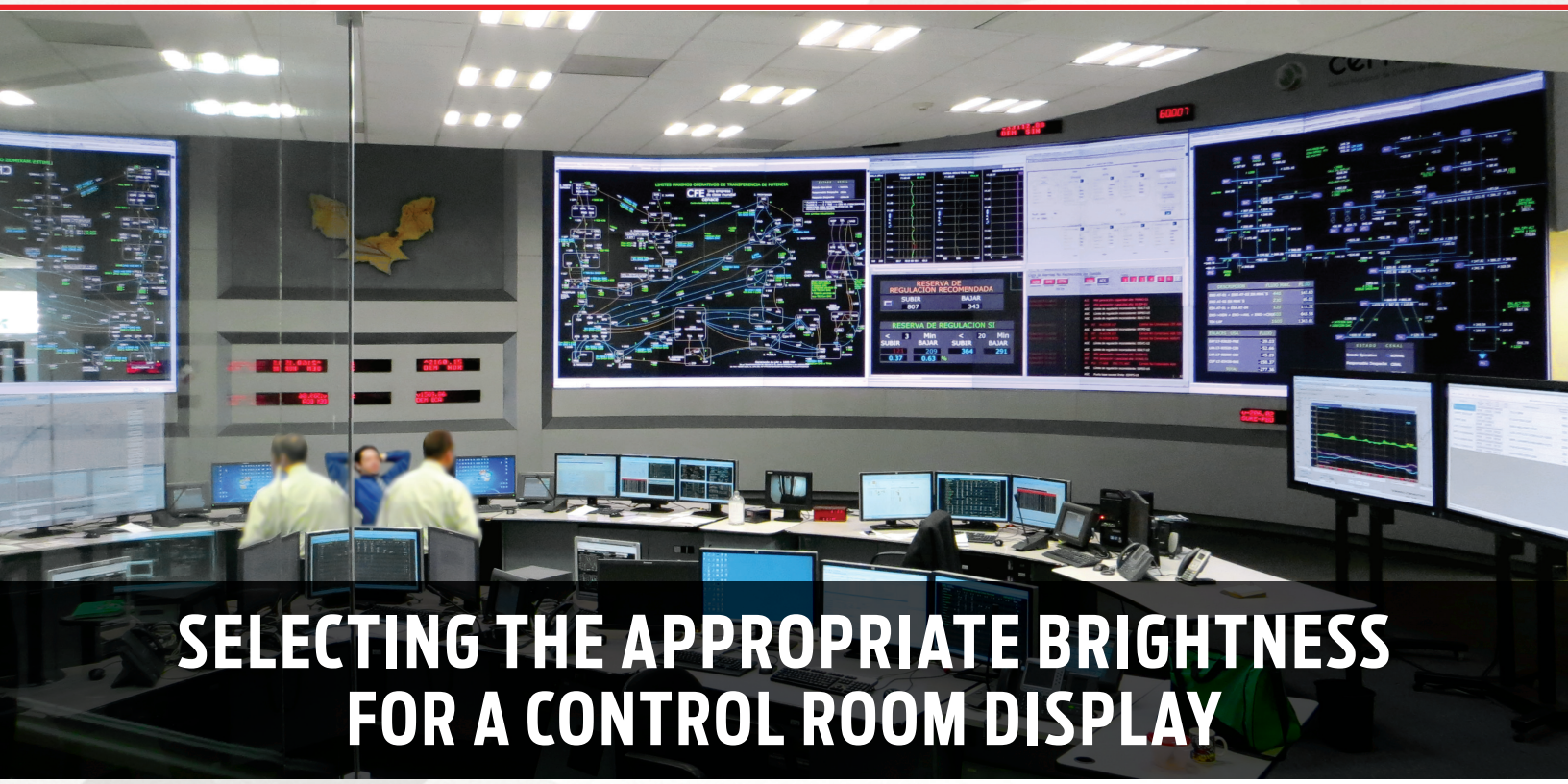
MITSUBISHI ELECTRIC
Changes for the Better

DISPLAYSOLUTIONS
WHITEPAPER



SELECTING THE APPROPRIATE BRIGHTNESS FOR A CONTROL ROOM DISPLAY

OPERATOR COMFORT, NOT IMPACT, IS THE GOAL

The demands on a control room display wall are high.

