prescolite

White Paper: VirtualSource®

Because of the spherical bulb shape of an incandescent lamp, incandescent downlights when designed properly exhibit a symmetrical cutoff angle in all lateral planes (see figure 1), i.e., a parallel cutoff of direct lamp view (physical cutoff), and view of the lamp image in the side wall of the reflector (optical cutoff). In the 1970's it became typical in virtually all downlight manufacturers' catalogs to read the descriptive term "parallel cutoff" or "simultaneous cutoff." A signature of specification-grade incandescent products was this particular claim.

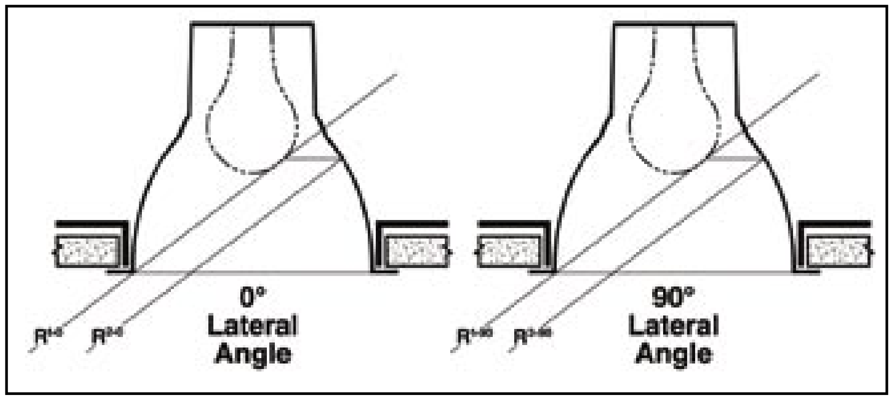

FIGURE 1
Ray 1 (R1) is the direct view to the lamp or the physical cutoff. Ray 2 (R2) is the direct image reflected off of the reflector side wall or the optical cutoff. Because R1 is parallel to R2 we say that the cutoff to lamp and lamp image is parallel. Because the A-line lamp is spherical (looking up at it) this parallelism is maintained at any lateral angle of view to the lamp. Thus, $R^{1\text{-}0} = R^{1\text{-}90}$ (same physical cutoff), and $R^{2\text{-}0} = R^{2\text{-}90}$ (same optical cutoff).

With the introduction of the compact fluorescent lamped downlight as a part of the standard product vocabulary in downlighting, many manufacturers continued to keep copy in their catalogs stating that their products for these new lamps had parallel or simultaneous cutoff. This was a logical claim for them to feel that they had to make in as much as they were introducing these products as specification-grade products for commercial-grade work. The problem is that this claim is geometrically not possible using the same design approaches that are used in incandescent lighting.

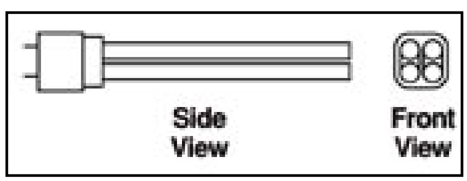

FIGURE 2
Horizontal T-4 compact fluorescent lamps are tubular and asymmetrical.

Because T-4 horizontal compact fluorescent lamps are tubular and are not symmetrical (see figure 2), they have different relative physical cutoff (and thereby optical cutoff) between 0° and 90° (see figure 3).

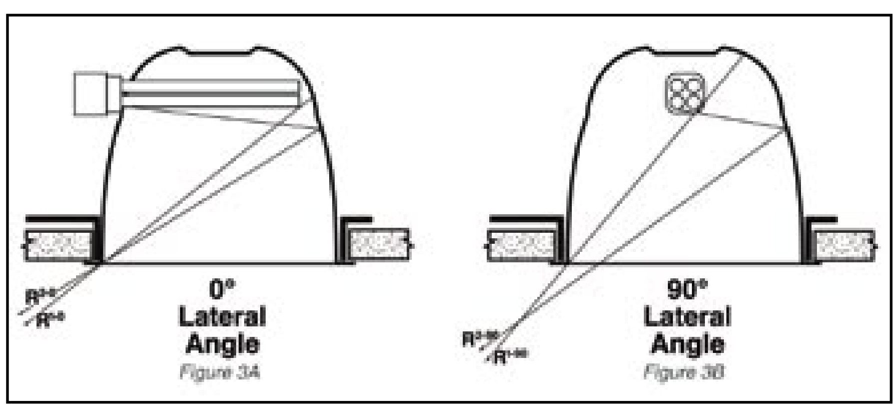

FIGURE 3
R1 is different between 3A and 3B because of the lamp asymmetry. Thus, $R^{1\text{-}0} \neq R^{1\text{-}90}$ (different physical cutoff), and $R^{2\text{-}0} \neq R^{2\text{-}90}$ (different optical cutoff).

