140	0.135	0.124	0.127	0.131	0.132
-10.000	0.113	0.219	0.221	0.223	0.198	0.203	0.239	0.244	0.245	0.250	0.252
-10.560	0.245	0.247	0.253	0.250	0.266	0.271	0.284	0.296	0.295	0.303	0.302
-11.120	0.340	0.290	0.301	0.314	0.329	0.342	0.352	0.359	0.362	0.371	0.380
-11.680	0.358	0.358	0.370	0.390	0.409	0.420	0.437	0.445	0.446	0.456	0.464

HEADLAMP RATIO MAP A:B
FOR THE INTENSITY MAPS

COLUMNS 23 TO 33 (VALUES AS RATIOS)

VERTICAL ANGLE (DEGS)	-8.640	-8.160	-7.680	HORIZONTAL ANGLE -7.200	(VALUES AS RATIOS)	-6.240	-5.760 (DEGS)	-5.280	-4.800	-4.320	-3.840
7.680	1.073	1.063	1.061	1.068	1.074	1.060	1.048	1.062	1.068	1.093	1.121
7.200	1.068	1.038	1.065	1.084	1.092	1.072	1.042	1.049	1.119	1.131	1.178
6.720	1.074	1.063	1.081	1.084	1.075	1.087	1.086	1.086	1.107	1.168	1.212
6.240	1.065	1.050	1.064	1.075	1.069	1.071	1.065	1.085	1.119	1.184	1.206
5.760	1.014	1.038	1.086	1.103	1.108	1.075	1.076	1.093	1.127	1.190	1.229
5.280	1.014	1.069	1.051	1.066	1.046	1.046	1.058	1.075	1.109	1.179	1.245
4.800	1.064	1.080	1.085	1.086	1.109	1.091	1.119	1.152	1.201	1.277	1.353
4.320	1.064	1.094	1.137	1.116	1.137	1.173	1.228	1.260	1.347	1.438	1.538
3.840	1.070	1.094	1.118	1.151	1.194	1.223	1.270	1.319	1.380	1.454	1.536
3.360	1.144	1.151	1.163	1.203	1.233	1.252	1.337	1.397	1.403	1.436	1.436
2.880	1.198	1.202	1.226	1.257	1.290	1.359	1.389	1.411	1.430	1.430	1.427
2.400	1.288	1.292	1.426	1.364	1.430	1.447	1.491	1.486	1.455	1.480	1.460
1.920	1.398	1.415	1.459	1.535	1.540	1.572	1.588	1.582	1.558	1.648	1.622
1.440	1.586	1.596	1.613	1.663	1.732	1.761	1.759	1.730	1.669	1.648	1.790
0.960	1.828	1.840	1.853	1.911	2.022	1.997	2.116	2.038	1.911	1.882	1.880
0.480	1.934	1.880	1.858	1.860	1.927	1.993	1.997	1.966	1.919	1.882	1.880
0.000	1.321	1.334	1.363	1.389	1.382	1.353	1.345	1.328	1.293	1.336	1.371
0.480	0.324	0.329	0.330	0.334	0.332	0.329	0.320	0.326	0.336	0.357	0.379
0.960	0.407	0.398	0.393	0.387	0.390	0.390	0.379	0.375	0.363	0.361	0.364
1.440	0.500	0.520	0.515	0.509	0.510	0.507	0.500	0.492	0.490	0.479	0.466
1.920	0.614	0.606	0.593	0.593	0.618	0.628	0.624	0.631	0.638	0.637	0.622
2.400	0.654	0.602	0.586	0.616	0.656	0.681	0.685	0.681	0.712	0.707	0.663
2.880	0.571	0.523	0.526	0.549	0.584	0.609	0.625	0.651	0.655	0.651	0.643
3.360	0.571	0.416	0.436	0.455	0.480	0.507	0.525	0.521	0.528	0.515	0.543
3.840	0.373	0.359	0.343	0.364	0.375	0.393	0.412	0.423	0.421	0.437	0.440
4.320	0.247	0.281	0.285	0.285	0.290	0.297	0.307	0.323	0.333	0.337	0.331
4.800	0.245	0.248	0.248	0.245	0.242	0.247	0.254	0.259	0.263	0.264	0.259
5.280	0.221	0.231	0.230	0.223	0.226	0.227	0.230	0.234	0.235	0.232	0.225
5.760	0.213	0.220	0.215	0.223	0.226	0.219	0.218	0.219	0.223	0.225	0.215
6.240	0.202	0.205	0.205	0.206	0.206	0.205	0.202	0.205	0.205	0.203	0.199
6.720	0.201	0.198	0.198	0.197	0.197	0.192	0.191	0.187	0.188	0.190	0.186
7.200	0.197	0.198	0.198	0.196	0.195	0.189	0.185	0.180	0.181	0.185	0.178
7.680	0.187	0.187	0.187	0.184	0.184	0.184	0.181	0.179	0.181	0.184	0.186
8.160	0.185	0.185	0.183	0.179	0.176	0.178	0.181	0.181	0.184	0.184	0.191
8.640	0.191	0.198	0.197	0.195	0.191	0.205	0.209	0.204	0.211	0.211	0.211
9.120	0.235	0.228	0.231	0.235	0.238	0.242	0.239	0.238	0.243	0.245	0.245
9.600	0.356	0.263	0.272	0.274	0.274	0.270	0.269	0.269	0.274	0.276	0.280
10.080	0.354	0.327	0.326	0.326	0.324	0.330	0.329	0.334	0.345	0.345	0.353
10.560	0.356	0.387	0.392	0.386	0.390	0.395	0.395	0.405	0.419	0.419	0.427
11.040	0.479	0.491	0.489	0.484	0.493	0.514	0.514	0.551	0.571	0.565	0.564
11.520	0.479	0.491	0.489	0.484	0.493	0.514	0.514	0.551	0.571	0.565	0.564

