To use torad and radout successfully, you must use only those AutoCAD primitives that each of them supports. Luckily, most commonly used entities are supported, except that torad does not support closed 3D PLINEs and the corresponding entities that rely on it, such as POLYMESH. Radout supports closed 3D PLINEs and is also up to seven times faster.

To use one of these AutoCAD add-on programs, de-archive the application's file into the *support* subdirectory. Launch AutoCAD, access the *File\Applications*… menu, and click on the *File*… button. For torad, find the *torad.lsp* file, or for radout, find the *rowin.exe* or *rodos.exe* file and click OK. This procedure need only be carried out once for each new drawing. The next time the drawing is loaded, again access the *File\Applications...* menu, select the program you want to use, and click the LOAD button. If the program is successfully loaded, you will then be able to access the torad or radout control screen by typing `torad` or `radout` into the AutoCAD text dialog screen.

Torad is currently available free of charge, and radout is available for a minimal shareware registration fee. Torad is available from the main *Radiance* ftp site:

ftp://radsite.lbl.gov/rad/pub/translator/torad.zip

Radout is available from Georg Mischler at

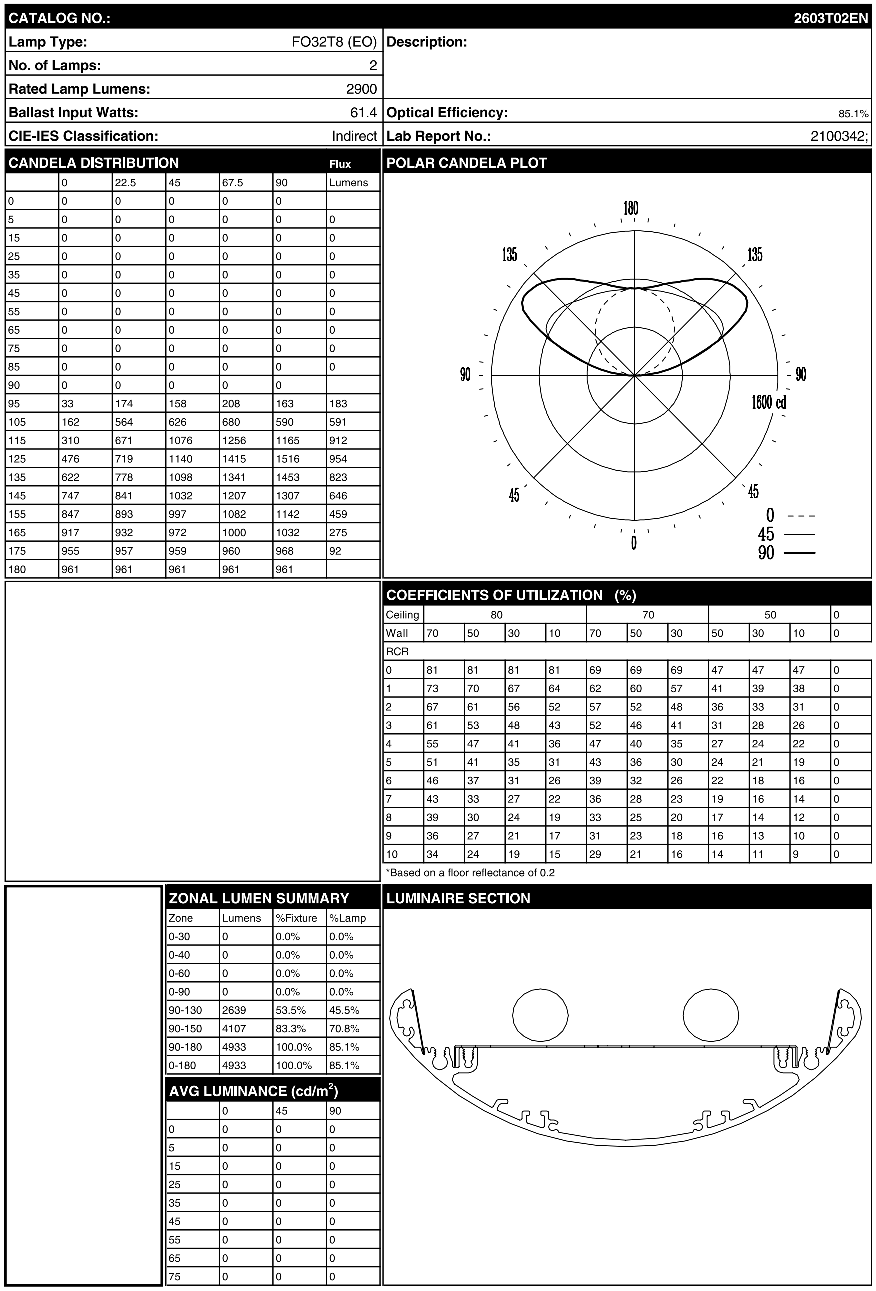
www.schorsch.com/autocad/radout/index.html