Consequently, horizontal compact fluorescent lamps in a non-Virtual Source™ reflector results in “visual noise” that lighting designers find objectionable (see figure 4).

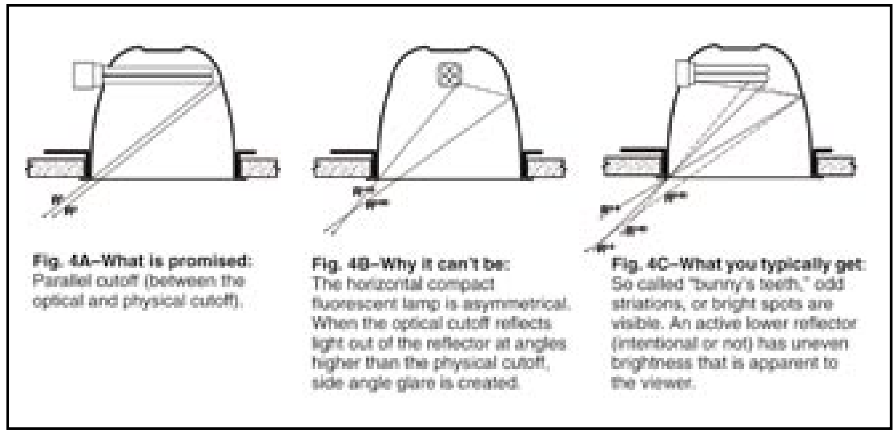

FIGURE 4
$R^{1\text{-}0} \neq R^{1\text{-}90} \neq R^{2\text{-}0} \neq R^{2\text{-}90}$.
How “visual noise” occurs.

With Prescolite’s introduction of Virtual Source optics (patent pending) a major change in compact fluorescent performance can be observed. Virtual Source is a uniquely new approach to reflector design. While once it is understood it appears simple, there is a complex set of geometry that underlies its achievement of what was not achievable before.

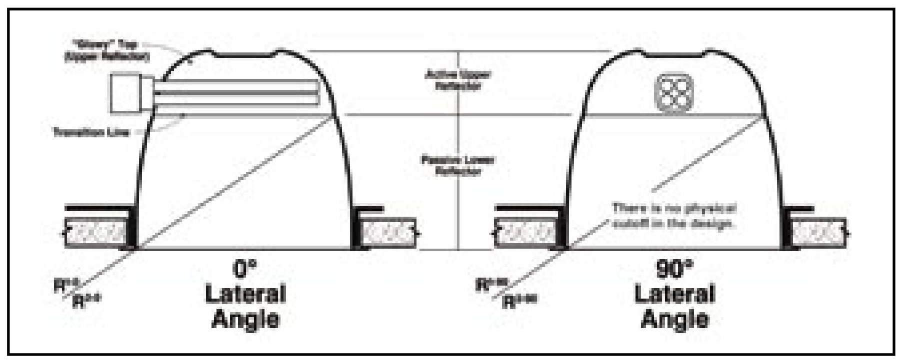

FIGURE 5
R1 is the same as R2. A line (or ray) is parallel to itself—thus Virtual Source™ optics provide true parallel and simultaneous cutoff to a virtual lamp (virtual physical cutoff) and lamp image (optical cutoff). The transition line between the upper and lower reflector defines a consistent optical cutoff in all lateral planes. $R^{1\text{-}0} = R^{1\text{-}90} = R^{2\text{-}0} = R^{2\text{-}90}$.