HEADLAMP RATIO MAP A:B
FOR THE INTENSITY MAPS

VERTICAL ANGLE (DEGS)	-3.360	-2.880	-2.400	COLUMNS 34 TO 44 (VALUES AS RATIOS)	HORIZONTAL ANGLE -1.920	-0.960	(DEGS) -0.480	0.000	0.480	0.960	1.440
7.680	1.163	1.264	1.349	1.460	1.567	1.618	1.560	1.538	1.541	1.564	1.589
7.200	1.229	1.311	1.417	1.504	1.610	1.659	1.597	1.577	1.585	1.636	1.686
6.720	1.261	1.349	1.386	1.440	1.500	1.528	1.538	1.549	1.646	1.750	1.796
6.240	1.296	1.392	1.404	1.448	1.482	1.494	1.496	1.505	1.743	1.874	1.905
5.760	1.346	1.429	1.431	1.481	1.421	1.425	1.470	1.503	1.658	1.832	1.814
5.280	1.327	1.365	1.393	1.468	1.492	1.503	1.523	1.603	1.694	1.781	1.899
4.800	1.419	1.498	1.516	1.568	1.575	1.581	1.576	1.619	1.711	1.781	1.899
4.320	1.501	1.522	1.544	1.603	1.609	1.604	1.624	1.688	1.711	1.755	1.892
3.840	1.457	1.500	1.529	1.554	1.579	1.586	1.577	1.608	1.696	1.788	1.905
3.360	1.450	1.431	1.449	1.486	1.518	1.566	1.561	1.609	1.698	1.792	2.018
2.880	1.407	1.408	1.421	1.452	1.524	1.574	1.611	1.693	1.796	1.899	2.275
2.400	1.449	1.475	1.418	1.481	1.545	1.614	1.669	1.829	1.989	2.145	2.781
1.920	1.590	1.604	1.636	1.557	1.615	2.034	1.869	2.037	2.327	2.605	3.521
1.440	1.440	1.783	1.796	1.883	2.045	2.274	2.509	3.093	3.806	4.294	5.481
0.960	1.867	1.764	1.937	2.041	2.164	2.374	2.752	3.437	4.777	4.446	7.259
0.480	1.348	1.417	1.544	1.643	1.778	2.008	2.499	3.318	4.159	4.597	7.375
0.000	0.364	0.426	0.464	0.522	0.604	0.741	0.967	1.266	1.495	1.501	1.314
-0.480	0.364	0.370	0.378	0.402	0.439	0.506	0.608	0.732	1.018	1.196	1.220
-0.960	0.461	0.466	0.479	0.495	0.519	0.596	0.716	0.833	1.195	1.196	1.407
-1.440	0.536	0.534	0.547	0.559	0.708	0.780	0.900	1.068	1.385	1.384	1.860
-1.920	0.726	0.728	0.753	0.797	0.843	0.892	0.970	1.068	1.330	1.273	1.949
-2.400	0.690	0.714	0.749	0.791	0.831	0.870	0.923	0.997	1.115	1.073	1.471
-2.880	0.573	0.597	0.644	0.693	0.733	0.769	0.806	0.868	0.915	0.873	1.062
-3.360	0.455	0.474	0.512	0.552	0.579	0.626	0.653	0.699	0.704	0.732	0.758
-3.840	0.333	0.353	0.380	0.402	0.416	0.432	0.446	0.454	0.470	0.472	0.306
-4.320	0.259	0.258	0.263	0.268	0.271	0.277	0.279	0.284	0.289	0.296	0.241
-4.800	0.228	0.222	0.210	0.219	0.216	0.217	0.216	0.218	0.223	0.232	0.222
-5.280	0.210	0.205	0.199	0.199	0.198	0.197	0.195	0.197	0.205	0.212	0.219
-5.760	0.194	0.192	0.187	0.183	0.183	0.185	0.183	0.189	0.198	0.209	0.218
-6.240	0.181	0.179	0.174	0.174	0.177	0.180	0.182	0.190	0.195	0.208	0.218
-6.720	0.175	0.177	0.179	0.179	0.180	0.185	0.190	0.198	0.205	0.214	0.224
-7.200	0.183	0.186	0.186	0.186	0.191	0.195	0.199	0.206	0.218	0.228	0.239
-7.680	0.186	0.183	0.190	0.192	0.196	0.199	0.206	0.216	0.229	0.240	0.254
-8.160	0.186	0.195	0.197	0.203	0.207	0.209	0.217	0.224	0.243	0.250	0.289
-8.640	0.212	0.217	0.218	0.225	0.234	0.236	0.242	0.253	0.268	0.275	0.312
-9.120	0.242	0.247	0.251	0.254	0.267	0.271	0.273	0.285	0.292	0.300	0.349
-9.600	0.282	0.288	0.293	0.293	0.307	0.312	0.314	0.325	0.330	0.337	0.431
-10.080	0.352	0.357	0.361	0.366	0.376	0.399	0.392	0.409	0.401	0.416	0.581
-10.560	0.435	0.440	0.441	0.448	0.467	0.486	0.501	0.517	0.529	0.549	0.862
-11.040	0.460	0.468	0.468	0.468	0.466	0.484	0.470	0.475	0.478	0.489	0.562
-11.520	0.605	0.618	0.618	0.631	0.660	0.684	0.670	0.751	0.786	0.829	

HEADLAMP RATIO MAP A'B
FOR THE INTENSITY MAPS

VERTICAL ANGLE (DEGS)	1.920	2.400	2.880	HORIZONTAL ANGLE 3.360	4.320	(DEGS)	4.800	5.280	5.760	6.240	6.720
7.680	1.654	1.676	1.685	1.672	1.639	1.608	1.557	1.500	1.444	1.394	1.361
7.200	1.719	1.737	1.722	1.689	1.660	1.621	1.542	1.483	1.433	1.376	1.340
6.720	1.821	1.843	1.833	1.791	1.728	1.684	1.632	1.582	1.543	1.435	1.418
6.240	1.929	1.955	1.974	1.895	1.740	1.732	1.674	1.609	1.544	1.503	1.525
5.760	1.849	1.883	1.870	1.819	1.777	1.757	1.720	1.656	1.598	1.574	1.633
5.280	1.891	1.908	1.882	1.848	1.772	1.720	1.681	1.613	1.594	1.590	1.636
4.800	1.954	1.981	1.956	1.902	1.815	1.720	1.660	1.568	1.539	1.591	1.643
4.320	1.978	2.009	2.027	1.963	1.864	1.745	1.638	1.547	1.528	1.537	1.643
3.840	2.010	2.066	2.046	1.945	1.805	1.712	1.611	1.530	1.474	1.464	1.571
3.360	1.998	2.054	2.009	1.924	1.802	1.700	1.630	1.532	1.453	1.420	1.474
2.880	2.103	2.155	2.133	2.049	1.962	1.814	1.739	1.599	1.471	1.438	1.427
2.400	2.328	2.353	2.285	2.212	2.100	1.918	1.775	1.600	1.471	1.438	1.427
1.920	2.884	3.053	2.791	2.508	2.460	2.154	2.016	1.685	1.544	1.544	1.499
1.440	3.400	5.305	3.576	3.326	2.996	2.700	2.514	2.033	1.922	1.814	1.719
0.960	5.402	6.115	4.828	4.652	4.106	3.587	2.773	2.485	2.341	2.179	1.982
0.480	7.090	1.702	4.828	3.584	1.423	0.777	0.902	0.718	0.642	0.471	0.159
0.000	2.673	0.984	1.228	0.925	0.464	0.000	0.742	0.711	0.642	0.622	0.629
-0.480	1.100	0.984	0.926	0.874	0.828	0.849	0.831	0.837	0.864	0.906	0.804
-0.960	1.218	1.171	1.411	1.046	0.983	0.934	0.900	0.887	0.923	0.975	0.964
-1.440	1.487	1.422	1.411	1.312	1.242	1.158	1.118	1.094	1.100	1.149	1.064
-1.920	1.943	1.938	1.859	1.760	1.601	1.422	1.386	1.432	1.343	1.393	1.329
-2.400	2.208	2.238	2.169	2.066	1.812	1.622	1.502	1.424	1.423	1.393	1.313
-2.880	1.684	1.722	1.787	1.706	1.600	1.442	1.327	1.253	1.219	1.155	1.099
-3.360	1.139	1.174	1.186	1.081	1.035	1.014	0.998	0.948	0.932	0.848	0.811
-3.840	0.795	0.773	0.773	0.763	0.747	0.724	0.705	0.684	0.635	0.587	0.548
-4.320	0.473	0.473	0.473	0.473	0.478	0.479	0.474	0.437	0.440	0.403	0.380
-4.800	0.312	0.322	0.329	0.337	0.347	0.355	0.349	0.336	0.320	0.303	0.292
-5.280	0.252	0.266	0.276	0.286	0.292	0.297	0.296	0.283	0.266	0.256	0.245
-5.760	0.234	0.244	0.258	0.266	0.269	0.269	0.264	0.255	0.244	0.233	0.219
-6.240	0.231	0.243	0.251	0.256	0.258	0.255	0.249	0.240	0.231	0.220	0.209
-6.720	0.238	0.248	0.251	0.255	0.251	0.241	0.238	0.226	0.217	0.207	0.199
-7.200	0.254	0.262	0.269	0.268	0.257	0.248	0.235	0.225	0.211	0.203	0.194
-7.680	0.266	0.273	0.279	0.274	0.271	0.254	0.241	0.232	0.215	0.212	0.202
-8.160	0.273	0.284	0.281	0.277	0.268	0.258	0.248	0.240	0.226	0.216	0.203
-8.640	0.296	0.307	0.301	0.299	0.291	0.286	0.276	0.266	0.253	0.240	0.235
-9.120	0.321	0.337	0.327	0.330	0.331	0.324	0.318	0.303	0.288	0.282	0.272
-9.600	0.364	0.374	0.367	0.364	0.361	0.350	0.345	0.330	0.314	0.309	0.297
-10.080	0.455	0.457	0.487	0.487	0.475	0.467	0.450	0.434	0.414	0.399	0.374
-10.560	0.620	0.657	0.648	0.647	0.633	0.601	0.583	0.559	0.530	0.507	0.478
-11.040	0.889	0.911	0.911	0.899	0.878	0.858	0.835	0.811	0.747	0.713	0.665

