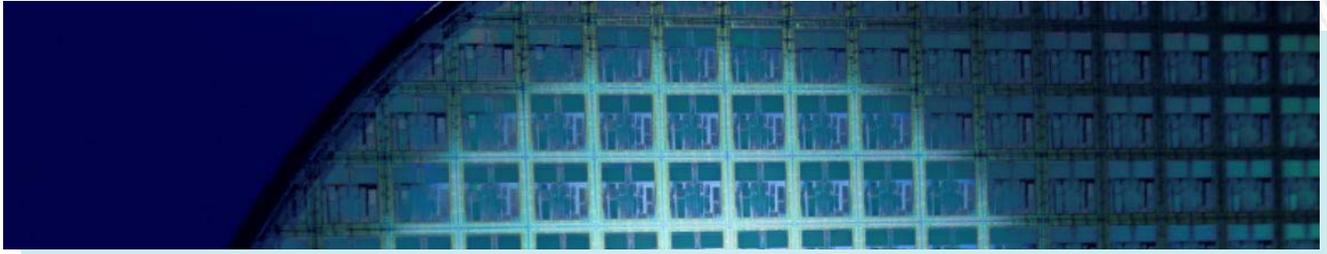# WHITE PAPER: RELIABILITY AND ENVIRONMENTAL HEALTH AND SAFETY: A BENCHMARK, ALL-IN CULTURE SHARED WITH EVERY CUSTOMER

SAFETY AND RELIABILITY

Protecting the Employee, Protecting the Asset, Assuring Performance Reliability—
Every High-Purity Chemical and Gas Delivery System Requires Rigorous Oversight

Whether it is leak testing a gas delivery cabinet, providing a complete customer safety audit or answering a question about emergency procedures for handling a leaking silane cylinder, Versum Materials embodies a 24/7 benchmark, all-in culture of reliability and environmental, health and safety.

It is a benchmark culture through which we passionately and wholeheartedly share best practices globally with all customers—from the largest semiconductor fabs to single-cylinder research labs.

With almost half a century of experience and expertise in manufacturing and supplying high-purity chemicals and gases, delivery systems, services and materials expertise that began with the start of California's Silicon Valley in the 1970s, your Versum Materials team wants you to appreciate that reliability and safety are even more important than the bottom line.

We strongly believe that you should not only understand how important reliability and safety are to us, but also that you know how important they must be for you, your colleagues and your customers.

This White Paper provides an overview of our evolving reliability and safety culture and a look into specific practices we strongly feel should be mandatory for a supplier of gases, equipment and services. Obviously, the total breadth and depth of our knowledge is always available to you.

VERSUM MATERIALS—A HISTORY OF SAFETY AND RELIABILITY

An acknowledged global leader in technology, quality, safety and reliability, Versum Materials is one of the world's largest suppliers of next generation CMP slurries, ultra-thin dielectric and metal film precursors, formulated cleans and etching products, and delivery equipment that has revolutionized the semiconductor, display and LED industries.

We have four equipment product lines: GASGUARD® Gas Delivery Systems, CHEMGUARD® Chemical Delivery Systems, FLOWMASTER® CMP Slurry Delivery Systems and VAPORGUARD® Automated Temperature Control Systems.

Versum Materials is a spin-off company of the Electronics Division of Air Products. We bring a deeper understanding, a love of collaboration and an extensive track record of success to the global electronic materials industry.

In the 1960s, the semiconductor industry was seeking products, like oxygen and hydrogen—building-block chemicals—used process intermediate chemicals. The company expanded its chemical business into the electronics market during the next decade and launched a number of game-changing technologies along the way.

An independent company since October 2016, Versum Materials has annual sales of about US $1 billion, 1,900 employees and 10 major facilities in Asia and North America. It is headquartered in Tempe, Arizona.

Versum Materials is not just focused on new materials. We also continue to invest in process technology at our manufacturing sites that can improve yields and also help reduce costs and increase safety for our customers.

We believe that the innovation-driven global Versum Materials team is the best in the industry, bringing customers and the electronics industry a combination of deep expertise and technical know-how. Versum Materials delivers the thinking, materials and expertise to help you develop transformational technology: the next generation semiconductors, the next tablet, display, computer or mobile device.

OUR ONGOING COMMITMENT AND BASIC PRINCIPLES

Versum Materials is committed to carrying on and expanding upon more than 75 years of policy and practices developed at Air Products, a global leader in not only environmental, health and safety and reliability, but also quality, sustainability, product stewardship and many other areas.