Those of you who may use AutoCAD on the DOS and Microsoft Windows platform may find this author's version of radout useful:

www.innernet.com/radiance/home.html

5.2.3 Collecting Luminaire Data

You contact the manufacturer of the specific luminaire that the architect would like to use, but, alas, they are unable to ship you one of their catalogs because they have run out. (Figure 5.7 shows what may be found in most luminaire catalogs.) They do, however, have IESNA candlepower distribution files that they will gladly provide for you. They assure you that in a few months all of their candlepower distribution files will be readily accessible for download via the Internet. You decide to accept the IESNA files, and you browse through the architect's library in search of a catalog of similar products. Luckily, you find one of similar size, rated wattage, type, and shape. Don't worry if you're not familiar with IESNA files, because we will go into some detail about the photometric database format so that you can create your own *Radiance* versions of other photometric database formats even if you don't have a conversion program.



CATALOG NO.:	2603T02EN
Lamp Type:	FO32T8 (EO)
No. of Lamps:	2
Rated Lamp Lumens:	2900
Ballast Input Watts:	61.4
CIE-IES Classification:	Indirect
Description:	
Optical Efficiency:	85.1%
Lab Report No.:	2100342;

CANDELA DISTRIBUTION

	0	22.5	45	67.5	90	Flux Lumens
0	0	0	0	0	0	
5	0	0	0	0	0	0
15	0	0	0	0	0	0
25	0	0	0	0	0	0
35	0	0	0	0	0	0
45	0	0	0	0	0	0
55	0	0	0	0	0	0
65	0	0	0	0	0	0
75	0	0	0	0	0	0
85	0	0	0	0	0	0
90	0	0	0	0	0	
95	33	174	158	208	163	183
105	162	564	626	680	590	591
115	310	671	1076	1256	1165	912
125	476	719	1140	1415	1516	954
135	622	778	1098	1341	1453	823
145	747	841	1032	1207	1307	646
155	847	893	997	1082	1142	459
165	917	932	972	1000	1032	275
175	955	957	959	960	968	92
180	961	961	961	961	961	

POLAR CANDELA PLOT

COEFFICIENTS OF UTILIZATION (%)

Ceiling	80				70			50			0
Wall	70	50	30	10	70	50	30	50	30	10	0
RCR											
0	81	81	81	81	69	69	69	47	47	47	0
1	73	70	67	64	62	60	57	41	39	38	0
2	67	61	56	52	57	52	48	36	33	31	0
3	61	53	48	43	52	46	41	31	28	26	0
4	55	47	41	36	47	40	35	27	24	22	0
5	51	41	35	31	43	36	30	24	21	19	0
6	46	37	31	26	39	32	26	22	18	16	0
7	43	33	27	22	36	28	23	19	16	14	0
8	39	30	24	19	33	25	20	17	14	12	0
9	36	27	21	17	31	23	18	16	13	10	0
10	34	24	19	15	29	21	16	14	11	9	0

*Based on a floor reflectance of 0.2

ZONAL LUMEN SUMMARY

Zone	Lumens	%Fixture	%Lamp
0-30	0	0.0%	0.0%
0-40	0	0.0%	0.0%
0-60	0	0.0%	0.0%
0-90	0	0.0%	0.0%
90-130	2639	53.5%	45.5%
90-150	4107	83.3%	70.8%
90-180	4933	100.0%	85.1%
0-180	4933	100.0%	85.1%

AVG LUMINANCE (cd/m^2)

	0	45	90
0	0	0	0
5	0	0	0
15	0	0	0
25	0	0	0
35	0	0	0
45	0	0	0
55	0	0	0
65	0	0	0
75	0	0	0

LUMINAIRE SECTION

Figure 5.7 Manufacturer's luminaire specification sheet. (Copyright © Lightolier, Inc., Fall River, Mass. A division of Genlyte, Union City, NJ.)