HEADLAMP RATIO MAP A:B
FOR THE INTENSITY MAPS

COLUMNS 56 TO 66 (VALUES AS RATIOS)

VERTICAL ANGLE (DEGS)	7.200	7.680	8.160	HORIZONTAL ANGLE 9.120	9.500	(DEGS) 10.080	10.560	11.040	11.520	12.000
7.680	1.298	1.281	1.282	1.207	1.199	1.209	1.246	1.272	1.328	1.390
7.200	1.297	1.279	1.282	1.203	1.249	1.240	1.273	1.272	1.328	1.390
6.720	1.382	1.331	1.339	1.279	1.320	1.306	1.273	1.272	1.328	1.390
6.240	1.515	1.429	1.454	1.462	1.494	1.458	1.451	1.391	1.283	1.307
5.760	1.648	1.618	1.634	1.599	1.633	1.606	1.653	1.558	1.471	1.440
5.280	1.664	1.645	1.709	1.785	1.759	1.832	1.750	1.668	1.550	1.647
4.800	1.655	1.678	1.773	1.836	1.802	1.883	1.848	1.747	1.720	1.710
4.320	1.588	1.641	1.701	1.763	1.831	1.893	1.898	1.771	1.696	1.669
3.840	1.437	1.544	1.588	1.632	1.678	1.693	1.705	1.676	1.606	1.510
3.360	1.458	1.458	1.463	1.427	1.508	1.472	1.496	1.488	1.499	1.409
2.880	1.501	1.458	1.454	1.393	1.365	1.351	1.354	1.340	1.386	1.396
2.400	1.558	1.533	1.405	1.293	1.267	1.228	1.211	1.220	1.286	1.266
1.920	1.734	1.431	1.201	1.077	1.067	1.027	0.976	0.894	0.838	0.815
1.440	1.034	0.902	0.708	0.576	0.575	0.602	0.628	0.659	0.687	0.713
0.960	0.676	0.673	0.598	0.526	0.550	0.577	0.618	0.692	0.738	0.792
0.480	0.899	0.933	0.839	0.669	0.648	0.638	0.657	0.720	0.795	0.867
0.000	1.084	1.116	1.029	0.877	0.850	0.840	0.840	0.915	0.999	1.104
-0.480	1.207	1.296	1.179	1.038	1.029	1.019	1.022	1.115	1.237	1.375
-1.440	1.390	1.369	1.258	1.129	1.141	1.167	1.265	1.318	1.450	1.625
-2.400	1.355	1.333	1.188	1.021	1.163	1.199	1.329	1.422	1.554	1.695
-3.360	1.036	0.963	1.105	0.921	1.122	1.210	1.477	1.473	1.608	1.735
-4.320	0.570	0.735	1.070	0.708	0.956	1.025	1.137	1.311	1.494	1.701
-5.280	0.282	0.571	0.501	0.523	0.729	0.759	0.826	0.936	1.080	1.277
-6.240	0.237	0.371	0.371	0.385	0.530	0.403	0.414	0.435	0.471	0.535
-7.200	0.211	0.282	0.230	0.289	0.295	0.306	0.317	0.330	0.355	0.382
-8.160	0.192	0.267	0.207	0.213	0.241	0.250	0.259	0.268	0.284	0.303
-9.120	0.186	0.196	0.194	0.200	0.203	0.202	0.209	0.216	0.226	0.235
-10.080	0.187	0.184	0.188	0.190	0.182	0.185	0.194	0.203	0.210	0.216
-11.040	0.195	0.182	0.182	0.176	0.177	0.179	0.188	0.195	0.198	0.203
-12.000	0.201	0.191	0.182	0.174	0.174	0.175	0.176	0.185	0.186	0.192
-13.920	0.224	0.209	0.204	0.192	0.189	0.175	0.176	0.173	0.178	0.183
-14.880	0.254	0.243	0.232	0.226	0.225	0.225	0.229	0.227	0.219	0.221
-15.840	0.259	0.284	0.275	0.265	0.268	0.272	0.280	0.284	0.276	0.268
-16.800	0.260	0.339	0.326	0.311	0.312	0.316	0.329	0.329	0.322	0.311
-17.760	0.260	0.460	0.424	0.409	0.409	0.392	0.394	0.377	0.363	0.355
-18.720	0.260	0.584	0.559	0.517	0.484	0.456	0.436	0.424	0.409	0.400

HEADLAMP RATIO MAP A:B
FOR THE INTENSITY MAPS

COLUMNS 67 TO 77 (VALUES AS RATIOS)

VERTICAL ANGLE (DEGS)	12.480	12.960	13.440	HORIZONTAL ANGLE 13.920	14.400	14.880	(DEGS) 15.360	15.840	16.320	16.800	17.280
7.680	1.434	1.451	1.466	1.527	1.575	1.622	1.669	1.725	1.781	1.778	1.791
7.200	1.387	1.411	1.444	1.502	1.555	1.605	1.659	1.708	1.754	1.774	1.764
6.720	1.362	1.381	1.413	1.463	1.539	1.596	1.652	1.690	1.756	1.768	1.746
6.240	1.370	1.403	1.424	1.467	1.555	1.588	1.636	1.686	1.757	1.754	1.745
5.760	1.409	1.434	1.477	1.497	1.553	1.613	1.657	1.718	1.770	1.784	1.773
5.280	1.572	1.538	1.582	1.558	1.552	1.603	1.623	1.717	1.742	1.768	1.779
4.800	1.726	1.672	1.723	1.684	1.658	1.712	1.733	1.740	1.761	1.774	1.751
4.320	1.719	1.662	1.746	1.761	1.770	1.792	1.779	1.832	1.823	1.774	1.723
3.840	1.688	1.706	1.685	1.692	1.728	1.756	1.774	1.803	1.803	1.750	1.615
3.360	1.588	1.600	1.581	1.714	1.737	1.758	1.797	1.843	1.835	1.769	1.663
2.880	1.459	1.516	1.578	1.646	1.678	1.703	1.797	1.843	1.835	1.769	1.586
2.400	1.414	1.436	1.455	1.485	1.504	1.521	1.513	1.510	1.437	1.306	1.126
1.920	1.285	1.259	1.203	1.150	1.070	0.992	0.935	0.879	0.826	0.826	0.788
1.440	0.797	0.768	0.761	0.762	0.772	0.781	0.796	0.803	0.826	0.848	0.841
0.960	0.742	0.765	0.805	0.849	0.896	0.962	1.025	1.083	1.132	1.171	1.179
0.480	0.844	0.908	0.996	1.110	1.242	1.400	1.534	1.623	1.726	1.803	1.824
0.000	0.967	1.073	1.194	1.432	1.715	1.998	2.238	2.410	2.570	2.703	2.728
-0.480	1.226	1.410	1.563	2.038	2.546	3.084	3.404	3.683	3.889	4.033	4.038
-0.960	1.539	1.766	2.144	2.688	3.378	4.195	4.659	4.989	5.127	5.419	5.404
-1.440	1.776	2.062	2.492	3.207	3.978	4.711	5.305	5.580	5.786	6.127	6.105
-1.920	1.835	2.211	2.608	3.324	3.928	4.711	5.305	5.436	5.733	6.127	6.029
-2.400	1.835	2.199	2.597	3.324	3.928	4.711	5.305	5.436	5.733	6.127	6.029
-2.880	1.651	2.183	2.526	2.957	3.485	4.328	4.820	5.205	5.461	5.529	5.559
-3.360	1.594	2.183	2.526	2.957	3.485	4.328	4.820	5.205	5.461	5.529	5.559
-3.840	1.018	1.262	1.375	2.629	2.520	3.444	3.727	3.935	4.163	4.369	4.521
-4.320	0.633	0.773	0.930	1.931	1.404	2.643	2.854	3.035	3.153	3.545	3.735
-4.800	0.432	0.501	0.586	1.148	0.834	1.690	2.028	2.298	2.579	2.841	3.022
-5.280	0.330	0.369	0.418	0.688	0.451	1.020	1.253	1.473	1.713	1.955	2.140
-5.760	0.275	0.296	0.322	0.470	0.351	0.652	0.791	0.930	1.075	1.214	1.360
-6.240	0.245	0.258	0.273	0.360	0.406	0.469	0.545	0.636	0.724	0.828	0.931
-6.720	0.223	0.230	0.240	0.293	0.326	0.369	0.411	0.469	0.533	0.599	0.681
-7.200	0.205	0.209	0.216	0.228	0.243	0.258	0.273	0.291	0.317	0.352	0.454
-7.680	0.196	0.198	0.200	0.208	0.220	0.232	0.239	0.248	0.260	0.278	0.295
-8.160	0.182	0.185	0.187	0.195	0.204	0.206	0.210	0.217	0.223	0.231	0.244
-8.640	0.182	0.181	0.179	0.185	0.204	0.186	0.187	0.190	0.196	0.197	0.204
-9.120	0.180	0.187	0.186	0.185	0.188	0.192	0.195	0.197	0.196	0.197	0.204
-9.600	0.218	0.213	0.215	0.208	0.193	0.192	0.186	0.177	0.173	0.173	0.176
-10.080	0.255	0.253	0.242	0.236	0.225	0.218	0.206	0.199	0.193	0.189	0.182
-10.560	0.293	0.285	0.269	0.260	0.252	0.239	0.227	0.218	0.214	0.209	0.202
-11.040	0.335	0.315	0.302	0.291	0.288	0.271	0.258	0.237	0.228	0.218	0.210
-11.520	0.392	0.368	0.351	0.334	0.317	0.301	0.281	0.262	0.252	0.241	0.232