We believe safety is a moral responsibility. We inherited one of the best safety records and we want to improve on it even further. That's why all Versum Materials employees are accountable for working safely and reporting unsafe conditions.

We follow these basic principles:

1. One Hundred (100) percent compliance with all laws and regulations in the countries and regions where we conduct business. Often times taking the "safer" approach than dictated by the regulations.

2. Continuous improvement in sustainability performance. We measure performance, set improvement targets and hold management accountable for results.

3. Transparency in our sustainability performance. We encourage open dialogue on our sustainability activities.

4. Sourcing from companies that share our values around human rights, ethics and environmental responsibility. We expect our suppliers to comply with our Code of Conduct and meet our sustainability expectations, including Conflict Free sourcing.

5. Ongoing assessment of risk associated with our facilities, processes, products and logistics, and reduction of these risks to their lowest practical level to protect our employees, customers, communities and the environment.

6. Alignment of our policies and programs with the Electronic Industry Citizenship Coalition (EICC) Code of Conduct.

THE BIGGER PICTURE

Sustainability is the foundation upon which all aspects of our business are built, and—with safety as our top priority--we put sustainability and accountability at the forefront of everything we do. We enable employees and customers to perform more powerfully, without compromising safety, integrity or the environment. We believe sustainability is a good business practice and adds value to our customers, our employees, our communities and our shareholders.

For us, sustainability has three key strategies:

1. We help customers improve their sustainability performance through higher productivity, better quality products, reduced energy use and lower emissions.

2. We set aggressive environmental performance goals for greenhouse gases, energy, water, waste and emissions, and we measure progress continually to improve our own operations, which, in turn, benefits customers.

3. We are building a culture of safety, simplicity, speed and self-confidence. Our goal is zero accidents and zero incidents.

Quality is used in many ways to mean many things. At Versum Materials, it can be a broad concept, such as a quality reputation, or a more specific one like product quality. All of our businesses and functions serving customers set quality goals and objectives, and share and discuss them throughout the company.

They are dedicated to the continual improvement of Versum Materials' overall quality performance and are also responsible for the development of the skills our employees need to perform their roles well. We regularly review our performance and take the needed action to make sure quality goals and objectives are met.

As far as the environment, we strive to minimize our operations and products and enable you to do the same. The majority of Versum Materials products and services allow you to reduce your environmental impact when it comes to greenhouse gases, hazardous waste, toxic releases and other issues.

A focus on product stewardship allows us to ensure that safety and reliability are an integral part of the life cycle of Versum Materials products, including their development, design, manufacture, marketing, distribution, use, recycle and final disposal.

GASGUARD® GAS DELIVERY SYSTEMS

Versum Materials' GASGUARD Delivery Systems, introduced in 1983, are the global benchmark for fabwide delivery technology.

With the experience of multiple factories and design centers, a worldwide installation base of over 10,000 systems, hundreds of millions of service hours and the operational excellence of our global MEGASYS® onsite management teams, GASGUARD Delivery Systems designs stress a continuing focus on safety, reliability and your costs.

GASGUARD systems are designed and built for the safe storage and handling of high purity toxic, flammable, pyrophoric, corrosive, oxidizing, and reactive cylinder gases.

They meet all applicable requirements of the National Fire Protection Agency (NFPA), International Fire Code (IFC), Toxic Gas Ordinance (TGO), and Semiconductor and Equipment and Materials International (SEMI).