It must allow multiple operators to see crucial information, providing a common operating picture they can use to work collaboratively in critical situations.

The displays must be crisp, clear and readable, but just as important, they must be comfortable to view all day, every day, as operators shift their eyes constantly from their local monitors to the display wall and to materials on their desks.

For that reason, the optimal brightness of a control room display wall is a lot different than the brightness of the video walls you may see in an airport, retail mall or entertainment venue. There, impact is the key, as the displays are meant to capture attention and hold it for short periods of time. Brightness and contrast are at a premium.

In a control room, on the other hand, too much brightness is the enemy. It can cause eyestrain that will impair operators' ability to work efficiently, limiting their productivity and the value of the installation.

In this paper, we will look at the principals of brightness in a control room and how they affect the choice of the display.

PUPIL DILATION AND OPERATOR COMFORT

Imagine yourself spending the afternoon in a dark theater – an older theater where the exits lead directly onto the street. The movie ends, you step out into bright sunlight, and what happens?

Most of the time we're not aware of our pupils adjusting with changing brightness, because lighting levels tend to be similar within a given environment. But if our eyes must adjust suddenly or adjust often, it can be very uncomfortable.

A similar thing will happen in your control room if the brightness of the display wall is too much higher or lower than the brightness of the operator workstations. The effect is more subtle, and operators may not consciously notice the shift – but they will experience eyestrain, and that will lead in turn to overall fatigue, inattention, even headaches or neck and shoulder pain. Very likely, they will compensate by avoiding looking at the display wall.

In consequence, productivity drops. The operators' work suffers, and your investment in the display wall will not produce the benefit you expected.

MEASURING BRIGHTNESS

The solution is to match the brightness of the display wall properly to the room lights and the operators' local displays.

Before we can do that, we need to understand how to measure the brightness of the displays and the room. Brightness can be expressed in several units, notably lumens or ANSI lumens, which is appropriate for the output of light bulbs and projectors, but not display walls.

The problem with measuring lumens is that it expresses the brightness of the light source, not the screen or work surface. The brightness of a screen will vary considerably with its gain and whether it is reflective (front surface) or transmissive (rear). In the same way, the brightness of a desktop will vary with the color and reflectivity of its surface, given the particular lumen output of the lighting fixtures.

Instead, we use candelas per meter squared, written as cd/m^2 or nits (1 nit = 1 cd/m^2).

This unit is unique in that it expresses the brightness of a surface, no matter what the source of illumination. So a brightness of 500 cd/m^2, or 500 nits, is equivalent if measured off a white piece of paper on a desk, an all-white screen on a computer display, or an all-white image on a projection screen. It's the brightness you see coming to your eyes from that surface.

To illustrate, take a close look at the photo [below] showing the tigers and cityscapes displayed on four Mitsubishi projection cubes. The light engine and its lumen output is the same for all four cubes, but the brightness of the image, measured in nits, varies with the screen size.

By expressing brightness in nits, we incorporate all the factors that make up the final image.

BRIGHTNESS DIFFERENTIALS

In choosing a display, it's important to realize that the human eye is quite good at adjusting between different light levels, but correspondingly poor at perceiving those differences.

Normally to even notice a difference in brightness, the variation must be large, in the neighborhood of 50% to 100%. That is to say, most people would not notice any difference between a display measured at 500 nits and one measured at 750. We would need to raise the brightness to almost 1,000 nits before people would agree, "Yes, that looks brighter."

In consequence, at a trade show, it takes a very bright display to stand out from others, and you may be tempted to think, it's the brightest display that we want in our control room. Yet if you decide on that basis, you'll be making a costly mistake.