HEADLAMP RATIO MAP A:B FOR THE INTENSITY MAPS		COLUMNS 78 TO 81 (VALUES AS RATIOS)		HORIZONTAL ANGLE 19.200	(DEGS)
VERTICAL ANGLE (DEGS)	17.760	18.240	18.720		
7.680	1.802	1.784	1.756	1.717	
7.200	1.764	1.737	1.720	1.692	
6.720	1.743	1.745	1.712	1.638	
6.240	1.708	1.696	1.703	1.614	
5.760	1.749	1.703	1.699	1.577	
5.280	1.719	1.664	1.628	1.585	
4.800	1.714	1.626	1.597	1.536	
4.320	1.670	1.588	1.560	1.411	
3.840	1.549	1.467	1.441	1.368	
3.360	1.449	1.354	1.253	1.123	
2.880	1.476	0.867	0.780	0.712	
2.400	0.748	0.729	0.717	0.697	
1.920	0.848	0.859	0.899	0.921	
1.440	1.188	1.251	1.352	1.420	
0.960	1.830	1.948	2.112	2.284	
0.480	2.772	2.955	3.256	3.631	
0.000	4.111	4.476	4.850	5.204	
-0.480	5.478	5.866	6.357	7.062	
-0.960	6.279	6.726	7.392	8.026	
-1.440	6.267	6.761	7.440	8.250	
-1.920	5.615	6.243	7.009	7.942	
-2.400	5.162	5.693	6.394	7.394	
-2.880	4.759	5.237	5.940	6.793	
-3.360	3.936	4.320	4.983	5.554	
-3.840	3.225	3.466	3.881	4.278	
-4.320	2.352	2.652	2.891	3.190	
-4.800	1.547	1.775	1.979	2.192	
-5.280	1.063	1.191	1.334	1.437	
-5.760	0.777	0.878	0.982	1.044	
-6.240	0.570	0.622	0.758	0.799	
-6.720	0.418	0.481	0.554	0.598	
-7.200	0.320	0.358	0.409	0.457	
-7.680	0.258	0.282	0.320	0.354	
-8.160	0.217	0.230	0.254	0.282	
-8.640	0.175	0.182	0.197	0.214	
-9.120	0.165	0.166	0.170	0.183	
-9.600	0.172	0.165	0.165	0.174	
-10.080	0.191	0.184	0.178	0.178	
-10.560	0.206	0.196	0.188	0.184	
-11.040	0.229	0.217	0.202	0.194	

APPENDIX B

This appendix contains the source listing for the MAIN3 ratio mapping program and the program output for a sample run illustrating its use.

Source listing

The source listing for the MAIN3 ratio mapping program is presented on pages B.6 through B.10 of this appendix and is preceded by a block diagram indicating the basic structure of the program.

There is but one module required for the operation of this program, the mainline program MAIN3, which effects the construction of the ratio mapping for each pair of illuminance maps presented to it. This module is a member of the VIEW program library and, as such, is stored in source form in the library SRC.VIEW and in object form in the library OBJ.VIEW.

Sample program

The sample program examined the basic differences between two particular headlamp configurations as exemplified by the ratio of their illuminance projected onto a vertical mapping plane.

The illuminance maps for the two headlamp configurations, as depicted on pages B.11 and B.12, represent the illuminance mapped by the MAIN1 program onto the vertical plane extending laterally 12 feet either side of the road centre line and vertically to a height of 22 feet above road level and situated at a distance of 150 feet ahead of the headlamps. The headlamps, representing the S.A.E. and E.C.E. low beam modes and for which two of the intensity maps were examined in the previous appendix, were labelled as group A and B respectively. They were assumed to be mounted in a test vehicle centred in the driving lane, so that they were located 3.26 and 8.73 feet right of the road centre line and at a height of 2.208 feet. The headlamps of group A were observed to produce a maximum illuminance on the vertical mapping plane of $.978 \text{ lumens/ft}^2$, while the group B headlamps produced a maximum of $.930 \text{ lumens/ft}^2$, only 5% less. Both maxima were situated in the lower right corner of the grid. Minimum illuminance values of $.004 \text{ lumens/ft}^2$ for the A headlamps and $.003 \text{ lumens/ft}^2$ for the B headlamps were observed in the upper left corner of the mapping plane.

