ATLAS MATERIAL TESTING SOLUTIONS

# SunSpots

Material Testing Product and Technology News

Volume 32
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*Winter 2002*

*Atlas now offers state-of-the-art surface evaluation with the VIEEW™ Page 13*

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## A Closer Look at Airbag System Testing Techniques

*by Burkhard Severon*
*K.H.Steuernagel Lichttechnik GmbH*

Tests to determine accelerated aging effects on automotive components have been performed for many decades within the automotive industry. These tests predominantly focused on the change in material properties, like fading, cracking, and distortion. The goal, therefore, was an acceptable appearance even after many years in service. For airbag modules, especially the exposed cover, there is a different concern. Acceptable appearance is desired, but safety is a necessity. Will the aged airbag module perform within the tight limits of the specification and still ensure the safety functions?

This paper focuses on two procedures of the International Standard ISO 12097-2 "Road Vehicles – Airbag Components Part 2 Testing of Airbag Modules" that require the application of light and radiation techniques: 1) the solar radiation simulation tests as part of the environmental test program, and 2) the static deployment test at extreme temperature conditions.

### Environmental Testing — Solar Radiation Simulation Test

The **DIN 75220 "Aging of Automobile Components in Solar Simulation Units"** is a basic component of the solar radiation simulation test **ISO 12097-2**. Acquired by a VDA (German Car Industry Association) committee of automotive industry representatives—including suppliers and manufacturers of test systems—this regulation was published in November 1992.

Within the automotive industry, solar simulation systems are well known, accepted tools. They offer reproducible, repeatable accelerated

*Continued on page 7*

**Atlas** Test Instruments Group

# Redesigned HVUL2 Meets New Flammability Test Standards


*Atlas' upgraded HVUL2 offers improved performance and meets new IEC standards.*

Atlas' new HVUL2 Horizontal Vertical Flame Chamber is designed for flammability testing of plastic materials used in major consumer industries worldwide, particularly in electric and electronic appliances. The new model was prompted by ISO and the International Electrotechnical Commission (IEC) standards IEC 60695 (1999) *Fire hazard testing,* Part 11-10 *50 W horizontal and vertical flame test methods,* and Part 11-20 *500 W flame test methods.* These new standards replace ISO 1210:1992 and 10351:1992, respectively. The latest edition of UL94 (Test for Flammability of Plastic Materials) for horizontal and vertical Bunsen burner tests in its final revision refers to the new IEC international standards which specify an apparatus having an inside volume of at least 0.75 $m^3$.

The new HVUL2 is the same width and height as its predecessor, the HVUL, but is about 100 mm (4 in) deeper, thus increasing the inside volume from 0.6 $m^3$ to 1.0 $m^3$. The HVUL2 comes standard with a more powerful exhaust blower and a burner calibration kit.

The new HVUL2 incorporates the standard features of the HVUL with the following additions:

- An exhaust damper that can be slid closed during tests to prevent fumes from coming back into the chamber.
- A powerful 1/3 hp blower for better exhausting of the test chamber.
- Improved 8 mm red LED timer displays located behind and in line of sight with the specimen test area. This new location allows the timers to be easily viewed while observing the specimen under test.
- A new matte black finish on the interior chamber complies with IEC standards that specify a low interior light level of less than 20 lux.
- Four separate flame height gauges for 20 mm and 125 mm flame, foam samples, and plastic samples.
- An improved sliding tempered glass viewing window for better sealing during burning.

The HVUL2 may also be used for conducting tests in accordance with ASTM D 635, 3801, 4804, 4986, and 5048; and ISO 9772.3, 9774, and IEC 707 (partial).

For more information, please contact your local sales representative or visit our web site at **www.atlas-mts.com.**

# Quickwash Plus® Gets Rave Reviews

The **Quickwash Plus®** developed by Raitech, Inc., Partner of Atlas Textile Test Products, has helped a customer meet a difficult specification in record time.

The U.S. Army contracted Comfort Technologies Inc., of Gastonia, North Carolina, to print T-shirts with highly reflective ink designed to last the lifetime of the shirt. The Army's specifications were demanding — requiring more than 100 wash/dry cycles — and they needed the shirts quickly.

*The Quickwash Plus saves time and money with accelerated capabilities.*

To meet the challenge, Comfort Technologies Production Manager Tamara Cline Caldwell went with the Quickwash Plus. As a result, product development was finished within a month rather than the anticipated eight to ten months. And the Quickwash cut Comfort's cost by an estimated 75 to 80 percent.

"It was a very difficult spec to meet," Tamara reported, "but we did it. With the Quickwash, we are able to check on how our ink is performing in an afternoon."

The Quickwash Plus provides an economical way to perform multiple wash tests and extended wash applications from color loss to reflective inks. It is known for reducing traditional test times for dimensional change and shrinkage testing. Traditional tests take between 12 and 24 hours to complete, while the Quickwash Plus clocks in at about 15 minutes per test. The machine has also been successful in testing the efficacy of enzymes or bleaches on fabric, as well as the durability of applied finishes.

For more information on the Quickwash Plus and Raitech's full line of specialty instruments, contact your local Atlas sales representative or Raitech directly at (704) 329-0930.

# Atlas Technical Support Ensures Quality Testing

With the increasing demand on industries to produce higher quality products, the significance of reliable instrument operation has become increasingly important. Information obtained from tests performed in a poorly maintained or improperly calibrated instrument can be counterproductive.

Atlas provides a complete Technical Support network for all Atlas products worldwide. Services range from calibrations and repairs to instrument upgrades. Along with normal required service, many of our representatives now offer Preventative Maintenance programs to assure consistent quality testing.

Besides the above support, Atlas conducts annual training for all service offices to keep our technical staff up to date with the latest changes and upgrades.

For more information on service in your area, contact your local Atlas representative or visit us on the web at **www.atlas-mts.com.**

# The Quartz-Borosilicate Filter Combination — The Real Story

Countless standards, applications, and industries use the Ci-Series of Atlas Weather-Ometers®, particularly automotive industry specifications SAE J1960 for exterior material testing and SAE J1885 for interior applications. Many non-automotive industries even utilize modified versions of these standards. First written in the mid 1980s, these documents give specific information regarding:

- **Irradiance, Temperature, Humidity, and Spray Cycles —** The primary factors of weather are appropriately included in the cycles listed in these specs. These levels agree with measurements taken in natural "real world" conditions.
- **Instrument Configuration —** The laboratory weathering instruments are also specifically mentioned. Section 4.2.3 identifies "…xenon-arcs employed shall be of the 'long-arc' water cooled type. They shall employ cylindrical inner and outer optical filters to direct the flow of cooling water and to provide a selected spectral power distribution."[1]
- **Rack Configuration —** The specification requires either a two-tiered or three-tiered inclined type cylindrical rack with a light source vertically located at the central axis. The rack must rotate around the light source. These features are extremely important to provide the needed uniformity and repeatability for exposure.
- **Maintenance and Calibration —** The appendices in these specifications suggest several steps regarding the operation, maintenance, and calibration of the instrument to assist in conducting more reproducible test results.
- **Filter combination —** The specification advises that a Quartz-Borosilicate filter combination should be used. This filter combination allows more and shorter wavelengths in the UV region to reach the exposed specimen surface.