The first fact you need to learn in order to design lighting-accurate luminaires is that for complex luminaires, the surface in *Radiance* responsible for emitting light can be a different one from that for describing the visible appearance of the location where the light is emitted. These invisible surfaces are called *impostors.* Complex luminaires may contain parabolic or louvered elements, chandeliers, translucent surfaces, or other macro-scale diffusing geometry. Because *Radiance* samples a light source with a single point on the emitting surface, it is necessary to create impostor surfaces to circumvent the complexities of the actual luminaire. It is not always possible for a backwards ray-tracing algorithm to follow all of the bounces of light far enough and reliably enough to reach a light source that is hidden behind louvers, diffracting lenses, convex or concave mirrors, and so on. This calculation is sometimes possible, but always expensive and the results will be unreliable. Besides, the candlepower distribution curves available for most luminaires already account for the complexity of the luminaires. What we need are some simple, invisible impostor surfaces to provide a place to "anchor" the candlepower distribution curves. A suspended direct/indirect luminaire is one type that requires impostor geometry for correct appearance.

The designer has supplied you with an IESNA candlepower distribution file for a direct/indirect luminaire. The first step in creating the appropriate model for this luminaire is to learn as much as possible about the IESNA file that the designer provides, and to verify that the designer intends to use the same number of lamps in this luminaire as is indicated in the IESNA file. To do this, you must inspect the provided file. Much of the difficulty of interpreting IESNA files is alleviated with Ian Ashdown's IES file parser; the latest version can also be downloaded from *ftp://ftp.ledalite.com/pub/ies_100c.zip.*

The header of an example IESNA file, *111621pn.ies*, is shown here:

```
REPORT NUMBER: ITL36346                 DATE:  11-28-1989
CATALOG NUMBER: 111621-PN-12HP-NN
LUMINAIRE: EXTRUDED SQUARE ALUMINUM HOUSING, WHITE PAINTED
      REFLECTORS, SEMI-SPECULAR PARABOLIC LOUVER, OPEN TOP.
LAMPS: THREE F40T12/CW, EACH RATED 3150 LUMENS.
BALLASTS: ONE EACH PHILIPS HM-140-TPS AND VALMONT 8G1022W
MOUNTING: SUSPENDED-DIRECT/INDIRECT
TILT=NONE
```

When this file is passed through the **ies_read** program, the following categories of summary information are produced. The entire file is included in the Supplemental Information section at the end of this chapter:

Photometric Data File Information

Luminaire Description

Lamp Data

Luminaire Dimensions

Electrical Data

Photometric Data

Calculated Information

Candela Distribution

Zonal Lumen Summary

CIE Classification

Coefficients of Utilization

Notes

Converting IESNA Candlepower Distribution Data

In other chapters of this book, some basic and more advanced uses of the **ies2rad** program are presented. In this chapter, we will discuss a nonstandard use of ies2rad to create a *Radiance* model for the direct/indirect suspended luminaire whose IESNA data file is shown above. For this luminaire, renderings from applying ies2rad in the usual way will be inaccurate and undesirable. (The version of *Radiance* included on the CD-ROM circumvents the problem described here, but the discussion is still a useful demonstration of imposter geometry.) A dark band, or "shadow," will encircle the room between the heights of the upper and lower edges of the light-emitting surfaces of the luminaire. This is because, relative to points within this band, the surface normals of these light-emitting surfaces are oriented away; therefore, no direct light source rays are traced to either of these light-emitting surfaces. However, the direct/indirect nature of this luminaire belies this computational limitation. There is some small component of the output distribu-tion that travels at near-horizontal angles to the luminaire. The fact that this small component is not included in the calculation causes the dark band to appear.

To circumvent the computational limitation, an "impostor geometry" is created that completely encloses the luminaire and provides the anchor for the IESNA candlepower distribution. The first step in this process is to convert the IESNA file in such a way that the area of emitting surfaces is equal to 1. This is accomplished by using the -i option of ies2rad, set equal to the radius of a sphere whose area is equal to 1:

```
projected_area (meter squared) = 1 = PI * (radius)^2
radius = sqrt( 1 / PI )
radius = .56419
```

This value is a constant and works regardless of the units of your scene.

```
% ies2rad -t white -i .56419 111621PN.IES
```