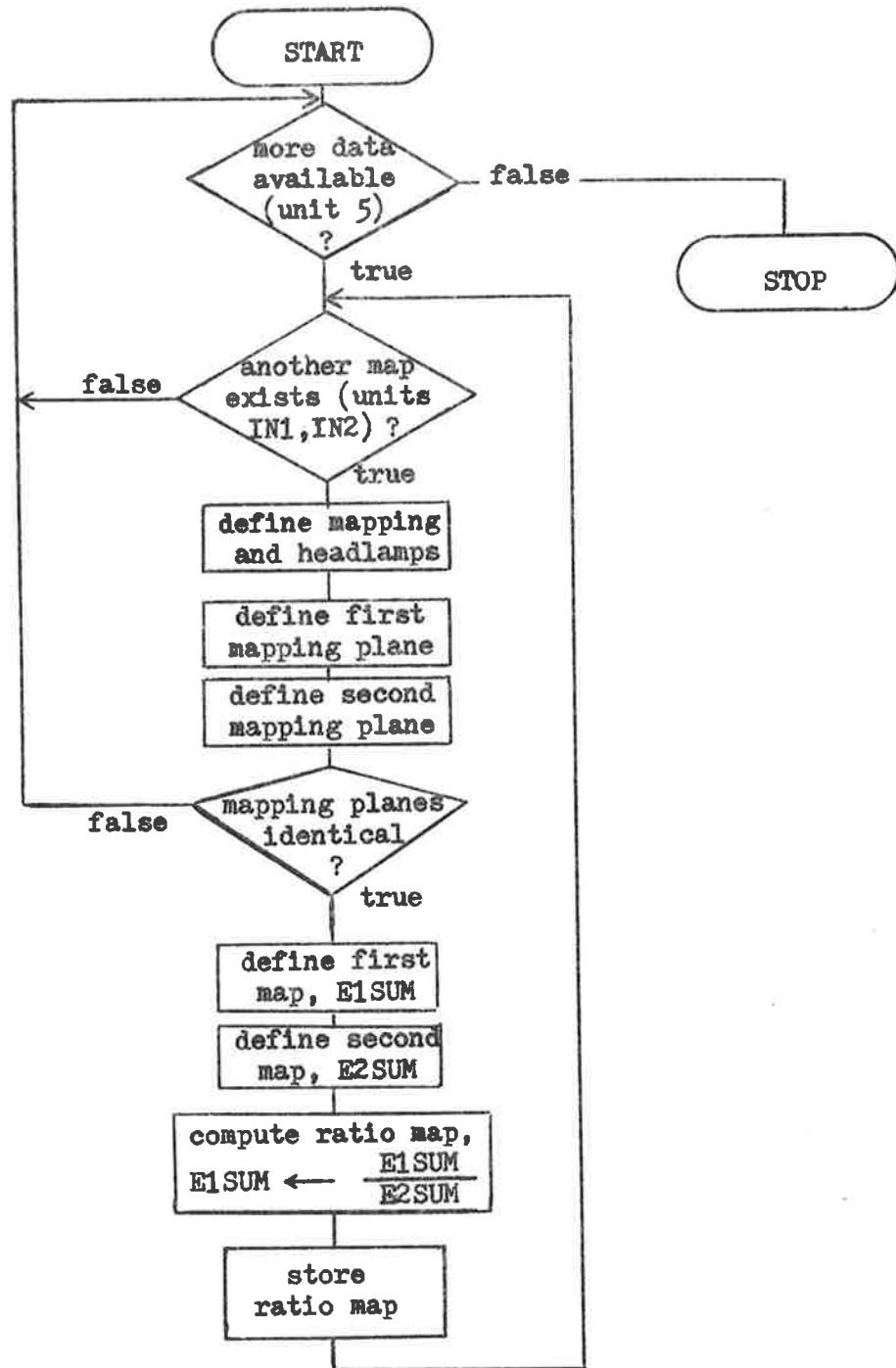
The card deck employed for the sample ratio mapping program is shown on page B.13 and the actual program output is included on the following page. Neither the base illuminance maps nor the ratio map produced from them were listed by MAIN3.

As in the case of the previous sample problem, the resulting ratio map for the illuminance over the vertical mapping plane was plotted by the MAIN2 plotting routines (page B.15). The printed output from the plotting program was then edited in order to provide a listing of the ratio map, included as pages B.16 and B.17 of this appendix. The mapping of the A headlamps with respect to the B headlamps produced illuminance ratio values ranging from .349 to 13.683, with the maximum situated at (+12.,+4.) and the minimum at (-8.,0.). The mean ratio value was 1.918, with a standard deviation of 1.354.

The plot of the ratio map in this case showed that the A headlamps offered significantly greater illuminance than the B headlamps throughout most of the mapping plane. The unity ratio contour ranged across the left side of the grid at a height of about 2 feet, declining to the road level by 6 feet right of centre (the location of the vehicle track, incidentally). In the region below this line, the B headlamps appeared stronger. There was a notable band, between $2\frac{1}{2}$ to 5 feet on the left side of the grid and expanding diagonally on the right side towards the upper right corner, wherein the A headlamps produced over twice the illuminance of the B headlamps. This band would appear to result from the sharply-defined illuminance cut-off for the E.C.E. type of low beam as noted previously in the case of the intensity maps. These illuminance characteristics were reflected in the mean ratio

value of 1.9 and the relatively large deviation (70% of the mean). Thus, where the headlamp differences tended to cancel each other out in different areas of the large field represented by the intensity maps (page A.14), one headlamp tends to predominate in the narrow band of headlamp angles representing the illuminance mapping plane (page B.15), namely in the central region of the grid where headlamp A produces about twice the illuminance as does headlamp B.

It should be remembered that the headlamp configurations examined here were employed merely to demonstrate the use of the illuminance ratio mapping program; they were not intended to represent typical S.A.E. or E.C.E. headlamps. The intensity ratio map indicated potential differences between individual headlamps and throughout their measured range of angular displacements. The illuminance ratio map showed the differences between particular headlamp configurations employed in a real-world situation. Note that, if the mapping plane closely approximates the original range of headlamp angles, then the illuminance map for a single headlamp should appear similar to a projection of the intensity map and hence to the original illuminance measurements for that headlamp. In this case, for example, the trends present in the illuminance ratio map appeared to follow logically from the intensity ratio map indications that headlamp A offered significantly greater illuminance output in the upper region of the grid.



Block diagram of the MAIN3 program structure

***** "MAIN3" PROGRAM *****

THIS PROGRAM DETERMINES THE RATIO MAP FOR TWO GRID SURFACES
CONSISTING OF THE RATIO OF THE ILLUMINANCE VALUES AT EACH
POINT ON THE SURFACE.

REAL*8 DIM(2) /*WIDTH-X *, *LENGTH-Y*/
REAL REF(200), E1SUM(8192), E2SUM(8192), XYZ(3,4), AIM(3,4)

EQUIVALENCE (E1SUM,REF,XYZ), (AIM,E2SUM)

NSET = 0
NPAGE = 0
M1 = 0
M2 = 0

(1) I/O DEVICE NUMBERS ---

100 READ (5,110,END=900) IN1, IN2, IDUT
110 FORMAT (3I4)

NSET = 1 + NSET
NPAGE = 1 + NPAGE
WRITE (6,120) NPAGE, NSET, IN1, IN2, IDUT
120 FORMAT (1H1, ///, ' "VIEW" --- "MAIN3" PROGRAM', 69X, 'PAGE', I4,
1 /, 12X, 'COMPUTATION OF THE RATIO MAP FOR TWO GRID ',
2 'SURFACES', //, 12X, 'PROBLEM', I4, ///, 12X, 'DEVICE ',
3 'ASSIGNMENT IS AS FOLLOWS', /, 19X, 'FIRST MAP INPUT ON ',
4 'UNIT', I4, /, 19X, 'SECOND MAP INPUT ON UNIT', I3, /,
5 19X, 'RATIO MAP OUTPUT ON UNIT', I3)
MSTOP = -1

