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Daylight Redirecting Window Film

Diffuses and Redirects Daylight
Increased Illuminance 11%

Researchers at Lawrence Berkeley National Laboratory (LBNL) retrofitted a 3M prototype daylight redirecting film to windows at six military sites in three climate zones.

REFLECTS DAYLIGHT DEEP INTO WORKSPACES

Daylight redirecting film (DRF) is installed on the interior, upper portion of windows to diffuse and redirect daylight to the ceiling, where it is then reflected deeper into workspaces. Bringing daylight into buildings promises to save substantial lighting energy. Currently, most daylight redirecting technologies—light shelves, light redirecting blinds, prismatic panels—are either not suitable or prohibitively expensive for window retrofits.

SAVED ENERGY, EXTENDED AND INCREASED LIGHTING

Findings estimated a five year simple payback and validated a three-fold increase in the daylit zone, as well as lighting energy savings of between 0.39 and 2.11 kWh/ft^2/yr. All sites except Norfolk left DRF in place at the end of the study.

Technology Tested

3M DAYLIGHT REDIRECTING FILM (DRF)

- Thin translucent film covered with microscopic prisms and fused to a layer of pressure-sensitive adhesive that attaches to the inside surface of a window.
- Reflects natural light up to 40 feet from the window; extends daylight zone up to 8 feet for every 1 vertical foot of film.
- Rejects 99.9% of ultraviolet rays.

Best suited to:

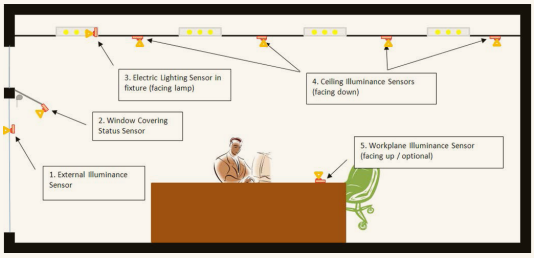
- Buildings with unshaded windows that face south, west, or east and where the view is not required through the DRF.
- Windows with high visible light transmission and a clerestory (upper) window area beginning at least 7 feet above the finished floor.
- Spaces with high-reflectance ceilings and flush mounted light fixtures.
- Spaces with daylight-sensing photo controls in place to realize energy savings.
- Sunny climates offer a greater opportunity for lighting and whole building energy savings.

Limitations:

- Glare potential. To mitigate glare, diffusing film was attached to the window frames in front of the DRF. A new version of DRF integrates a diffuser and requires no mechanical attachments.

ABOUT ESTCP

The Environmental Security Technology Certification Program (ESTCP) is the U.S. Department of Defense's environmental technology demonstration and validation program. The program's goal is to identify and assess innovative technologies that address DoD's high-priority environmental requirements efficiently and cost-effectively.



Demonstration Sites: 6 Buildings in 3 Climate Zones

Six buildings representing three major climate zones were chosen for the demonstration: Naval Station Norfolk, Norfolk, VA; Naval War College, Newport, RI; Fort Bliss, El Paso, TX; Marine Corps Air Ground Combat Center, Twentynine Palms, CA; Naval Postgraduate School, Monterey, CA; Naval Hospital Bremerton, Bremerton, WA. The sites included a range of building types and study conditions, from private offices with one or two windows to large open spaces with multiple rows of windows. All in all, the study affected 376 linear feet of windows, 123 workstations, and approximately 260 building occupants.

ATTACHMENT TYPES AND WINDOW TREATMENTS AT DEMONSTRATION SITES

Location	Orientation	Bottom of Film AFF	Height of Film	Diffuser Type	Other Treatment	Blinds for Treated Area	Other Special Conditions
Norfolk, VA	S	6'0"	3'0"	100%	35% VT film on view windows	Retracted	none
29 Palms, CA	SE, SW	8'0"	2'0"	50%	none	no change	none
Newport, RI	S	11	2'0"	50%	none	horizontal mini mount below film	casement windows
Fort Bliss, TX	S, SE	7'6"	1'6"	50%	none	blinds lowered below film	reflective tinted windows
Bremerton, WA	SE	7	2'0"	50%	none	1/2" horizontal blinds, below film	patient privacy requires blinds down
Monterrey, CA	W	7'6"	2'1"	50%	40% VT film on view windows	1/2" horizontal blinds, below hopper	hopper windows, exterior shade

INSTALLATION COSTS*

DRF Film + Installation $25/ft^2

*Cost information is for reference only. Individual sites should do due diligence to determine local costs.

3M PROJECTED INSTALLED COSTS*

New construction $20/ft^2
Retrofit upto $40/ft^2

*Based on technology maturity. A related LBNL study showed an average 5 year simple payback at an electric rate of $0.20/kWh.

Additional Resources

- **EW-201014 FINAL REPORTS AND TECHNOLOGY TRANSFER TOOLS**
  https://serdp-estcp.org/Program-Areas/Energy-and-Water/Energy/Conservation-and-Efficiency/EW-201014
- **TECHNOLOGY USED AT DEMONSTRATION SITE**
  Prototype Daylight redirecting film, 3m, www.3m.com/3M/en_US/building-window-solutions-us/solutions/daylighting/.

NOTE: Before incorporating new technology, refer to Unified Facilities Criteria (UFCs) and other appropriate guidance to ensure compliance with current requirements. https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc

Demonstration Results

ENERGY SAVINGS

- DRF does not contribute to energy savings by itself. Advanced lighting controls for dimming are required to realize savings.
- Average daytime peak lighting reduction of 13%.
- Lighting energy savings from 0.39–2.11 kWh/ft^2/yr.
- Average annual whole building savings 1.30 times direct lighting savings.

DAYLIGHT ILLUMINANCE

- Daylit zone extended 24' from the window wall compared to ~8' for a space with no DRF.
- Daylight illuminance or Spatial Daylight Autonomy (sDA) increased 3–24%, averaging 11%.

INSTALLATION

- DRF is not blast rated at this time. Installation is least expensive for new construction. Retrofit costs are primarily driven by installation challenges of the existing building construction.

OPERATIONS & MAINTENANCE

- Staff did not report any maintenance concerns with DRF.
- 10-year warranty; 15-year expected technology lifespan.

USER SATISFACTION

- Occupant comfort was preserved or increased in all but one installation (Norfolk) where the product was not installed high enough above eye level.
- Increase in occupant ranking of view quality. No discernible change in operation of blinds.

COST-EFFECTIVENESS

- Simple payback averaged 10 years, ranging from 3 to 35 years depending on electricity rates and climate.
- Savings-to-Investment Ratio (SIR) from 0.38 to 3.75 (cost-effective when SIR is greater than 1).

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