It has recently come to our attention that a competitive artificial weathering equipment manufacturer is advertising new "Q/B Filters" that "…have equivalent transmission to the Atlas quartz inner filter/borosilicate outer filter combination."[2] We feel it is important to inform our valued customers that **this statement has not been independently confirmed.** No information is currently available to verify the consistency, repeatability, or potential aging of these filters to prove that they are equivalent to the reliable, pre-aged Atlas filters.

The article also states that the "…Q/B Filters are specified in automotive specifications SAE J1960 and SAE J1885."[3] Without public and independent documentation that these filters are truly equivalent, **this is a false statement.** The **only** filters specified in SAE J1960 and SAE J1885 are cylindrical quartz inner and borosilicate outer filters. Another confusing issue is the name of these new filters. The abbreviation for the Atlas Quartz/Boro filter combination, Q/B, is so widely used it has become a part of the weathering lexicon.

Since these new filters purportedly meet the specification, it is implied that the devices that use these filters must also be acceptable to meet the SAE J1960 and SAE J1885 requirements. **This is misleading and incorrect.** Devices using these so-called Q/B filters are air-cooled. As noted above, **only** instruments that use a water-cooled xenon lamp may be used. Furthermore, the devices using the new filters expose specimens on a flat tray. **Only** instruments that provide an inclined, rotating rack for uniformity and repeatability have been accepted by the SAE committees responsible for these documents.

For more information about the Quartz/Borosilicate filter combination or SAE J1885 and SAE J1960, please contact Matt McGreer, General Manager Client Education, at (773) 327-4520 or mmcgreer@atlas-mts.com.

[1] *SAE J1885, Accelerated Exposure of Automotive Interior Trim Components Using a Controlled Irradiance Water Cooled Xenon-Arc Apparatus, March 1992*

[2,3] *Q-Panel LabNotes, "New Q/B Xenon Filters for Auto Testing," Issue 3, 2001, Q-Panel Lab Products*

# Simultaneous Control of BST and CHT — A New Feature

Besides radiation, temperature is the most important factor in weathering testing. The Black Standard Temperature (BST) references the upper limit for the surface temperature of a specimen in a weathering instrument. All other temperature values are lower, depending on the specimens' colors and surface structures.

The Test Chamber Temperature (CHT) indicates the lowest temperature a specimen can have. Only compliance with both temperatures — BST and CHT — ensures the best possible reproducibility and repeatability.

As many industries are already aware of this, numerous standards specify Black Standard Temperature as well as Test Chamber Temperature, especially in the automotive industry (e.g., hot lightfastness testing to VDA 75202 and ISO 105-B06). The basic ISO standards for plastics and coatings have also been revised to identify BST and CHT set points.

*Atlas' Xenotest® Alpha now allows automatic simultaneous control of BST and CHT.*

The Xenotest® Alpha and Xenotest® Beta, proven accelerated weathering instruments in many industries, now allow automatic simultaneous control of BST and CHT. All instruments, manufactured as of January 1, 2002 offer this additional feature — at no extra charge.

The time-consuming test runs previously necessary to determine the appropriate blower speed to adjust the temperature (BST or CHT) are now obsolete. The simultaneous control also eliminates the need to adapt the blower speed after a lamp change, which was previously required due to different infrared outputs of used and new lamps.

For more information on this new development, please contact your local representative or Andreas Riedl at ariedl@atlasmtt.de. ■

## AtlasSpeaks

# 2002

**Technische Akademie Wuppertal**
April 18–19
Wuppertal, Germany

Dr. Jörg Boxhammer, Atlas Material Testing Technology GmbH, will present a paper on temperature measuring at the exposed sample level when running accelerated light- and weatherfastness tests.

Dr. Dieter Kockott, Atlas Material Testing Technology GmbH, will speak about spectral sensitivity and activation spectra of polymers.

**INDA Nonwoven Fabrics Conference**
March 19–21
Greenville, South Carolina

Matt McGreer, Atlas Material Testing Technology LLC, will present "Durability Testing of Materials for Interior Automotive Applications."

**IFAI Interior/Exterior Weathering Workshop**
May 14
Detroit, Michigan

Matt McGreer, Atlas Material Testing Technology LLC, will present material on the fundamentals of weathering testing.

## AtlasShows

# 2002

**PaintIndia**
February 21–23
Mumbai, India

**SAE 2002**
March 4–7
Booth #1049
Cobo Hall
Detroit, Michigan

**Chemistry**
March 14–17
Istanbul, Turkey

**Sink or Swim 2002**
April 18
Cleveland, Ohio

**Analytica**
April 23–26
Munich, Germany

**Plastics for the Industry**
April 24–25
Kortrijk, Belgium

**Coatings for Africa**
May 16–17
Cape Town, South Africa

**EuroCoat 2002**
June 4–6
Barcelona, Spain

**SPCI**
June 4–6
Stockholm, Sweden

**Quality 2002**
June 12–13
Novi, Michigan

**Igatex**
June 20–22
Karachi, Pakistan

**Surfex 2002**
June 26–27
Manchester, England

**Interplastica**
September 16–19
Moscow, Russia

**Tex-Chem**
September 26–29
Istanbul, Turkey

**Interplas**
September 30–October 4
Birmingham, England

**AATCC**
October 1–4
Charlotte, North Carolina

**Plastic and Rubber**
October 9–13
Istanbul, Turkey

**Fakuma**
October 15–19
Friedrichshafen, Germany

**FSCT ICE 2002**
October 30–November 1
New Orleans, Louisiana

**HET Instrument**
November 4–8
Utrecht, Netherlands

**Expoquimia**
November 12–16
Barcelona, Spain

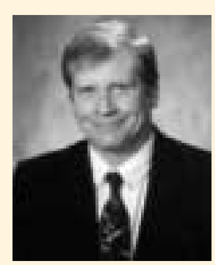
**TexTech**
November 14–17
Chandigarh, India

## Atlas Partner Wins Industry Recognition

Atlas congratulates Richard Fischer, Ph.D., Division Scientist, Traffic Control Materials Division, 3M for being inducted into the prestigious Carlton Society, 3M's scientific hall of fame. Dr. Fischer earned the honor for his "creativity and technical leadership in applying science to understand and model the durability of materials and products in an outdoor environment, underpinning several large 3M businesses, and greatly enhancing 3M's reputation; and for his many contributions to innovative product development in adhesives, sealants, coatings, inks, films, and reflective sheeting."