(2) NEXT MAPPING DISTANCE ---

200 IF (M1.LE.0) GO TO 210
NPAGE = 1 + NPAGE
WRITE (6,120) NPAGE, NSET, IN1, IN2, IDUT

210 READ (IN1,211,END=220) M1, TEMP1
211 FORMAT (I2, 21X, F8.3)
GO TO 230

220 MSTOP = M2

***** "MAIN3" PROGRAM *****

```

1      * FOR MAP 2*)
C
  READ (IN1,330) ((XYZ(I,J),I=1,3), (AIM(I,J),I=1,3), J=1,NL1)
330  FORMAT (//, (6F8.3))
      K = 1
  WRITE (IDOUT,331) K, ((XYZ(I,J),I=1,3), (AIM(I,J),I=1,3), J=1,NL1)
331  FORMAT ('MAP #', I1, ' HEADLAMP LOCATION AND ANGLES OF AIM', /,
1      (6F8.3))
      WRITE (6,332)
332  FORMAT (//, 12X, 'THE HEADLAMP LOCATION CO-ORDINATES AND ANGLES ',
1      'OF AIM ARE AS FOLLOWS', //, 20X, 'MAP LAMP LOCATION ',
2      'WRT M (FT) ANGLES OF AIM (DEGS)', /, 21X, '#', 5X,
3      '#', 5X, 'X', 7X, 'Y', 7X, 'Z', 7X, 'H', 7X, 'V', 7X,
4      'R')
      WRITE (6,333) (K, J, (XYZ(I,J),I=1,3), (AIM(I,J),I=1,3), J=1,NL1)
333  FDMAT (/, (21X, I1, 5X, I1, 1X, 6F8.3))
C
  READ (IN2,330) ((XYZ(I,J),I=1,3), (AIM(I,J),I=1,3), J=1,NL2)
      K = 2
  WRITE (IDOUT,331) K, ((XYZ(I,J),I=1,3), (AIM(I,J),I=1,3), J=1,NL2)
  WRITE (6,333) (K, J, (XYZ(I,J),I=1,3), (AIM(I,J),I=1,3), J=1,NL2)
C
C
C
C      (4) MAPPING PLANE ---
  READ (IN1,400) I, (REF(J),J=1,I)
400  FORMAT (/, I4, /, (10F8.3))
      TEMP1 = REF(1)
      TEMP2 = REF(2)
  READ (IN2,400) NXE, (REF(J),J=1,NXE)
C
  IF (I.EQ.NXE .AND. TEMP1.EQ.REF(1) .AND. TEMP2.EQ.REF(2)) GO TO
1  420
  WRITE (6,410) DIM(1), I, NXE, TEMP1, REF(1), TEMP2, REF(2)
410  FORMAT (//, 12X, '***** MAPPING PLANE ', A8, ' IS IN ERROR', /,
1      18X, 'DIMENSION IS', I4, ' FOR MAP 1 AND', I4, ' FOR MAP',
2      ' 2', /, 18X, 'FIRST VECTOR ELEMENT IS', F8.3, ' FOR ',
3      'MAP 1 AND', F8.3, ' FOR MAP 2', /, 18X, 'SECOND VECTOR ',
4      'ELEMENT IS', F8.3, ' FOR MAP 1 AND', F8.3, ' FOR MAP 2')
  GO TO 100
C
420  TEMP3 = TEMP2 - TEMP1
      TEMP2 = REF(NXE)
  WRITE (IDOUT,421) NXE, (REF(I),I=1,NXE)
421  FORMAT ('MAPPING PLANE ', /, I4, /, (10F8.3))
C
  READ (IN1,422) I, (REF(J),J=1,I)
422  FORMAT (I4, /, (10F8.3))

```

C

***** "MAIN3" PROGRAM *****

```
TEMP4 = REF(1)
TEMP5 = REF(2)
READ (IN2,422) NZE, (REF(J),J=1,NZE)
C
  IF (I.EQ.NZE .AND. TEMP4.EQ.REF(1) .AND. TEMP5.EQ.REF(2)) GO TO
1   430
  WRITE (6,410) DIM(2), I, NZE, TEMP4, REF(1), TEMP5, REF(2)
  GO TO 100
C
430 WRITE (IOUT,422) NZE, (REF(I),I=1,NZE)
  TEMP5 = TEMP5 - TEMP4
  K = NXE * NZE
  WRITE (6,440) NXE, NZE, DIM(1), TEMP1, TEMP2, TEMP3, DIM(2),
1   TEMP4, REF(NZE), TEMP5
440 FORMAT (//, 12X, 'THE MAPPING PLANE SPECIFICATIONS ARE AS ',
1   'FOLLOWS', /, 30X, 'THE GRID SIZE IS', I4, ' BY', I4, /,
2   (30X, A8, ' RANGES FROM', F8.3, ' TO', F8.3, ' FT. IN ',
3   'STEPS OF', F8.3, ' FT'))
C
C
C
C   (5) ILLUMINATION MAPS ---
C
  READ (IN1,500) (E1SUM(I),I=1,K)
500 FORMAT (5E16.7)
  READ (IN2,500) (E2SUM(I),I=1,K)
  IF (M1.GT.1) GO TO 502
  READ (IN1,501) I
501 FORMAT (I1)
  READ (IN2,501) I
C
502 J = C
  DO 510 I=1,K
  TEMP1 = E2SUM(I)
  IF (TEMP1.EQ.C.) J = 1 + J
510 E1SUM(I) = E1SUM(I) / TEMP1
C
  WRITE (IOUT,500) (E1SUM(I),I=1,K)
  IF (M1.GT.1) GO TO 525
  WRITE (IOUT,520)
520 FORMAT ('C TARGETS')
C
525 IF (J.LT.1) GO TO 540
  WRITE (6,530) J
530 FORMAT (//, 12X, '***** NUMBER OF ZERO ELEMENTS IN THE SECOND ',
1   'MAP IS', I4)
C
540 WRITE (6,541) IOUT
541 FORMAT (//, 12X, 'RATIO MAP HAS BEEN CREATED AND STORED ON UNIT',
```

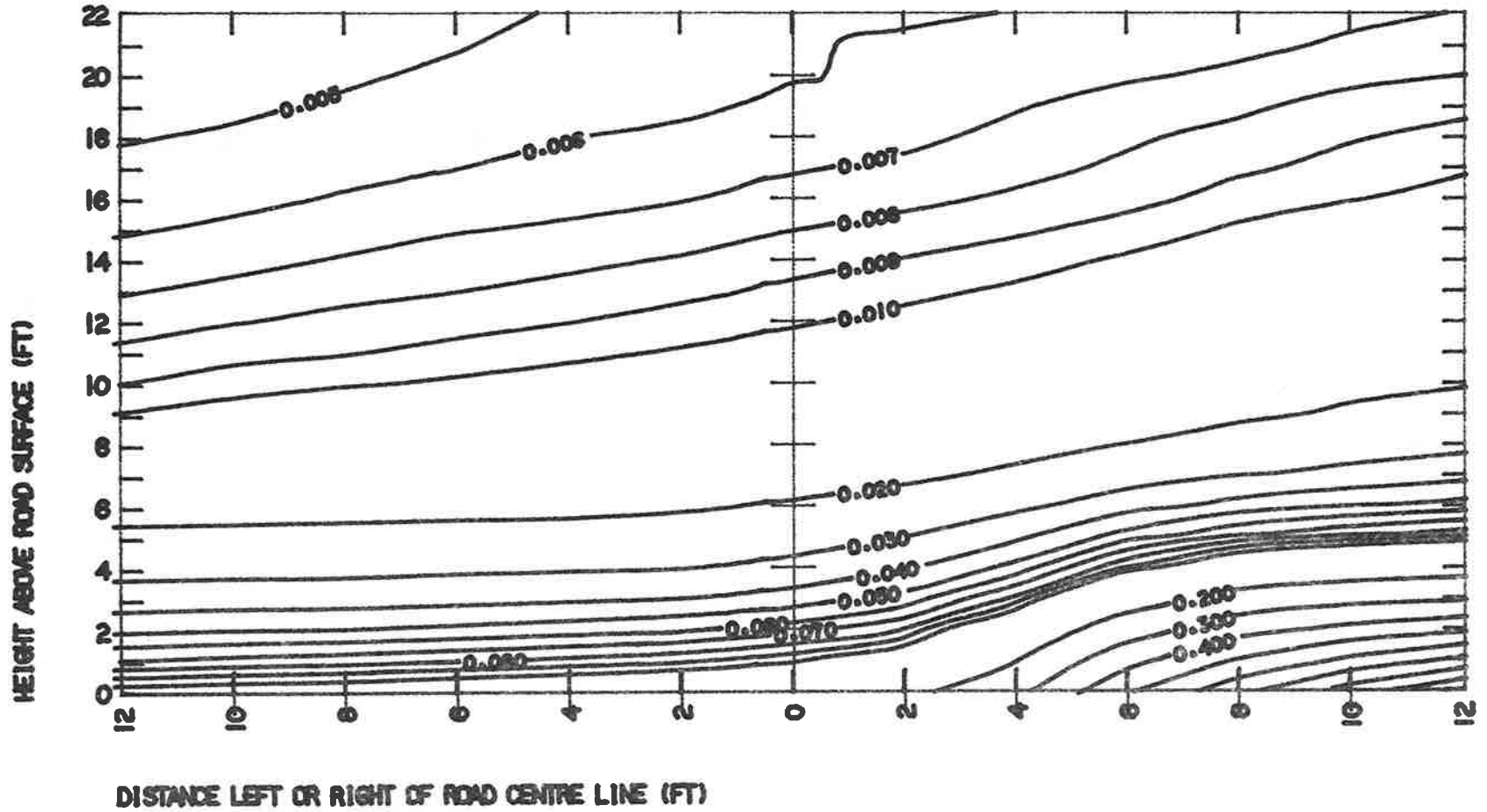
C

***** "MAIN3" PROGRAM *****

```
      1      I3)
      GO TO 200
C
C 900 WRITE (6,910)
C 910 FORMAT (1H1, ///)
C
      STOP
      END
```