The function of the GASGUARD cabinet is to ensure a safe environment for employees during cylinder changes or in the unlikely event of a hazardous gas leak. The cabinet must be connected to a properly designed exhaust system that is continuously operated in order to provide a safe environment.
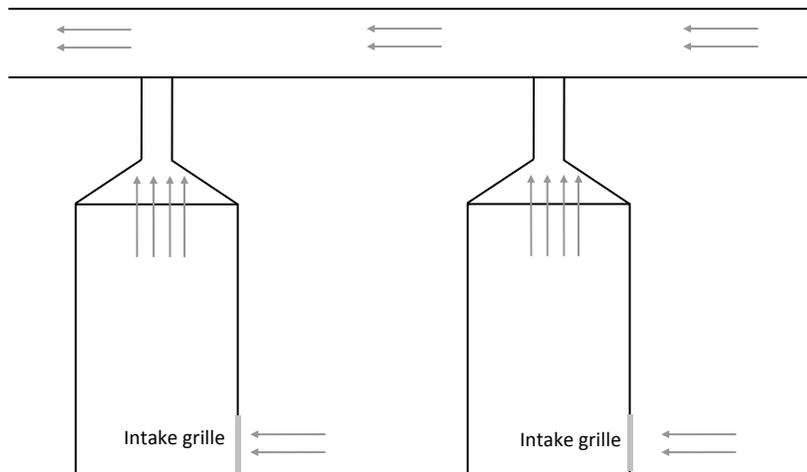
The cabinet also provides the secondary containment for any leak from the hazardous gas cylinder, cylinder connection and pigtail and the process panel. The exhaust system continuously removes any leaking hazardous gas from the cabinet to a safe disposal system. One or more exhaust stacks are provided for connection to the customer's exhaust system.

The Versum Materials GASGUARD AP11 controller is a microprocessor-based unit housed in a custom designed metal enclosure. It continuously monitors system inputs and automatically performs purging operations by sequencing valve actuation. Adequate purging is ensured by checking pressure and vacuum at each step within the purge cycles. The controller also has the capability of shutting down the system if an unsafe condition arises.

The controller screen allows the operator to easily understand the operation and to quickly identify operating problems. The color scheme for open and closed valves can be found on the legend of the controller face. The path of gas flow is indicated by an animated dashed line and controller status is displayed in the middle of the top of the screen. Any shutdown alarms are displayed in the shutdown alarm box in the top left hand corner of the screen. Fault alarms are displayed in the fault alarm box in the top right hand corner of the screen.

GASGUARD systems can be networked for added flexibility, reliability and safety. Remote monitoring is made possible using the GASGUARD OPC Server software or Versum Materials' SCADA system, GCS (Global Communications System).

Either method provides continuous on-line 24/7-hour monitoring of the status of all connected GAS-GUARD cabinets, VMBs and BSGS systems. The AP11 controller communicates to GCS or OPC via Ethernet.

A SAMPLING OF SAFETY AND RELIABILITY
ADVANTAGES FOR VERSUM MATERIALS GASGUARD SYSTEMS

As mentioned earlier, based on our extensive experience with molecules and equipment, we design and build our mass customized GASGUARD delivery systems and options with numerous safety and reliability features that should be mandatory for any system.

Equally important, with our deep understanding of molecules and their physics, chemistry and physical properties, when it comes to UHP gases and components, we know how to research and evaluate their compatibility for specific applications. For example, Versum Materials has developed a sophisticated passivation procedure to support the safe delivery of powerful fluorine mixtures while still maintaining essential UHP components. (See Appendix A)

Our objective is to eliminate or minimize potential problems that run the gamut from simple to serious. That includes function issues such as alarms, electromagnetic interference (EMI) and system failures and personal safety risks including electrical shocks, fires, explosions and exposure to hazardous materials. In addition, we strive to significantly lower warranty and repair costs and downtime.

Here is a sampling of the many standard safety features and reliability built in to GASGUARD systems. These features can be categorized as 1) Product Design Practices, 2) Internal Processes, and 3) Support Services:

1. **Product Design Practices**:
- Product design begins with a complete and thorough understanding of the chemical and physical characteristics of the gases being fed through the system. This is critically important as it impacts the materials selected in the gas distribution system to prevent corrosion, particle contamination, erosion, and failure of the components. (See Appendix A)
- We ensure total compliance and certification including ISO 9001 (Quality), ISO 14001 several countries), OSHA, TGO, NEC, IFC, REACH, ASME, ASTM, GHS, SEMC, NRTL, NFPA, ATEX, IFC, CSA, ITRI, KSA, CE, CCC, SEMI S2 Class 1 Div. 2, CE, UL, etc. (See Appendix B)
- Inspection of finished products using Failure Mode and Effects Analysis (FMEA). (See Appendix C)
- HALT, HASS, and leak testing of all systems before they leave our Semiconductor Equipment Manufacturing Facility locations. (See Appendix D)
- Auto-crossover for two-cylinder cabinets maintains continuous supply and reduces downtime by automatically switching from a depleted to a full cylinder.
- Dual isolation valves prevent incidents, especially during maintenance on hazardous process gas systems.
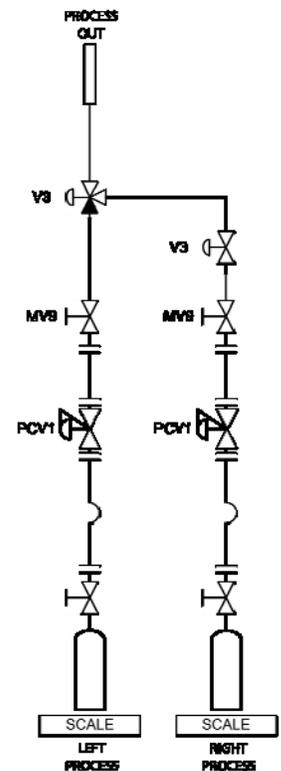
- Versum Materials' proprietary eV temperature control system heats gases to maintain flow and has essential over-temperature protection.
- An ultraviolet/infrared (UV/IR) detector or temperature switch for pyrophoric gas systems. A UV/IR detector and delayed start feature provided for silane and silane mixes system.
- Lowest exhaust requirements in the industry while still designed for worst-case gases.
- Exhaust and venting designs that prevents potentially harmful dead air space in the cabinet.
- Redundant and/or backup power capabilities assuring gas flow in case of system failures
- Automatic backup for shutdown and recovery. Our optional Auto Recovery System (ARS) provides a second microprocessor for redundancy and to enhance uptime.
- Fail-safe valves. With loss of power or pneumatics, valves close automatically. Purge effective studies that are software driven and tested.
- The AP11 controller's extensive software capability allows an operator to manage and control all data related to gas delivery. Tamperproof, real time information with four levels of security.
- AP11 controller fault and shutdown alarms notify the operator through an alarm horn, light and alarm label of a problem with the system. Shutdown alarms close all pneumatic valves and abort the controller program. The system's multiple alarms are monitored continuously.
- A password security system prevents unauthorized operation or modification of the GASGUARD controller menu,
- Manual operation access to the controller is denied with a shutdown alarm.
- Solenoid management allows gas equipment to run uninterrupted while the controller is being serviced.
- Three different sizes of specially designed Emergency Response Containment Vessels (ERCV) to safely contain leaking cylinders.
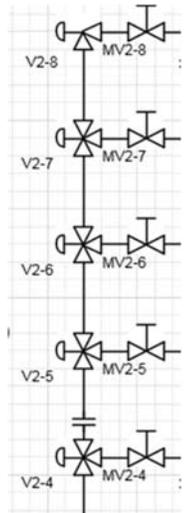
2. **Internal Process**
- Management of Change (MOC) process for internal engineering of all systems and components. (See Appendix E)
- In-house Services and Safety audits for customers to help them ensure best practices for their processes and facilities.
- Training for Versum Materials employees in Process Hazards Analysis, Quantitative Fault Tree Analysis, Consequence Analysis and HAZOP.

3. **Support Services:**
- Safety training available to all customers, from general high purity gases safety to product specific safety. Contact your sales representative or call 800-224-2724.
- Access to a comprehensive, downloadable library of safety data sheets (SDS), material safety data sheets (MSDS), products manuals and other literature.
- GASGUARD systems are fully warranted; critical spares are always available.

CONCLUSION

When it comes to environmental health and safety, reliability, quality and the many other things that impact our businesses, we are stronger together. All of us at Versum Materials aspire to collaborate more confidently and build intimate relationships based on trust, respect, integrity and a deeper understanding of customers' needs.

We want to continue to assist tech companies around the world stretch the boundaries of science and technology. We welcome your input and questions regarding safety and any other aspect of our industry.

FOR MORE INFORMATION:

CONTACT
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PRODUCT SAFETY TRAINING
800-224-2724

EMERGENCY RESPONSE
800-523-9374 (Continental US and Puerto Rico)
610-481-7711 (Other locations)

The information contained herein is offered without charge for use by technically qualified personnel at their discretion and risk. All statements, technical information and recommendations contained herein are based on tests and data which we believe to be reliable, but the accuracy or completeness thereof is not guaranteed and no warranty of any kind is made with respect thereto.

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APPENDIX A

Approved Gas List where system design and components meet chemical and physical requirements of the gas to prevent corrosion, erosion, system failure and contamination.