We are proud to say that Dick, who is also one of the most respected scientists in the weathering community as a whole, has been a friend and partner of Atlas for nearly 20 years.

Congratulations, Dick! The honor and recognition for your tremendous contributions are well deserved.



*Dr. Richard Fischer*

*Airbag System Testing, from page 1*

tests to determine and improve the aging behavior of automotive components.

The essential factors for this test are solar radiation (defined as "global or total radiation"), ambient temperature, and relative humidity.

## Solar Radiation Simulation Test — DIN 75220

The specification provides guidelines for conducting the test, but some critical aspects need to be considered carefully as there is still room for interpretation and several definitions are lacking.

For the solar radiation simulation test on airbag modules, the selected parameters are shown in the chart to the right.

Two different environments have been selected to show severe weathering effects on automotive components — the "hot and dry" and the "warm and humid" climates. Those climates were chosen based on longtime experience and the abundance of reference data from natural weathering tests in locations like Arizona (hot and dry) and Florida (warm and humid). These regions have been so frequently used that automotive solar simulation tests are sometimes called "Arizona-Tests" and "Florida-Tests."

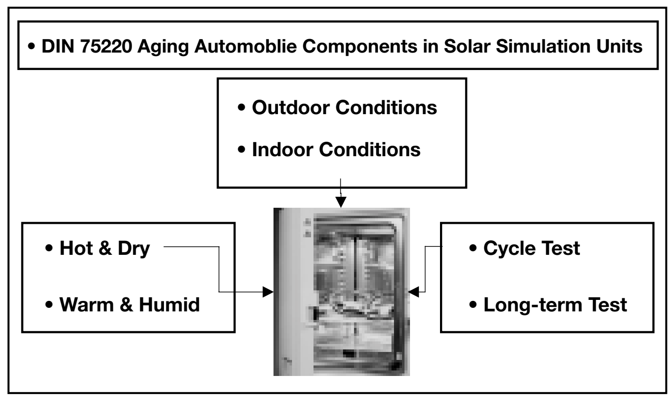



*Figure 1*

The distinction between outdoor and indoor test conditions often creates confusion. Fundamentally, we can say "outdoor" means the climate conditions that need to be simulated on the external surfaces of a vehicle, and "indoor" means to simulate the climate conditions found in an enclosed car interior when exposed to outdoor conditions. The confusion mainly occurs with the indoor conditions, due to a lack of definitions in the DIN 75220 standard and the design of the solar simulation systems. Irradiance, spectral radiation distribution, and ambient temperature determine the essential differences between outdoor and indoor.

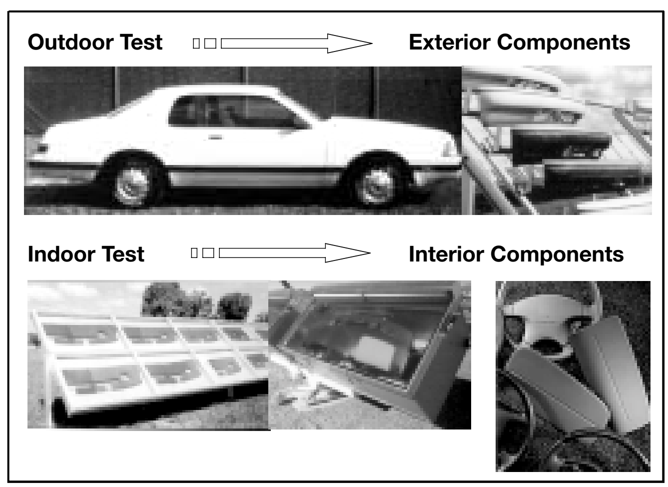



*Figure 2*

The outdoor test is performed within a large climatic chamber where complete vehicles, as well as exterior components, are exposed to direct sunlight. Irradiance, spectral power distribution, and ambient temperature are set close to the terrestrial extremes in order to achieve accelerated effects.

For the indoor test, the specification offers different options. Definitions of DIN 75220:

**Test Box —** "The test box is a device in which the climatic conditions found in an enclosed car interior are simulated: indoor conditions."

This means that if the climate conditions remain constant, the test box could be designed in any way.

This is different from what is found under "test equipment":

**Test Box —** "The test box, which is made from a vehicle, a section from the passenger area, or a model of this, is used to simulate the internal conditions in different models of vehicles."

This gives at least a hint that the geometrical design of the test box should use the passenger cabin as a model, but a detailed specification is not defined.

ISO 12097-2 provides even more freedom concerning the design. The

*Continued on next page*

*Airbag System Testing, from previous page*

varying design of indoor test boxes primarily affects the sample surface temperature. This problem will be addressed later.

## Solar Radiation: Quantity & Quality

### Solar Radiation Simulation Test — DIN 75220 — Factors of Weathering

Global solar radiation is the sum of direct and diffuse solar radiation received on a horizontal plane on the earth's surface. The reference for global radiation in respect to spectral radiation distribution and irradiance is shown in the CIE Publication No. 85, "Solar Spectral Irradiance," Table 4.

The table to the left explains this spectral power distribution.

**Spectral Power Distribution**

| | Wavelength Range | % of Total<br>CIE Pub. 85 T4 | DIN 75220 |
|---|---|---|---|
| UV | 280–320 nm | 0,36% | 0,3…0,7% |
| UV | 320–360 nm | 2,54% | 1,8…3,0% |
| UV | 360–400 nm | 3,76% | 2,4…4,4% |
| VIS | 400–520 nm | 18,25% | 16,1…19,7% |
| VIS | 520–640 nm | 18,14% | 14,9…18,3% |
| VIS | 640–800 nm | 17,54% | 12,8…19,0% |
| IR | 800–3.000 nm | 39,41% | 33,7…50,5% |

*Figure 3*

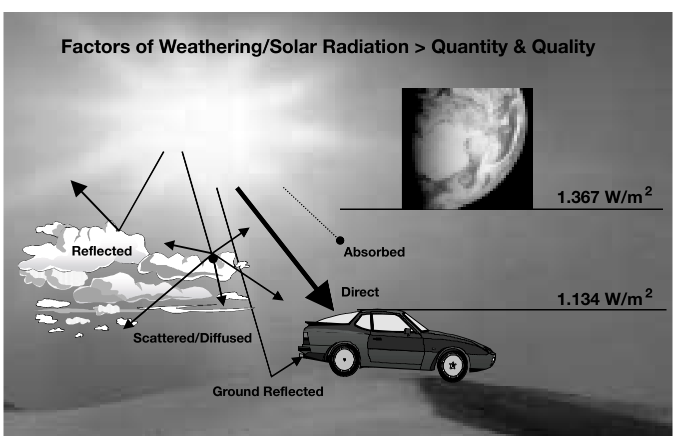



*Figure 4*

### *Outdoor Test*

For simulation of global radiation, the following conditions are specified:

Irradiance of 1.000 W/m² ± 100 W/m² in the spectral range from 280–3.000 nm.