With Virtual Source there is no physical cutoff. There is only an optical cutoff defined by a precise transition line (see figure 5). The optical cutoff has the same exiting ray as a virtual physical cutoff (thus the name: Virtual Source). Since a line is always parallel to itself, the Virtual Source reflector design is the only design geometry that can actually provide simultaneous cutoff to the virtual lamp (the virtual physical cutoff) and to the lamp image (the optical cutoff).

The upper reflector (or “glowy top”) is active. Specifically it is active in driving light not only efficiently out of the fixture, but effectively out of the fixture in the 0 to 40 degree range. Comparable products have been photometrically measured to distribute over 20% of their light above 40 degrees. Virtual Source, in its 8” aperture, two-lamp, 26 watt version for example, distributes only about 7% of its light above 40 degrees. In a direct comparison of product with 74% efficiency, the Virtual Source active upper reflector delivered 24% more light into the 0 to 40 degree range. Therefore, at same efficiencies the Virtual Source approach achieved much better lighting effectiveness than optical designs based upon traditional design approaches.

At normal viewing angles, the lower reflector is passive, exhibiting uniform luminance.The lower reflector remains passive until the viewer’s line of sight passes the line of optical cutoff. The physical cutoff is virtual in nature, occurring in the same angle of reflection as the optical cutoff. This is the unique nature of Virtual Source optical design.

The result is a three stage reflector which can be described by placing the viewer so that they are looking at the reflector at a normal viewing angle, in line with the edge of the reflector aperture to the point of occlusion (the point where the bright "glowy" top is just barely visible). Moving in and out at this viewing angle, the viewer can appreciate the ultra sharp cutoff, the total passivity of the lower reflector, and how bright (active) the upper reflector is; so bright that it is even hard to tell when the actual lamps are in view. After the viewer experiences the "glowy" top, the lower reflector becomes active, starting at the transition line in a top-to-bottom direction (see figure 6).

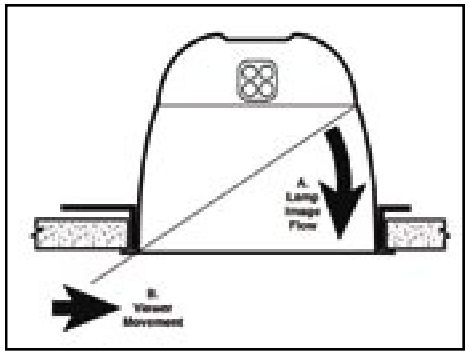

FIGURE 6
"T-2-B" Virtual Source reflectors exhibit top-to-bottom image flow. The rate of flow is designed so that A=B. This design of image flow is unique to Prescolite and represents the first studied application of ergonomic design into downlighting. The passive lower reflector always fills logically and smoothly with light, at a rate always constant to the viewer's movement. The result is quiet, unobtrusive downlighting by des

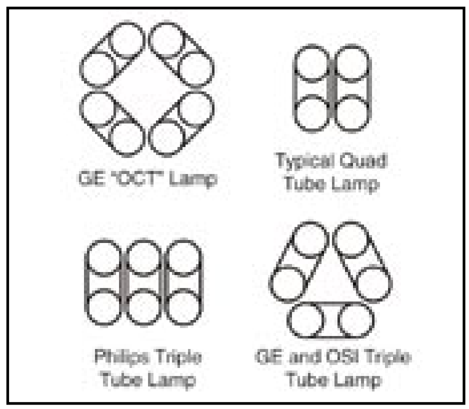

FIGURE 7
Compact fluorescent lamps are almost symmetrical in end view, but not quite.

Understanding how Virtual SourceTM optics work and why they are such a benefit to the designer using horizontally oriented lamps is actually very simple. But, the question arises: if Virtual Source optics are superior, why doesn't Prescolite offer Virtual Source optics for vertically oriented compact fluorescent lamps. Are

Prescolite vertically lamped downlights just like everybody else's? Prescolite uses a similar, but still different, approach for vertically oriented T4 compact fluorescent lamps. Both triple tube and quad tube lamps are almost symmetrical in end view. Almost, but not quite (see figure 7).

Because the dimensional asymmetry is not that great (as it is in the horizontal orientation), the optical approach is to utilize a modification of Virtual Source design. This modification is very slight to the lay person, but in its technical geometry, very different. Prescolite downlights for vertically oriented compact fluorescent lamps have a real physical cutoff and a real optical cutoff. However, the design approach is quite different than the traditional reflector design approach used prior to Virtual Source's discovery. Typically reflectors for vertical quad and triple tube lamps are based on the same theory of design that has been used since the 1970's for incandescent lamps (see figure 8).