Acetylene (C_2H_2)
Ammonia (NH_3)
Ammonia (NH_3)
Argon (Ar)
Arsine (AsH_3)
Boron Trichloride (BCl_3)
Boron Trifluoride (BF_3)
Butene (C_4H_8)
Carbon Dioxide (CO_2)
Carbon Monoxide (CO)
Carbonyl Sulfide (COS)
Chlorine (Cl_2)
Chlorine Trifluoride (ClF_3)
Deuterium (D_2)
Diborane Mixes (up to 10% B_2H_6)
Dichlorosilane (SiH_2Cl_2)
Difluoromethane (CH_2F_2)
Dimethylamine (C_2H_7N)
Disilane (Si_2H_6)
Dueterated Ammonia (ND_3)
Ethane (C_2H_6)
Ethylene (C_2H_4)
Fluorine Mixes (up to 20% F_2)
Fluoromethane (CH_3F)
Germane (GeH_4)
Helium (He)
Hexafluoro-1_3-butadiene (C_4F_6)
Hexafluoroethane (C_2F_6)
Hydrogen (H_2)
Hydrogen Bromide (HBr)
Hydrogen Chloride (HCl)
Hydrogen Fluoride (HF)
Hydrogen mix (H_2 mix)
Hydrogen Selenide (H_2Se)
Hydrogen Sulfide (H_2S)
Krypton (Kr)
Methane (CH_4)
Methylsilane (CH_6Si)
Monochlorosilane (SiH_3Cl)
Neon (Ne)
Nitric Oxide (NO)
Nitrogen (N_2)
Nitrogen Trifluoride (NF_3)
Nitrous Oxide (N_2O)
Octafluorocyclobutane (C_4F_8)

Octafluorocyclopentene (C_5F_8)
Octafluoropropane (C_3F_8)
Octafluorotetrahydrofuran (C_4F_8O)
Oxygen (O_2)
Phosphine (PH_3)
Propane (C_3H_8)
Propylene (C_3H_6)
Silane (SiH_4)
Silicon Tetrachloride ($SiCl_4$)
Silicon Tetrafluoride (SiF_4)
Sulfur Dioxide (SO_2)
Sulfur Hexafluoride (SF_6)
Tetrafluoroethane ($C_2H_2F_4$)
Tetrafluoromethane (CF_4)
Trichlorosilane ($SiHCl_3$)

APPENDIX B

ASME - The American Society of Mechanical Engineers (ASME) is a professional association that, in its own words, "promotes the art, science, and practice of multidisciplinary engineering and allied sciences around the globe" via "continuing education, training and professional development, codes and standards, research, conferences and publications, government relations, and other forms of outreach.

ASTM – American Society for Testing Materials (ASTM International) is an international standards organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services. Some 12,575 ASTM voluntary consensus standards operate globally.

ATEX - The ATEX directive consists of two EU directives describing what equipment and work environment is allowed in an environment with an explosive atmosphere. ATEX derives its name from the French title of the 94/9/EC directive: Appareils destinés à être utilisés en ATmosphères EXplosibles.

CCC - The China Compulsory Certificate mark, commonly known as a CCC Mark, is a compulsory safety mark for many products imported, sold or used in the Chinese market. It was implemented on May 1, 2002 and became fully effective on August 1, 2003. It is the result of the integration of China's two previous compulsory inspection systems, namely "CCIB" (Safety Mark, introduced in 1989 and required for products in 47 product categories) and "CCEE" (also known as "Great Wall" Mark, for electrical commodities in 7 product categories), into a single procedure.

CE - CE marking is a mandatory conformity marking for certain products sold within the European Economic Area (EEA) since 1985. The CE marking is also found on products sold outside the EEA that are manufactured in, or designed to be sold in, the EEA. This makes the CE marking recognizable worldwide even to people who are not familiar with the European Economic Area. It is in that sense similar to the FCC Declaration of Conformity used on certain electronic devices sold in the United States. The CE marking is the manufacturer's declaration that the product meets the requirements of the applicable EC directives.

CSA - CSA International (Canadian Standards Association), a member of the CSA Group, is a provider of product testing and certification services for electrical, mechanical, plumbing, gas and a variety of other products. Recognized in the U.S., Canada and around the world, CSA's marks appear on billions of products worldwide. CSA International certification marks indicate that a product, process or service has been tested to a Canadian or U.S. standard and it meets the requirements of an applicable CSA standard or another recognized document used as a basis for certification.

