SOME HAZY THOUGHTS ON MIST

By Mike Wood

How much is too much? Too much of anything—even a good thing—is too much. This is as true with fog as it is with anything else, so the Fog & Smoke Working Group has been trying to rationalize and quantify standards for the use of fog effects within the entertainment industry. Quantifying fog effects has proven to be more difficult than one would expect, but the attempts have been quite useful for demonstrating how to make a little fog look like a lot.

One very common technique used for fog production is the creation of atomized glycols through simple heat exchangers. As these machines are in everyday use, inevitably much of the recent controversy surrounding fog has concentrated on glycol machines and so, therefore, has the working group's focus. Literature studies have been commissioned and published, and a great deal of the preparatory work has been done to pave the way for the eventual publication of a standard for the use of these machines. The goal in particular is to establish a standard level for the allowable safe concentrations of the glycols in the air. Although there are some standards for these glycols published by U.S., German and U.K. authorities, these are often based on obscuration of vision rather than safety concerns, and are not necessarily applicable. After all, we use fog deliberately to obscure vision!

PHOTOS: MIKE WOOD

Fog combined with careful lighting can produce dramatic effects. The complete series of photographs discussed in this article is available at http://info.highend.com/hes/wood/fogtests/Prelimfog.html.

However even when we have an agreed standard, how do users know they are within it? How does the lighting designer, owner, or stage manager of an average theatre, night club, or concert know what the glycol concentration on stage is? Of course there are highly expensive scientific instruments that allow you to take samples and accurately measure these parameters—but they are currently out of the price reach of the majority of users. I hope that some enterprising manufacturer will come up with the $200 hand-held glycol meter, but, until one does, there is an outstanding need.

It was suggested during one of the meetings that it might be possible to take photographs of various fog densities and publish these photographs in the guide. This seemed like a good approach, so a series of tests was started to try and produce photographs which allowed the repeatable measurement with reasonable accuracy of fog density. Repeatable turned out to be the problem, but the investigation has helped demonstrate how light behaves in fog, which is useful information for any lighting or fog effects designer.

As a starting point a simple series of photographs was taken in a large room with flat, overhead fluorescent lighting. The camera was fixed and objects were positioned at regular intervals away from the camera. A series of pictures was then taken whilst slowly increasing the density of fog in the room from 0 to 20mg/m^3 in 2.5mg/m^3 increments. The results were fairly disappointing from the perspective of showing obvious differences with different concentrations. It is difficult to tell the pictures apart; the camera and your eye do a good job of evening out the images. As a way of measuring fog concentration, this technique failed.

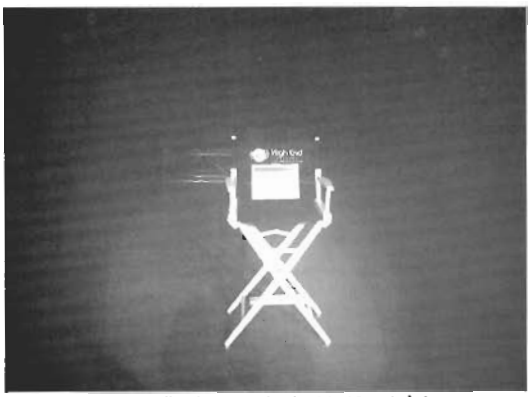
However, it did demonstrate that for certain lighting conditions, a little fog was indistinguishable from a larger amount of fog.

Obviously, something had to be done to improve the effective resolution of the technique if it was to work as a fog measurement method. So a simple visual contrast test chart was devised. This used a 50% neutral grey background with rectangles of varying density overprinted. These rectangles were graded to give a steadily increasing contrast from one side of the chart to the other. In fact, the chart is very similar to a grey scale test chart used in television camera setup. In theory, as the fog density increases, the squares and chart background will start to visually merge together, with the squares on the low contrast end merging first. The lowest contrast rectangle you can distinguish would be your measure of the fog density. Since blue light is dispersed by small particles more than red (that's why the sky looks blue), charts were made in red and blue to enhance the blurring caused by the fog.

In this photo, fog density was 10mg/m³ and general room lighting was used. Results with other densities were similar.

This technique worked, but only as a relative measure of fog density. That is, it gave repeatable results, but only if the lighting was kept exactly the same. A person could use it to set a fog level and repeat it night after night in a venue, but it could not be used to duplicate a fog level in a different venue where the lighting conditions were different. The results were highly dependent on the lighting. It had been clear from the beginning that changes in lighting were going to alter the results achieved, but it was surprising how much.

This turned out to be the major problem with this technique, so a new series of pictures was taken using the test chart already developed. This time the fog density was kept constant at approximately 10mg/m³ and the lighting conditions in the room were changed. The results were dramatic. An overall, diffuse light gave results comparable to the earlier tests, but strong use of front light and back light changed the situation markedly. The front-lit chart was very clear. All the rectangles could be seen clearly; it was almost as if the fog wasn't there. With back light everything disappears. The forward scatter from the light beam through the droplets



An example of front lighting combined with 10mg/m³ fog.

Low back light and the same amount of fog obscure the subject.