### *Indoor Test*

**Indoor Irradiation Conditions**

The most important factor in achieving indoor conditions is the glass cover (filter). Standard specifications call for a 4 mm thick window glass. Due to its relative high transmission within the UV range, it simulates the so-called "worst case." Further on, the specification advises, "…Obviously other types of glass may be used, but this shall be agreed. It should be noted that using other types of glass changes the transmittance and hence the spectral energy distribution…" The use of different types of glass is required frequently. Usually it is a type of laminated safety glass or tempered glass, replicating automotive glass typically used for the windshield or side and rear windows.

Tinted (heat absorbing or reflecting) glass is more commonly used for automotive applications than clear glass. Besides changes in the spectral radiation distribution, these different automotive glass types have a considerable effect on irradiance, and the changes in the irradiance values are often not obvious.

A typical complaint is "the required 830 W/m² cannot be reached." Only detailed information on the overall transmission values of the particular glass can give correct reference values on the irradiance that should be achieved. (See figures 5 and 6 on the next page.)

## Temperature: Quantity & Cycles

The radiation conditions are well specified for both the outdoor test and indoor test (although for indoor this is only true when using the recommended 4 mm window glass). The thermal conditions, also well defined, can lead to extreme differences in the test results. There may not be a correlation between outdoor weathering tests and exposures in poorly designed solar simulation units. For the outdoor test, it is relatively clear. An ambient temperature of **42 °C** ± 3 °C has been specified for the outdoor test, providing similar temperatures found in desert conditions like in Arizona or the Kalahari. For the indoor test, two different exposure zones have been defined:

Exposure Zone 1 = 80 °C ± 3 °C

Exposure Zone 2 = 65 °C ± 3 °C.

Besides the pure thermal conditions that are different in an open chamber and within a vehicle (formation of temperature layers, convection), attention must be paid to the speed of air flow. Even with the same irradiance and the same ambient temperature, different surface temperatures will result if the air flow does not remain constant. The ultimate goal is to simulate these temperature layers that exist in real world conditions as closely as possible.

Users must be aware that variations in sample surface temperatures on the test specimens will lead to different aging behavior.

As an example of how extreme these differences can be, the graph on the next page illustrates the change in color for gray pigmented PVC at various temperatures. A difference of about 6 °C in the surface temperature will nearly double the Δ E* value.

The measurement of the so-called "black standard temperature" can serve in this case as a relatively good reference to the actual sample surface temperature.

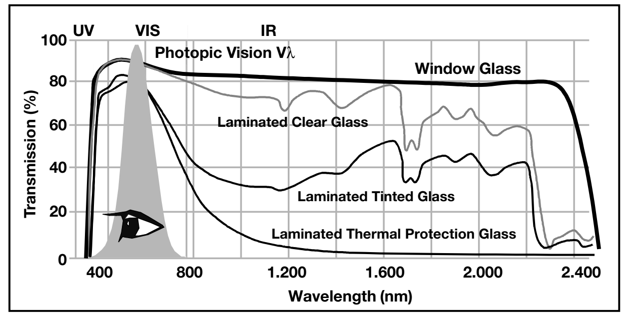



*Figure 5*

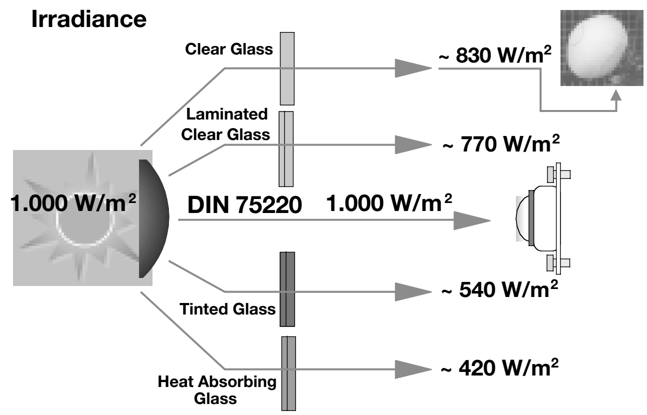



*Figure 6*

**Spectral Power Distribution**

| | Wavelength Range | DIN 75220 Outdoor | Transmittance of 4 mm Window Glass | DIN 75220 Indoor |
|---|---|---|---|---|
| UV | 280–320 nm | 0,3…0,7% | 7% | <0,04% |
| UV | 320–360 nm | 1,8…3,0% | 61% | 1,3…2,3% |
| UV | 360–400 nm | 2,4…4,4% | 88% | 2,6…4,6% |
| VIS | 400–520 nm | 16,1…19,7% | 89% | 17,3…21,1% |
| VIS | 520–640 nm | 14,9…18,3% | 89% | 16,0…19,6% |
| VIS | 640–800 nm | 12,8…19,0% | 83% | 12,8…19,0% |
| IR | 800–3.000 nm | 33,7…50,5% | 80% | 32,4…48,6% |

*Figure 7. Worst case scenario – transmission of 4 mm thick window glass*

## Water: Quantity, Phase & Humidity

Relative humidity is only described in very vague values, such as < 30% for a dry climate or > 60% for a humid one. Like temperature, humidity plays a role within the aging process of materials. Water absorption and desorption applies stress to the different layers of a material, which speeds up aging. Again, the large tolerances of relative humidity may lead to different test results.

### Test Sequences

Basically, there are two different kind of test sequences defined: a long-term

*Continued on next page*

*Airbag System Testing, from previous page*

test with 240 hours of constant climatic and irradiation conditions, and a cycle test with a combination of 15 24-hour dry climate cycles and 10 24-hour humid climate cycles. For testing airbag modules, only the 15 24-hour dry climate cycle is selected.

## Test Equipment

There are various ways to design the test equipment. Assuming that it all has to meet the specification, it is mainly a question of the required test room capacity. Some people want to test just a few single samples, others may need to test the integrated parts (e.g., a complete instrument panel) or even a complete vehicle.

In addition, there is often the need to perform tests in accordance to different standards specific to the automotive industry or other organizations. To accommodate this, KHS offers a large variety of modular equipment that can be tailored to individual test needs.

For example, two standard test units from the SolarClimatic series, shown at left, are capable of performing tests in accordance with most, if not all, standards for solar simulation tests on automotive components, including the MIL-810-F standard.