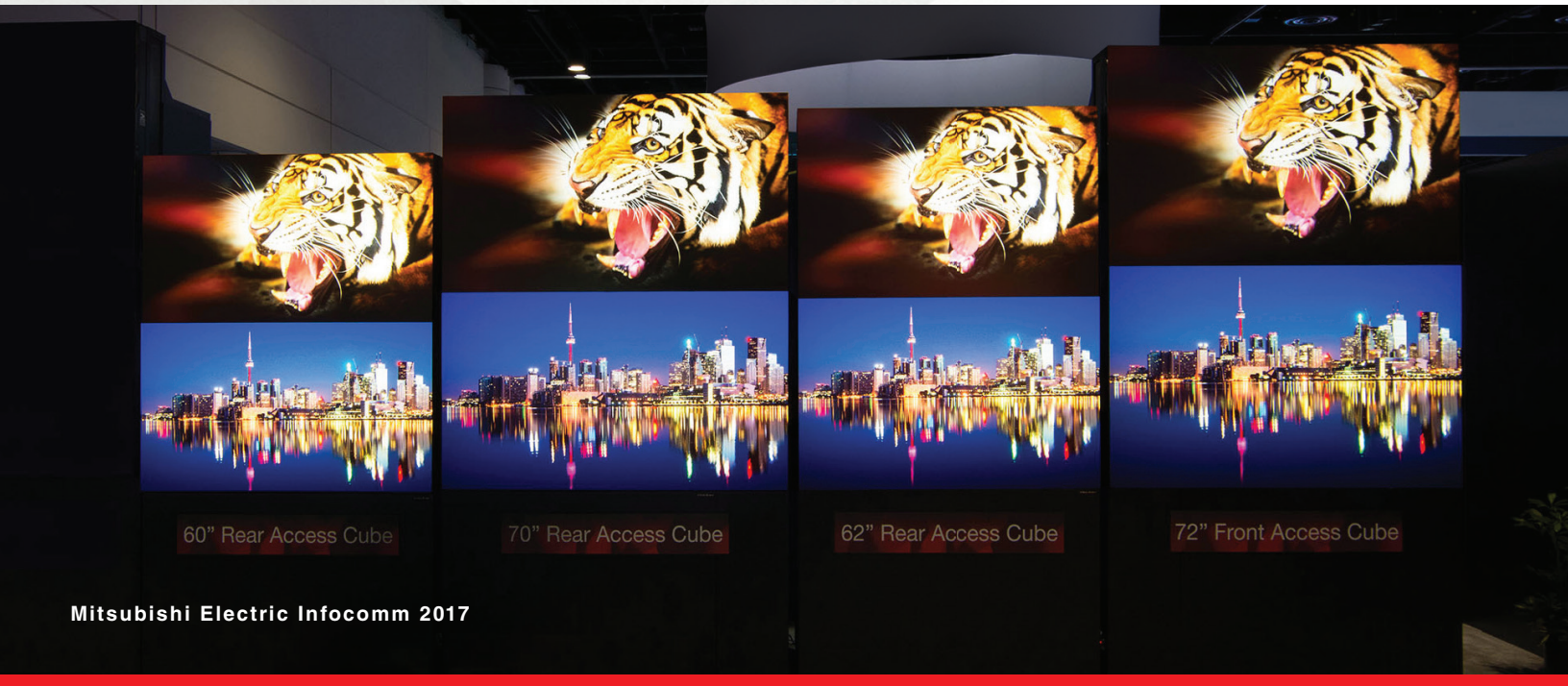
The reality is that most people will adjust their lighting system and/or their local computer monitor so that the monitor is no less than half, and no more than 2 to 3 times brighter than their surroundings. It's not something they have to think about. They just adjust the monitor or their task lighting until the two pieces fall into that range. In a control room, we advise our clients to set up the display wall so that it's 2 to 3 times brighter than the ambient light reflecting off their desks, as measured in nits. That way, the display wall will stand out, but not to an uncomfortable degree.