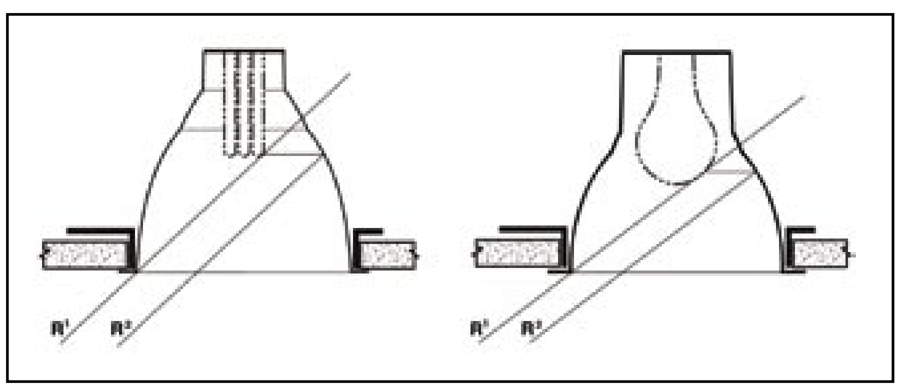

FIGURE 8
Typically reflectors for vertical quad and triple tube lamps are based on the same theory of design that has been used since the 1970's for incandescent lamps.

As is illustrated, the intent is to have two separate exiting rays that are parallel. The interesting thing is that they cannot be simultaneous, obviously one coming into view after the other. Also interesting is that while the lamps are not "so" asymmetrical, they are still asymmetrical, and the differences this can cause at different viewing angles implies that there may be noticeable differences in how a reflector may look from one lateral angle versus another. Understanding this explains why so many reflectors with vertical lamps have hot spots, uneven brightness, and change appearance unexpectedly when the viewer moves around them.

With a Prescolite downlight with a vertical lamp orientation, the viewer sees physical cutoff (the lamp) and behind this, in the background to this, they simultaneously see the optical cutoff (see figure 9).

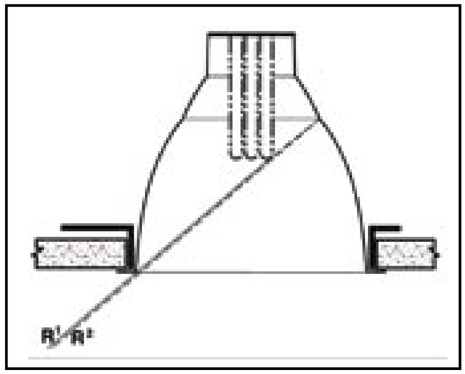

FIGURE 9
With Prescolite's vertically oriented downlights, the viewer simultaneously sees the physical cutoff (the lamp) and the optical cutoff in the background.

Prescolite's Virtual Source™ technology is applied to our vertical designs in a different way, reflecting the geometrical differences between the dimensional asymmetry of horizontal versus vertical lamps. There are strong similarities: the sharp cutoff defined by the hard transition line between the passive lower reflector and the glowy top of the highly efficient, but more importantly, highly effective upper reflector system.

A major benefit of the vertical lamp design of Prescolite optics is its impact on the differences in lamp geometry between different lamp manufacturer designs for the same lamp type. While some manufacturers report wide differences in performance, dependent upon which manufacturer's lamp design is being tested, the design approach of Prescolite makes the performance differences typically nominal in nature. There are differences, but the nature of the differences is typically within allowable tolerances of + or - 5%. (These are allowable since they are within the allowable differences for photometric measurement.)

In essence then, horizontal optics in Prescolite downlights employ (or will employ) Virtual Source optics, and these include descriptions of trademarked name and a pending patent. Our vertical optics employ what we can only describe as "virtual" Virtual Source optics. This is because the patent pending is specific to the horizontal design. But, "virtual" Virtual Source is the best description, because as this paper has explained and illustrated, the technology being employed is similar, the concepts being employed the same, the resulting effect the same, and only a highly technical and legal issue makes it necessary to refer to the two systems separately for complete accuracy.