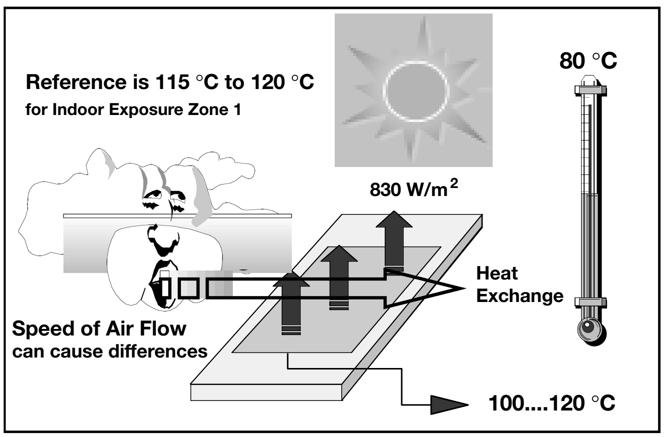



*Figure 8*

*Figure 9*

## Performance — Static Deployment Test

Six out of ten airbag modules that went through the various environmental tests need to prove their function during the static deployment test. This includes the two modules that had been exposed under solar simulation. The deployment of the modules has to be performed under specified sample temperatures. Maintaining these temperatures is particularly critical due to the necessary use of lighting systems.

Light plays an important role in the quantity and quality of data recorded in high-speed photography and videography. Besides the basic requirements of illuminance, spatial uniformity, and light modulation, the efficiency of the high-speed imaging sensor needs to be considered.

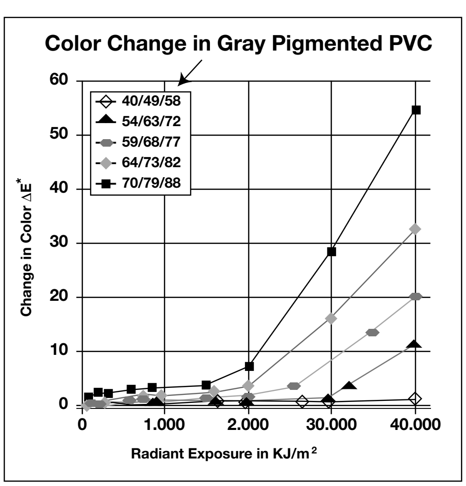



*Figure 10*

Special metal halide lamps have been found to be an extremely efficient light source for this application. Integrated into the **HIGH-S-LIGHT BOOST** technology of KHS, they provide:

- High luminous efficiency > 1001m/W
- Daylight color temperature of 5.600–6.000 K
- Matches the sensitivity of film and video perfectly
- Flicker-free light — modulation < 1%
- High illuminance due to the BOOST mode
- Low heat radiation
- Stabilized true power control
- Optical system for uniform illunination
- Modular design
- Useful subsystems

But there is also a downside. To get all of the filling components responsible for the illumination quality of the lamp, into full operation (vaporization), a certain amount of time is required once the lamp has been ignited. The time depends on the type of lamp, the control gear, and the ambient thermal conditions. Normally a delay of at least 90 seconds is necessary. Even though the lamp has relative "cold" radiation within this warm-up period—especially when operated in the stand-by mode—illuminated samples will absorb the radiated energy and build up heat.

To overcome this problem, and maintain the required temperatures, several solutions are available. One solution, offered by manufacturers of climatic and/or temperature controlled chambers—which are needed to condition the airbag modules—is a design that enables the direct performance of the static deployment test. In general, this can be achieved in two different ways:
1) move the samples rapidly out of the chamber by means of a sled or by mounting the module to the cabinet door, or
2) open the chamber by about 180° so the ignition of the airbag can be performed inside the chamber.

Because this is a way of precise temperature control, daily series testing is most often performed in different setups. The preconditioned airbag modules are rigidly mounted on fixtures in specially designed test rooms. Once in place, they are subjected to the lighting system that is installed for the proper illumination of the process. This would also cause problems in maintaining the module temperature.

To overcome this, and to avoid any radiation striking the module before the actual test is performed, KHS designed a pneumatic shutter for the luminaries of the HIGH-S-LIGHT BOOST FL series.

The function is internally coordinated with the stand-by and BOOST mode operation and the whole sequence is integrated into the overall test control. As the complete system is mounted to the luminary front frame, any existing system could be easily modified. The open/close positions of the shutter are permanently controlled and a corresponding signal is provided. Compressed air is used to cool the lamp fixture when the shutters are closed. This allows for unlimited operation time even when the luminary is closed.

The proposal, planning, and realization of a solar simulation unit and lighting system must always be done in close cooperation with the user and needs to take into account the technical requirements of the special application.

Even if standards give a guideline for the design, they are most often not precise enough to ensure reliable and reproducible test results. The performance of laboratory testing, like the solar simulation test, requires continuous verification of the correlation to natural weathering conditions and effects.

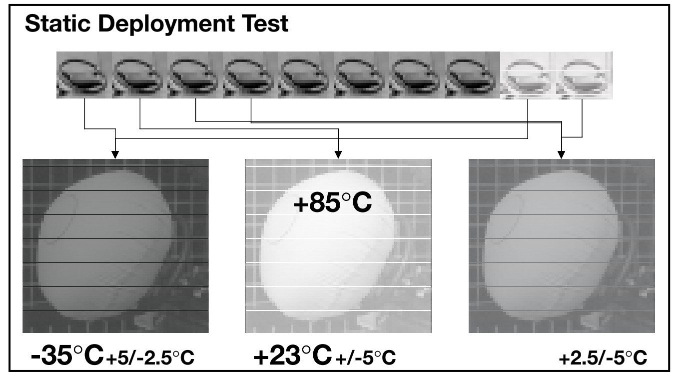



*Figure 11*

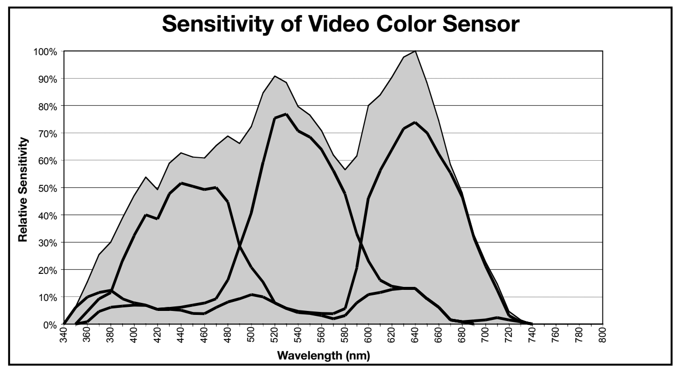



*Figure 12*

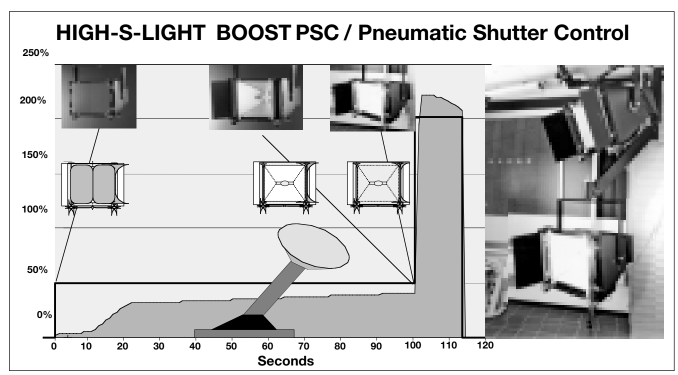



*Figure 13*

# Atlas Weathering Services Group

*Enhanced software and other improvements mean savings for Atlas' color measurement customers.*