Another way to look at it is that the illumination coming from the lighting fixtures should be as even as possible, and that all screens should fall within 0.9 to 3X the brightness measured off a piece of paper reflecting that light.

Control room lighting varies, but historically the ambient light level, at workstation height (including task lighting), has been no more than 70 to 120 nits. Using those numbers, a display that's 3X as bright would fall into the range of 210 to 360 nits.

THE IDEAL BRIGHTNESS

You should also be aware that there's a trend toward brighter lighting, even natural lighting in control rooms. Still, an ambient lighting level of 160 nits would be a very bright room, and using the 3X rule would render a display of no more than 480 nits.



For that reason, your first step in calculating optimal brightness is to determine the actual or expected lighting level of the operators' desktops, in nits.

To measure those lighting levels, you can use a hand-held photographic light meter in incident mode (that is, with a white dome aimed up at the lights), or with a spot meter reading off a white piece of paper. Most photographic meters will not output a measurement in nits, but many will include a conversion guide, for example from EV to cd/m^2, in the manual. Others will measure foot-lamberts. If that's the case, you can convert FL to nits using the formula 1 FL = 3.42 cd/m^2.

While these numbers seem very cut and dried, there is some room for judgment and experience, due to the simple fact that the images you show on the display wall may not use a white background. Because they tend to be darker, you may find adjusting the display to 4X the ambient light (that is, to 500 or even 600 nits) may sometimes be appropriate.

That's the reason that display wall projection cubes have been designed the way they have, with Bright, Normal, Eco and Advanced Eco modes to allow you to adjust from perhaps 100 to 600 nits, depending on the cube. And that's the reason that the brightest cubes are no more than 1000 - 1200 nits. It's not that the cubes cannot be made brighter, it's that there's no reason to do so.

Yet other technologies are being adapted to control rooms that were not originally designed for them. Direct-view LED, for example, was originally developed for outdoor viewing, and many indoor displays can produce brightnesses of 2,000 nits or more. Yet going this bright will be expensive and can be destructive to the productivity of your team.

This is not to say that direct view displays are not available at brightness levels appropriate to a control room. Many are, and in certain situations this may be the best technology for your room. But high brightness is not a reason to purchase one.

CONCLUSION

Whatever technology you choose, brightness is a crucial consideration for a control room display wall. You want a display that's crisp, clean, and roughly .9 to 3 or 4 times brighter than the ambient light reaching operators' workstations, as measured in cd/m^2, or nits.

Display walls in that brightness range will allow operators to work comfortably and efficiently, helping them effectively collaborate in the most critical situations.

REPORT INFORMATION:

This report has been created by Mitsubishi Electric US Visial & Imaging Systems Division (www.me-vis.com) and Mitsubishi Electric Sales Canada (www.mitsubishielectric.ca)

Mitsubishi Electric is the global leader for command and control display wall products, with a wide variety of rear-projection DLP display wall cubes and LCD display wall panels.

This report has been created agnostically to compare different sizes of HD resolution DLP cubes and for certain specifications, and it is based on Mitsubishi Electric products.

FOR MORE INFORMATION, PLEASE CONTACT YOUR REGIONAL SALESPERSON:

- **US - West**
  Lee A. Pagnan – (714) 912-4331
  lee.pagnan@meus.mea.com
- **Mexico, Central and South America**
  Christian Cooper – (949) 294-6497
  christian.cooper@meus.mea.com
- **Canada**
  Sanal Sreedharan – (647) 297-6955
  sanal.sreedharan@mesca.ca
- **US - East**
  Raymond D. Blankenship – (623) 208-9980
  ray.blankenship@meus.mea.com
- **Brazil, Chile and Argentina**
  Eng. Nilton Paulo Raimundo Mendes
  +5511 9-8385-5438 / +5511 2371-1192
  nilton.mendes@meus.mea.com