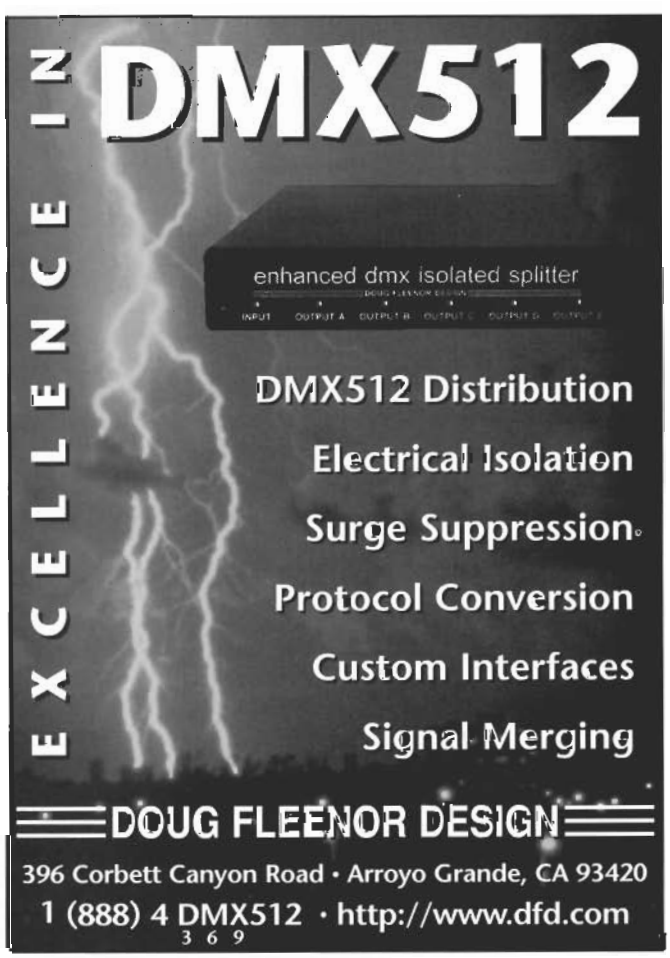
blurs the image in the camera (and your eye) so you cannot distinguish the rectangles. In fact, with a low back light you can't even see the chart!

All this may come as a surprise to anyone who has lit a scrim or gauze in a theatre and used lighting changes to reveal the scene behind. With a gauze, it appears solid when front lit and transparent when back lit. You'd expect the fog to behave in the same way, but it doesn't. It behaves in exactly the opposite manner: light from the front reveals rather than obscures.

This seems to run somewhat contrary to common experience with natural fog. When you are driving down a foggy road at night, it is the back scatter from the front light of your headlights that causes the problem. The headlights from oncoming traffic (back light) cause a problem with vision, but not as much as your own lights. The problem is particularly obvious if you have your lights on high beam.

I suspect this is due to the differences in the natural and artificial fogs. First, natural fog—at least the fog in which you are likely to notice you must use your low beams—is far denser than the artificial fog used in these tests. The level used in these tests, 10 mg/m³, is really only a light haze. Second, natural fog and glycol-based artificial fog have slightly different refraction indices. As a result, they will scatter light a little differently, and it may be that the amount of back scatter with natural fog is a bit greater. Third, with both natural and artificial fog, the back scatter is through a fairly narrow angle. When you are driving a car your eyes are not far above your headlights, so you are looking almost directly down the beam, along the line of greatest back scatter. Only a followspot operator would have a similar vantage point in a theatre or arena.

I'm sure that lighting designers are experiencing and using these differences



in their work all the time, maybe without even realizing that they are doing so. But it is useful to be aware of what is going on and the different effects you can achieve by using different densities of haze or fog, different lighting angles, and the similarities and differences to the standard gauze lighting techniques. I remember seeing a particularly effective use of both techniques where the designer had hung two parallel gauzes a foot or so apart and filled the gap between with fog. It was possible to get a range of transparency effects by side-lighting the fog with tight colored beams from side booms while varying the front and backlight on the gauzes. By flying out the rear gauze the fog was then able to dissipate over the stage creating yet another dissolve.

What the experiments with different lighting angles also pointed out was that dramatic effects can be produced with very little fog in the air, as long as the appropriate lighting angle is used. The results of these experiments are congruent with my experience as a theatre-goer. One of the first atmospheric effects I remember being impressed by was one used in *Jesus Christ Superstar*, when it played in 1972 on the West End in London with lighting by Jules Fisher. As Jesus died on the cross, light beams sprayed out from behind his head, and slowly rotated and scanned the audience. It was a stunning effect, but it required very little fog in the air. The light was being projected through the air at precisely the angle that our experiments showed would make the atmospheric effect and the light beams most visible to the audience. Certainly no fog fluid manufacturer would object to selling anyone lots of fluid to create a poorly designed effect, but good design can significantly cut the amount of fluid needed.

Unfortunately, our test results, while helping to demonstrate how to use a little fog fluid to create a big effect, don't help us with our original quest, which is to develop a simple technique to estimate fog density on stage. The simple technique of viewing a chart is so dependent on lighting that it is virtually useless as a measuring tool, unless control of the lighting is included in the test. Methods that would be possible and that perhaps bear further investigation include:

- Defining a controlled light source to illuminate the chart—maybe a single front light at a defined distance and angle;
- Using a translucent back-lit chart in a light box and extinguishing all ambient lighting;
- Projecting a chart onto a screen using a 35mm slide projector—again extinguishing all ambient lighting.

I'm sure there are other possibilities and the reader may have better suggestions. (Please let me know if you do!) For the moment the goal of an inexpensive, repeatable haze measuring device remains unattained, but knowing what doesn't work is more than half the job!

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