## Color Pricing Slashed for 2002!

Atlas Weathering Services Group (AWSG) is pleased to announce a significant reduction in the cost of color measurements, effective January 1, 2002. Since 1995, AWSG has maintained the price of color measurements at $6.00 per reading, with a $65.00 minimum charge. We are now able to offer color measurements at just $3.50 per reading — a reduction in price of more than 41%! The $65 minimum charge will still apply.

This dramatic price reduction was made possible through the use of more sophisticated software and improved work-flow processes. Those clients who routinely have AWSG perform color readings on their test samples will realize significant savings at the new rate of only $3.50 per reading. Not only will the lower pricing apply to new exposure programs, but also to existing programs that are currently in progress.

## Save a Tree — Go 'E'!

Atlas Weathering Services Group is committed to finding ways to increase quality and efficiency for its customers. As part of this commitment, AWSG is pleased to announce the availability of electronic Portable Document Format (PDF) test reports, effective January 1, 2002. Electronic reports will help our customers reach their ultimate goals — a quality product, a competitive edge, a faster time to market. In addition, a savings in time and money should be realized by not having to store, archive, and retrieve paper reports.

The universal PDF format allows you to extract, store, and sort the data more efficiently than ever. Test reports can now be sent via e-mail on AWSG letterhead complete with digital signatures. Except for a minor change in the appearance of the AWSG letterhead, the reports are identical in format to the paper reports you are receiving now.

All you need to receive electronic reports is an e-mail address and Adobe Acrobat Reader. Acrobat Reader can be downloaded from a link at www.atlaswsg.com, or directly from www.adobe.com. This service is free of charge. To set up an account to receive electronic test reports, please contact AWSG Client Services at +1-800-255-DSET or by e-mail at info@atlaswsg.com.

Just think of the trees we will save by going paperless!

# AWSG Provides VIEEW™ Sample Analysis

Atlas Weathering Services Group is pleased to offer state-of-the-art surface evaluation using the Atlas **VIEEW™ Digital Image Analyzer,** at South Florida Test Service in Miami, Florida. The VIEEW system allows laboratory personnel to analyze surface structures quickly, precisely, and with reproducibility. Its combination of sturdy hardware and intelligent software makes it an indispensable tool for the objective inspection of surface defects.

The VIEEW system consists of a solid temperature-resistant and shock-resistant cabinet, an integrated black-and-white CCD camera, and high-end apochromatic lenses. VIEEW uses the camera and lenses to capture data from a sample. This data then flows into an intelligent teachable processor where it is processed, evaluated, and stored. The software allows the development of customized tests and assessments. The classification of surface damages on the sample, such as gravel impact, cross hatch, filiform corrosion, and delamination, is done in accordance with standards or customers specifications. VIEEW takes the classification of samples to a new level of quality, convenience, and repeatability.

A state-of-the-art optical and illumination system uses different light geometries for evaluating all types of surface defects. Direct light is used to examine top layer defects and textures of optically smooth surfaces. Diffuse light is used to examine the effects that cause changes to the surface contrast such as color change. Light geometries can also be combined to analyze and evaluate samples exhibiting both characteristics.

For more information about VIEEW or to obtain a quote, contact AWSG Client Services at +1-800-255-DSET or visit us on the web at **www.atlas-mts.com.**

*Analysis made easy: The VIEEW is now up and running at Atlas' Florida facility.*

## Marge Awarski Joins DSET Staff

We are pleased to announce that Marge Awarski joined the staff at Atlas Weathering Services Group, DSET Laboratories in January as an Operations Coordinator in the Static/Evaluations Department. Marge most recently held the dual titles of Research Scientist/Test Fence Coordinator for Lilly Industries at its Strongsville, Ohio outdoor weathering site. In these capacities, she oversaw the day-to-day operations of an outdoor exposure facility and evaluations laboratory, in addition to serving as international testing coordinator. Previously, Marge spent 16 years with The Glidden Company in the Industrial Coatings Division.

Please join us in welcoming Marge to the AWSG staff! She can be reached at +1-800-255-DSET.

*Marge Awarski*

# AtlasCommitment to Education

## ATCAE Debuts in Europe

### *Objectives and Program*

New test and evaluation methods for automotive interior and exterior materials will be the focus of the **ATCAE (Atlas Technical Conference for Accelerated Aging and Evaluation)** this June. Similar in format and content to the ASNAW Automotive held in Phoenix, Arizona, it will be the first **ATCAE** in Europe for the automotive industries and their suppliers. The conference will be conducted in German with simultaneous translation into English.

Highlighting the two-day meeting will be a tour of a well-known independent testing laboratory, including R&D facilities for the automotive industry.

The conference has two parts:

Part I (first day) will focus on automotive interior materials and cover topics such as new test methods and standards and the use of solar simulation.

Part II (second day) will deal with car exterior applications and report on the state of test and evaluation methods for polymers and coatings. It will also include detailed discussion on new analytical applications with the Atlas VIEEW™ Digital Image Analyzer.

The conference will benefit materials engineers, product specialists, quality control supervisors, and others involved with material durability testing in the automotive industries, car glass suppliers, interior trim material manufacturers, and related areas.

Speakers will be experts from well-known international automobile manufacturers and suppliers.

### *Tuition and Registration*

The conference is scheduled for June 12–13, 2002 in Bad Orb, near Frankfurt International Airport.

The €500 tuition covers all conference materials, the lab tour, and all meals and refreshments during the two days. Lodging, travel expenses, and other incidentals will not be included.

Advance registration is required — prior to April 15, 2002.

For more information, contact ATLAS MTT GmbH, attention Bruno Bentjerodt, tel.: +49/6051/707-245, fax: +49/6051/707-249, or e-mail: clienteducation@atlasmtt.de.