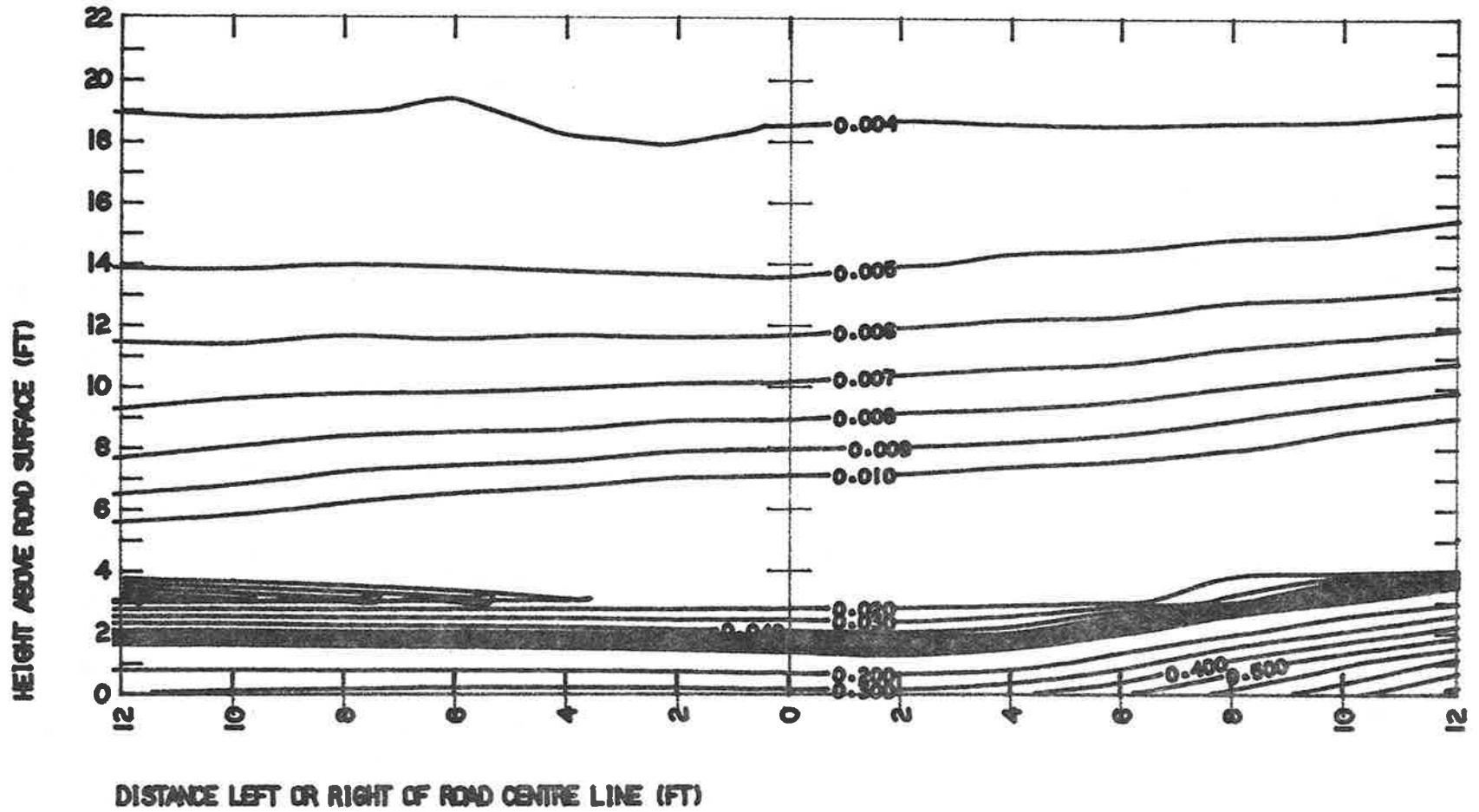
150 FT, HEADLAMPS A

ILLUMINANCE MAP (VALUES IN LUMENS/FT²)



150 FT. HEADLAMPS B

ILLUMINANCE MAP (VALUES IN LUMENS/FT**2)



```
LOGON ALH,DEFER=N,RESTART=Y
ERASE RILL.AVSB
DDEF DD1,VP,OBJ.VIEW,OPTION=JOBLIB
DDEF FT50F001,VS,ILLMAP.HLA;DDEF FT51F001,VS,ILLMAP.HLB
DDEF FT60F001,VS,RILL.AVSB,DCB=(RECFM=F,LRECL=80)
MAIN3
  50  51  60
%END
UNLOAD MAIN3;RELEASE DD1
RELEASE FT50F001;RELEASE FT51F001;RELEASE FT60F001
ERASE (ILLMAP.HLA,ILLMAP.HLB)
LOGOFF
```

PROBLEM 1

DEVICE ASSIGNMENT IS AS FOLLOWS
FIRST MAP INPUT ON UNIT 50
SECOND MAP INPUT ON UNIT 51
RATIO MAP OUTPUT ON UNIT 60

MAPPING SPECIFICATIONS ARE AS FOLLOWS
MAP NUMBER IS 2
DISTANCE TO THE MAPPING PLANE IS 150.000 FT
NUMBER OF HEADLAMPS IS 2 FOR MAP 1 AND 2 FOR MAP 2

THE HEADLAMP LOCATION CO-ORDINATES AND ANGLES OF AIM ARE AS FOLLOWS

MAP #	LAMP #	LOCATION WRT M (FT)			ANGLES OF AIM (DEGS)		
		X	Y	Z	H	V	P
1	1	3.260	0.000	2.208	0.000	0.000	0.000
1	2	8.730	0.000	2.208	0.000	0.000	0.000
2	1	3.260	0.000	2.208	0.000	0.000	0.000
2	2	8.730	0.000	2.208	0.000	0.000	0.000

THE MAPPING PLANE SPECIFICATIONS ARE AS FOLLOWS
THE GRID SIZE IS 13 BY 23
WIDTH-X RANGES FROM -12.000 TO 12.000 FT, IN STEPS OF 2.000 FT
LENGTH-Y RANGES FROM 0.000 TO 22.000 FT, IN STEPS OF 1.000 FT