The `-t white` option tells ies2rad to create a pure white light source that does not have any coloration because of lamp color temperature, and the `-i .56419` is the special value for the enclosing sphere that creates a sphere with area equal to 1. The *Radiance* input file resulting from the above command, shown below, is called *111621pn.rad*.

```
# ies2rad -t white -i .56419
# Dimensions in feet
#<REPORT NUMBER: ITL36346       DATE:  11-28-1989
#<CATALOG NUMBER: 111621-PN-12HP-NN
#<LUMINAIRE: EXTRUDED SQUARE ALUMINUM HOUSING,
#<WHITE PAINTED REFLECTORS, SEMISPECULAR PARABOLIC
#<LOUVER, OPEN TOP.
#<LAMPS: THREE F40T12/CW, EACH RATED 3150 LUMENS.
#<BALLASTS: ONE EACH PHILIPS HM-140-TPS AND VALMONT #<8G1022W
#<MOUNTING: SUSPENDED-DIRECT/INDIRECT
# 147.5 watt luminaire, lamp*ballast factor = 1

void brightdata 111621pn_dist
5 corr 111621pn.dat source.cal src_phi4 src_theta
0
1 1

111621pn_dist illum 111621pn_light
0
0
3 0.999999 0.999999 0.999999

111621pn_light sphere 111621pn.s
0
0
4 0 0 0 .56419
```

The simplicity of knowing what the output of the luminaire is, excluding the effect of the area of the emitting surface, allows you to easily adjust the output to match the known area of the luminaire for which you are creating the impostor geometry. Usually, when creating a luminaire from scratch, you must divide the radiant output of the luminaire by the projected area of the emitting surfaces. However, in this case we are using a special function file that takes care of this for us. In this case, we are concerned about the appearance of the luminaire when it gets very close to surrounding surfaces, so a sphere cannot create a tight enough bound on the enclosed geometry. The **lboxcorr** function found in *source.cal* is appropriate for computing the projected area of a box. Lboxcorr requires as input the dimensions, in meters, of the impostor parallelepiped. You must first convert the dimensions of the luminaire (as reported from the ies_read program) from feet into meters:

```
< from  111621PN.TXT >

Luminaire Dimensions
--------------------
Width  =       0.41
Length =       4.00
Height =       0.51

% calc
.41*.3048
$1=0.124968
4.00*.3048
$2=1.2192
.51*.3048
$3=0.155448
```

The dimensions of our impostor geometry will be just slightly larger than those of the luminaire geometry. Rounding up the third decimal place results in the following dimensions: width = .125, length = 1.22, height = .156.

The next step is to create a rectangular box just larger than the visible geometry of the luminaire to be enclosed, which will provide the impostor geometry needed to accurately simulate the output distribution of this direct/indirect light luminaire. The inline command we will add to our file in place of the original impostor sphere geometry is

```
!genbox 111621pn_light 111621pn.s .125 1.22 .156 \
       | xform -t -.0625 -.61 -.078
```

The box is transformed such that the center of its volume is at the origin. This command replaces the sphere geometry in our original ies2rad output.

To ensure that you are using lboxcorr correctly, check the *source.cal* file:

```
{ source.cal (abbreviated)

boxcorr function corrects for distribution modeled
with a rectangular box. lboxcorr provides a more
accurate calculation for nearby surfaces, but requires
that the source box be centered at the origin.
The dimensions of the box, which must be aligned with
the x,y,z axes, are given in meters regardless of the
units being used in the scene file.

A1        - optional multiplier
A2,A3,A4  - X,Y,Z dimensions of axis-aligned box
                 (in meters!)
}
                 { local definitions }
lboxprojection = ( noneg(abs(Px-Dx*Ts)-A2/2)*A3*A4 +
                 noneg(abs(Py-Dy*Ts)-A3/2)*A2*A4 +
               noneg(abs(Pz-Dz*Ts)-A4/2)*A2*A3 ) / Ts;

{ local box correction }
lboxcorr(v) = A1 * v / lboxprojection;
```

Back in our luminaire file, you can delete the lines referring to the sphere entity and allow the **genbox**-created surface to fall into place. Then change the illum description by changing `corr` to `lboxcorr` and entering the dimensions of the impostor geometry. As shown below, an efficiency factor of 75% was also applied as the first floating-point argument.[14]

```
void brightdata 111621pn_dist
5 lboxcorr 111621pn.dat source.cal src_phi4 src_theta
0
4 .75  .125  1.22  .156
```

[14] For tables of lamp data, lamp aging, and typical luminaire efficiencies, you are encouraged to consult the *IES Lighting Handbook* and manufacturers' lamp catalog/technical manuals.