# 2002

**Atlas School for Natural and Accelerated Weathering (ASNAW)**
October 23–25
Miami, Florida

**Fundamentals of Weathering I**
February 27 (German language)
Stuttgart, Germany

March 5–6
Denmark

March 12–14
Switzerland

March 20
Montreal, Quebec, Canada

March 28
Paris, France

April 17 (German language)
Sueddeutsches Kunststoffzentrum
Leipzig, Germany

June 5
Marlborough, Massachusetts

June 6
Parsippany, New Jersey

June 13
Lyon, France

June 26
Moscow, Russia

July 16
Cleveland, Ohio

July 17
Detroit, Michigan

August
India (Membai, Chennai, Delhi)

September 17
Buena Park, California

October 3
Paris, France

October
Braunschweig, Germany

October
Spain

**Fundamentals of Weathering II**
March 29
Paris, France

June 14
Lyon, France

July 18
Detroit, Michigan

September 18
Buena Park, California

October 4
Paris, France

**Ci4000/Ci5000 Weather-Ometer® Workshop**
March 5
May 8
October 28

**Ci35/Ci65 Weather-Ometer Workshop**
May 9–10
October 29–30

**Advanced Ci35/Ci65 Weather-Ometer Workshop**
October 31

**XENOTEST® Workshops**
May 28–29 (German language)
Linsengericht, Germany

November 26–27 (German language)
Linsengericht, Germany

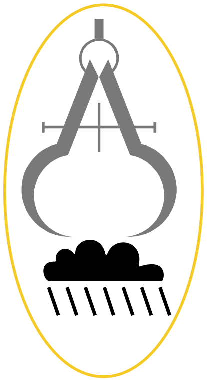
March 19–20 (English language)
Linsengericht, Germany

September 17–18 (English language)
Linsengericht, Germany

**European Weather-Ometer Workshops**
June 18–19 (German language)
Lochem, Netherlands

June 3–4 (English language)
Lochem, Netherlands

*For more information on our Educational Workshops and Seminars, please visit* **www.atlas-mts.com**.



# Weathering Experimenter's Toolbox

*by Henry K. Hardcastle III, Atlas Weathering Services Group*

It is important for weathering researchers to maintain a collection of tools for addressing complex weathering phenomena. Starting with this article, an overview of selected weathering experimentation tools will be regularly presented in *Sun Spots*. This new feature will examine gage characterizations, weathering test methods, approaches for weathering experimentation, and weathering philosophies. Each overview will feature application examples of weathering studies and empirical data, giving insight into variation and other aspects of weathering phenomena. It is hoped that the tools provided in this collection will help weathering researchers solve problems and gain greater understanding when undertaking difficult projects.

## *Gage Capability and R&R*

Instrumental evaluations of weathered surfaces is not always easy. Often, surface degradation results in non-uniformity across a specimen's surface. Small size target areas of some measurement instruments may yield highly variable data when measuring different spots of the same specimen. Weathering researchers should be familiar with variation associated with measurements before making decisions regarding measured weathering data. Sources of variation associated with any measurement include **repeatability** and **reproducibility** (R&R). The R&R study is a powerful tool weathering researchers can use to characterize measurement variation.

A fine treatment of R&R application may be found in Larry B. Barrentine's *Concepts for R&R Studies* from ASQC Press. The Barrentine treatment utilizes the revised G.M. long form and describes repeatability as the variation of measurements of a gage and reproducibility as the variation in measurements by operators. With some simple modifications, this method can be adapted to characterize variation from different weathering exposures and devices. "A total measurement system must go beyond R&R and eventually include all sources of measurement variation," Barrentine says.

Application of this tool using Barrentine's approach for 20° gloss readings on automotive paint specimens was performed as follows. A set of 10 different current automotive

| OPER. | | A | | | | B | | | | C | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SAMP. | #1 | #2 | #3 | R | #1 | #2 | #3 | R | #1 | #2 | #3 | R |
| A | 89.7 | 93.9 | 94.5 | 4.8 | 89.2 | 89.3 | 89.4 | 0.2 | 88.6 | 89.4 | 89.3 | 0.8 |
| B | 90.2 | 94.7 | 95 | 4.8 | 89.8 | 89.8 | 90.1 | 0.3 | 89.0 | 89.8 | 89.8 | 0.8 |
| C | 90.7 | 95.3 | 95.7 | 5.0 | 90.2 | 90.3 | 90.6 | 0.4 | 89.5 | 90.6 | 90.4 | 1.1 |
| D | 90.0 | 94.4 | 94.8 | 4.8 | 89.4 | 89.5 | 89.6 | 0.2 | 88.4 | 89.3 | 89.5 | 1.1 |
| E | 90.0 | 93.6 | 93.9 | 3.9 | 89.4 | 89.2 | 88.8 | 0.6 | 88.8 | 88.9 | 89.1 | 0.3 |
| F | 67.0 | 75.5 | 79.7 | 12.7* | 60.8 | 73.5 | 70.5 | 12.7* | 64.8 | 67.3 | 67.6 | 2.8 |
| G | 68.6 | 73.7 | 75.4 | 6.8 | 67.2 | 70.1 | 69.3 | 2.9 | 62.4 | 64.1 | 64.2 | 1.8 |
| H | 76.6 | 82.6 | 86.1 | 9.5* | 74.5 | 75.7 | 75.7 | 1.2 | 75.9 | 77.2 | 76.8 | 1.3 |
| I | 68.5 | 76.1 | 74.3 | 7.6 | 65.1 | 70.2 | 69.5 | 5.1 | 64.3 | 65.8 | 65.3 | 1.5 |
| J | 72.4 | 78.9 | 78.8 | 6.5 | 69.8 | 72.3 | 73.6 | 3.8 | 71.3 | 72.1 | 72.6 | 1.3 |
| | X-BAR A | 84.4 | R-BAR A | 6.6 | X-BAR B | 80.1 | R-BAR B | 2.7 | X-BAR C | 79.1 | R-BAR C | 1.3 |

** = Beyond upper control limit*

coatings with varying degrees of gloss was obtained (designated A–J). The specimens were measured by three different operators to characterize reproducibility (between operator variation). Each operator measured the set three times to characterize the repeatability (within operator variation). Data for the measurement trials was recorded as shown in the table on the previous page.

For this application, we wanted to use the gloss meters to be able to differentiate groups that were as small as four units apart in 20° gloss. From calculations in the modified G.M. long form and the Barrentine book, the following values were obtained:

### *Measurement Unit Analysis*

Repeatability - Equipment Variation (E.V.) = 10.9 gloss units
Reproducibility - Appraiser Variation (A.V.) = 2.73 gloss units
Repeatability and Reproducibility (R&R) = 11.2 gloss units

### *Tolerance Analysis*

% E.V. = 100 x [(E.V.) / (Tolerance)] = 272% of desired tolerance
% A.V. = 100 x [(A.V.) / (Tolerance)] = 69% of desired tolerance
% R&R = 100 x [(R&R) / (Tolerance)] = 280% of desired tolerance

The values are based on 99% of the area under the normal curve. Using this analysis, we compare the variation attributed to these sources to the tolerance value. We cast a suspect eye on differences closer than approximately 11 units. We know the gloss measurement system does not have sufficient resolution to discern smaller differences at 99% confidence. We can not confidently say that gloss differences smaller than 11 units are due to weathering since our measurement variation appears to be larger than this difference for these specimens using this measurement system.