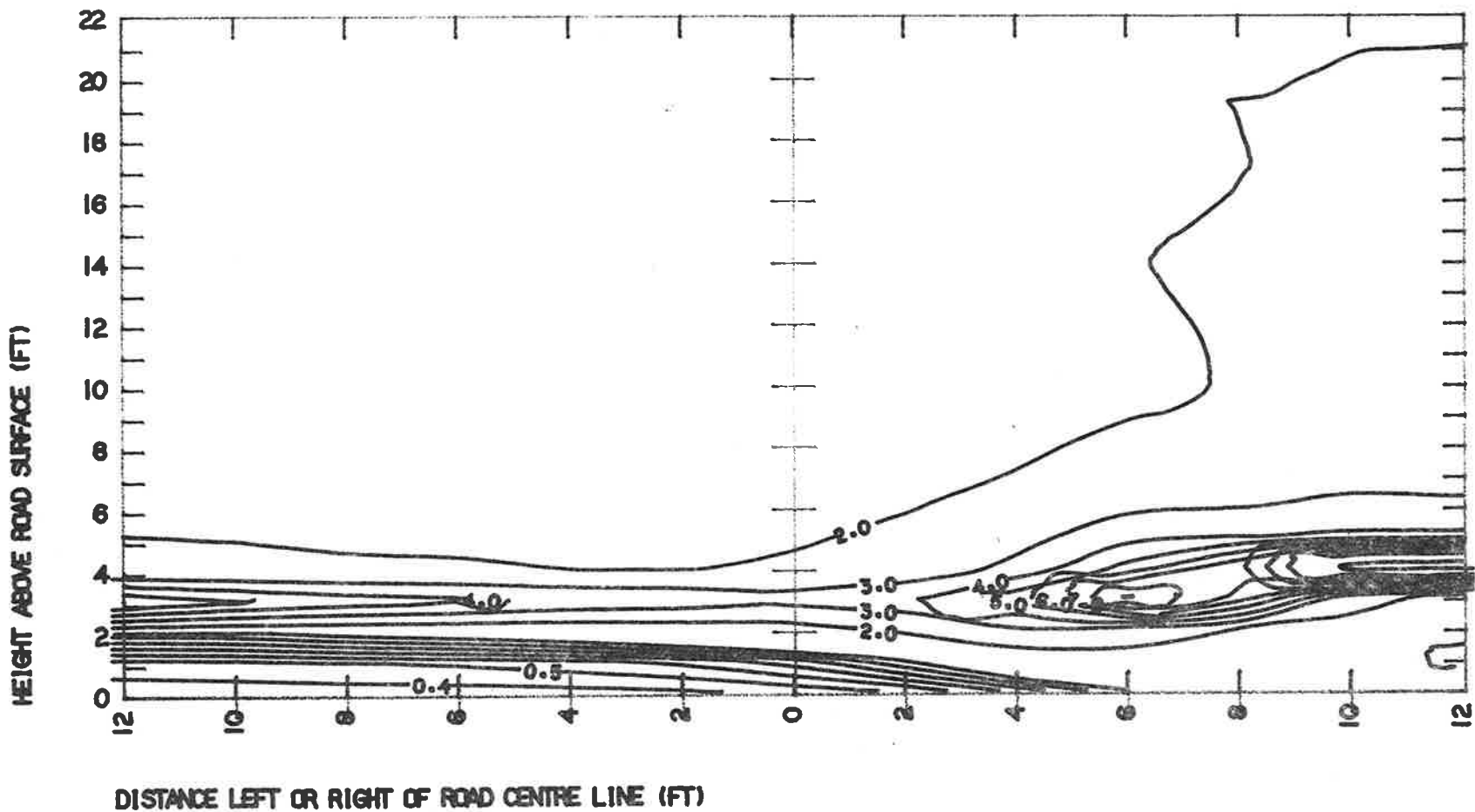
RATIO MAP HAS BEEN CREATED AND STORED ON UNIT 60

APPENDIX B

page B.14

150 FT. RATIO MAP A:B

CONSTRUCTED FROM THE HEADLAMP ILLUMINANCE MAPS



APPENDIX B

150 FT. RATIO MAP A:B FOR THE ILLUMINANCE MAPS		1 TO 11 (VALUES AS RATIOS)										
HEIGHT ABOVE ROAD (FT)	COLUMNS	DISTANCE LEFT OR RIGHT OF CENTRE (FT)										
		-12.000	-10.000	-8.000	-6.000	-4.000	-2.000	0.000	2.000	4.000	6.000	8.000
22.000	1.137	1.195	1.266	1.344	1.482	1.607	1.635	1.704	1.775	1.828		
21.000	1.137	1.196	1.291	1.368	1.495	1.608	1.638	1.717	1.801	1.864		
20.000	1.167	1.212	1.314	1.404	1.485	1.571	1.628	1.717	1.801	1.864		
19.000	1.170	1.225	1.332	1.449	1.508	1.590	1.635	1.729	1.801	1.864		
18.000	1.190	1.246	1.366	1.490	1.538	1.626	1.644	1.751	1.828	1.886		
17.000	1.197	1.253	1.379	1.516	1.549	1.643	1.644	1.745	1.828	1.886		
16.000	1.204	1.253	1.396	1.543	1.549	1.647	1.644	1.745	1.828	1.886		
15.000	1.224	1.314	1.450	1.606	1.606	1.707	1.690	1.813	1.886	1.926		
14.000	1.236	1.361	1.513	1.680	1.660	1.778	1.749	1.874	1.926	1.964		
13.000	1.308	1.373	1.497	1.670	1.631	1.764	1.733	1.840	1.922	1.961		
12.000	1.312	1.388	1.486	1.645	1.592	1.741	1.733	1.822	1.905	1.943		
11.000	1.331	1.421	1.488	1.645	1.538	1.695	1.665	1.763	1.846	1.884		
10.000	1.361	1.444	1.488	1.645	1.538	1.695	1.665	1.763	1.846	1.884		
9.000	1.413	1.444	1.488	1.645	1.538	1.695	1.665	1.763	1.846	1.884		
8.000	1.493	1.444	1.488	1.645	1.538	1.695	1.665	1.763	1.846	1.884		
7.000	1.519	1.517	1.499	1.579	1.516	1.678	1.662	1.801	1.898	1.936		
6.000	1.581	1.573	1.573	1.665	1.584	1.678	1.662	1.801	1.898	1.936		
5.000	1.640	1.633	1.699	1.665	1.664	1.792	1.816	1.898	1.936	1.974		
4.000	2.040	1.989	1.864	1.813	1.788	1.926	1.957	2.025	2.128	2.166		
3.000	6.027	2.138	2.094	2.005	1.989	2.113	2.150	2.247	2.328	2.366		
2.000	0.944	4.525	4.201	3.791	3.623	3.341	3.402	3.570	3.651	3.722		
1.000	0.434	1.052	1.121	1.220	1.378	1.604	1.682	1.901	2.047	2.161		
0.000	0.359	0.453	0.516	0.560	0.627	0.757	1.009	1.377	1.833	2.194		
		0.355	0.351	0.360	0.382	0.433	0.523	0.734	1.000	1.152		

150 FT. RATIO MAP A:B FOR THE ILLUMINANCE MAPS		COLUMNS 12 TO 13 (VALUES AS RATIOS)
HEIGHT ABOVE ROAD (FT)	DISTANCE LEFT OR RIGHT OF CENTRE (FT)	
22.000	10.000	12.000
21.000	1.923	1.956
20.000	1.973	2.001
19.000	2.046	2.088
18.000	2.141	2.188
17.000	2.124	2.165
16.000	2.099	2.151
15.000	2.109	2.167
14.000	2.153	2.190
13.000	2.204	2.240
12.000	2.216	2.261
11.000	2.191	2.230
10.000	2.166	2.193
9.000	2.175	2.200
8.000	2.200	2.242
7.000	2.357	2.379
6.000	2.638	2.635
5.000	3.201	3.142
4.000	4.146	4.150
3.000	12.878	13.683
2.000	1.830	1.604
1.000	1.381	1.039
0.000	1.052	0.973
	1.091	1.052

Note on the contour plot of the illuminance ratio map

One problem noted with the contour plotting facility at N.R.C. is evident in the plot of the illuminance ratio map (page B.15). In the case of certain ill-defined contours (i.e. where the grid surface data were found to be highly irregular in the area of a particular point), a series of overlapping contours has resulted. This occurs because of the contour-delineating routine's task of drawing the "best fitting" contour at each specified contour level, and thus treating the contours independently.