## Which is Better: Black Standard or Black Panel Thermometer?

Besides radiation, the temperature of the sample surface is the most critical factor in weathering tests. Online measurement of the real sample temperature is very expensive, technically difficult, and sensitive to errors in measurement.

Therefore, the temperature on the sample surface is determined by measuring the temperature of a standardized metal panel. A black coated panel indicates the maximum possible surface temperature of a specimen. Historically, two different types of black panel thermometers (BPT) have been used. A panel mounted on an insulating plastic baseplate has been used mainly in European countries and by ISO, the International Standards Organization, and is called black standard thermometer (BST).

The uninsulated type was introduced by ASTM. The temperature indicated by a BST is higher than that indicated by a BPT, depending upon the exposure conditions. Both types have their advantages and disadvantages. Because different types of BST and BPT are available, a test report should always specify which type was used.

# Silica Removal: A Delicate but Necessary Process

Silica is a common, waterborne weakly ionic contaminant that has a negative effect on the results of weathering tests. Silica contamination can deposit on lamps and filters, test chamber walls, and test specimens. This causes raised hard spots and/or a whitish powdery coating, which can interefere with color and appearance measurements, particularly gloss. Weathering tests conducted with contaminated water can also interfere with normal irradiance control and calibration by the Atlas Weather-Ometer® and lead to more frequent cleaning, as well as potential premature replacement of the Xenon lamps and filters. For accurate results, water used for weatherability testing should meet certain conductivity and silicate level specifications.

Conductivity measures the total amount of ions present in the water; it is measured separately from silicate levels as silica is a non-conductive element. Weakly charged elements, or elements that are not well-dissociated in water, are not removed efficiently by conventional water purification technologies. In the production of high purity water, silica and boron are generally the first ions to break through into purified water when the ion-exchange resin approaches depletion. In this study, the behavior of these two elements is studied through various steps in a Millipore water purification system.

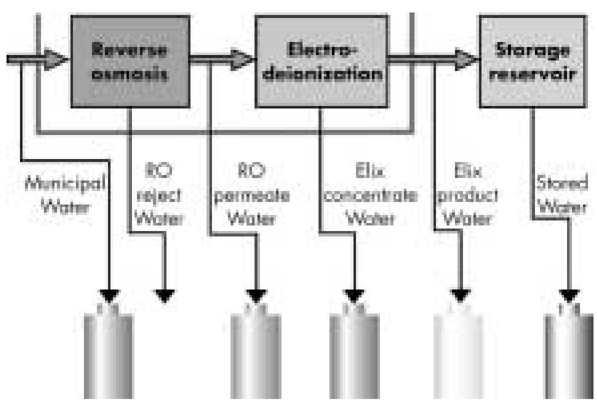



*Figure 1. Flow schematic of Elix 10 water system*

Silica ($SiO_2$) exisits in water in equilibrium with the bisilicate ($HSIO_3$) ion as a very weak acid. In the ionic form, silica can be removed by strong base anion exchange resins in the hydroxide form. Since the two forms exist in equilibrium, this "reactive" silica can be almost completely removed from solution. Most simple ion exchange mixed-bed systems use high capacity weak base resins, which are not effective at removing reactive silica.

Silica can also exist as a polymer, referred to as "colloidal" silica. These long chains of individual silica units exhibit no charged ionic character and cannot be removed by ion exchange. Both the reactive and colloidal silica forms can be problematic in weathering tests.

The specific water purification chain used in this study consists of a combination of technologies. The Elix® 10 water system combines reverse osmosis (RO) with Millipore's patented Elix technology (based upon the principles of electrodeionization). Consisting of a pre-treatment filter, a reverse osmosis membrane and an Elix purification module, the system delivers 10 liters per hour of purified water from tap or well water. This purified water is then stored in a specially designed storage reservoir made of polyethylene, selected for its low leaching characteristics.

The flow schematic of this purification chain and the locations of the different sampling ports are shown in Figure 1. Samples are collected after each purification step. They are collected in polyethylene bottles that were previously rinsed thoroughly in nitric acid and ultrapure water baths. Flow rates of either purified (product) water or reject (concentrate) water are measured during the Elix purification step in order to calculate mass balance.

## Results

The performance of the Elix purification module has been particularly analyzed. The improvement in water quality from municipal feed water to the reservoir is shown in Figure 2.

In the first step of the purification chain, the reverse osmosis membrane removes more than 95% of ionic contaminants and silica. After purification within the Elix module, the water quality is again improved. The conductivity of Elix product water is around 0.06 µS/cm — almost the theoretical conductivity of pure water. Silica concentration is less than 0.01 mg/L. The rejection efficiency of total ions (as measured by conductivity) and silica is 99% and 91%, respectively

The purified water is then stored in a reservoir. In some circumstances, storage may increase contamination due to extraction from the reservoir material or dissolution of gases from the atmosphere. Carbon dioxide is a major contaminant known to cause a rise in conductivity. In our experiment, a blow-molded reservoir equipped with a specific vent filter is used. Only a slight conductivity increase is observed after overnight storage in the reservoir. Moreover, no significant increase in silica and boron is detected during storage.

## Conclusion

Weakly ionized ions, such as boron and silica, do not impact resistivity measurement, thus affecting water quality without the user being aware of it. The water purification chain described in this article ensures constant minimal elemental contamination. The Elix module shows good ionic balance for extended periods of time without the need for resin regeneration. The combination of reverse osmosis and Elix technology shows good efficiency and stability of ionic reduction for all ionic substances, including silicates. The result is ultrapure water suitable for trace elemental analysis or sensitive applications like feedwater for weathering instruments.


*Millipore's Elix 5 purification module results in ultrapure water for analysis and sensitive applications.*

| | Conductivity µS/cm | Silica mg/L | Boron µg/L |
|---|---|---|---|
| Municipal water | 480 | 7.1 | 42.6 |
| RO permeate | 12.4 | 0.092 | 23.7 |
| *rejection by RO* | 97% | 99% | 44% |
| Elix concentrate | 33 | 0.26 | 65.1 |
| Elix product | 0.056 | 0.008 | <0.5 |
| *rejection by Elix* | 99% | 91% | 98% |
| Water in reservoir | 0.13 | 0.009 | <0.5 |

*Figure 2. Result of water purification steps*

SunSpots

Be sure to visit us at **SAE 2002,** March 4–7 in Detroit.

See you at Booth #1049!

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