GHS - GHS stands for the Globally Harmonized System of Classification and Labelling of Chemicals. GHS defines and classifies the hazards of chemical products, and communicates health and safety information on labels and safety data sheets). The goal is that the same set of rules for classifying hazards, and the same format and content for labels and safety data sheets (SDS) will be adopted and used around the world. An international team of hazard communication experts developed GHS.

IFC – International Fire Code - Internationally, code officials recognize the need for a modern, up-to-date fire code addressing conditions hazardous to life and property from fire, explosion, handling or use of hazardous materials and the use and occupancy of buildings and premises. The International Fire Code, in this 2015 edition, is designed to meet these needs through model code regulations that safeguard the public health and safety in all communities, large and small.

This comprehensive fire code establishes minimum regulations for fire prevention and fire protection systems using prescriptive and performance-related provisions. It is founded on broad-based principles that make possible the use of new materials and new system designs. This 2015 edition is fully compatible with the Family of International Codes.

ITRI – Industrial Technology Research Institute in Taiwan (ROC) developed a certification standard for explosion proof enclosures when using flammable gases.

ISO 14001 - The ISO 14001 standard is the most important standard within the ISO 14000 series. ISO 14001 specifies the requirements of an environmental management system (EMS) for small to large organizations. An EMS is a systemic approach to handling environmental issues within an organization.

ISO 9001 - The ISO 9000 family of quality management systems standards is designed to help organizations ensure that they meet the needs of customers and other stakeholders while meeting statutory and regulatory requirements related to a product or program. ISO 9000 deals with the fundamentals of quality management systems, including the eight management principles upon which the family of standards is based. ISO 9001 deals with the requirements that organizations wishing to meet the standard must fulfill. Third-party certification bodies provide independent confirmation that organizations meet the requirements of ISO 9001

KSA – formerly known as Korean Standards Association, is a public organization under South Korea's Ministry of Trade, Industry and Energy (MOTIE). KSA was established in 1962 pursuant to Article 32 of the Industrial Standardization Act.

NEC - A set of standards published by the National Fire Protection Association (NFPA) for the safe installation of electrical wiring and optical fiber and equipment on the premises. The NEC is approved by the American National Standards Institute (ANSI) as ANSI NFPA 70, and its use is commonly mandated by state and local law. The NEC is updated and published every three years.

NFPA - The National Fire Protection Association (NFPA) is a United States trade association, albeit with some international members, that creates and maintains private, copyrighted standards and codes for usage and adoption by local governments. This includes publications from model building codes to the many on equipment utilized by firefighters while engaging in hazardous material (hazmat) response, rescue response, and some firefighting.

NRTL - The United States Occupational Safety and Health Administration (OSHA) requires that 38 different types of products, devices, assemblies, or systems used in the workplace be "approved" (i.e., tested and certified) by third-party organizations called Nationally Recognized Testing Laboratories (NRTLs). "Nationally Recognized Testing Laboratory" (or "NRTL") is a recognition given by OSHA, as part of its NRTL Program, to testing facilities acknowledging that an organization has the necessary qualifications to perform safety testing and certification of specific products covered within its scope to provide product safety testing and certification services to manufacturers for use of select types of products, devices, assemblies, or systems.

OSHA – Occupational Safety and Health Administration, the division of the U.S. Department of Labor that sets and enforces occupational health and safety rules.

REACH – Registration Evaluation Authority Chemical Hazard - REACH is a regulation of the European Union, adopted to improve the protection of human health and the environment from the risks that can be posed by chemicals, while enhancing the competitiveness of the EU chemicals industry. It also promotes alternative methods for the hazard assessment of substances in order to reduce the number of tests on animals.

In principle, REACH applies to all chemical substances; not only those used in industrial processes but also in our day-to-day lives, for example in cleaning products, paints as well as in articles such as clothes, furniture and electrical appliances. Therefore, the regulation has an impact on most companies across the EU.

SEMI S2 Class 1 Div. 2 - Revision to SEMI S2-0706, Environmental, Safety and Health Guideline for Semiconductor Manufacturing Equipment, and SEMI S22-0706, Safety Guideline for the Electrical Design of Semiconductor Manufacturing Equipment SEMI S2-0706d ENVIRONMENTAL, HEALTH, AND SAFETY GUIDELINE FOR SEMICONDUCTOR MANUFACTURING EQUIPMENT. This safety guideline was technically approved by the global Environmental Health and Safety Committee. This edition was approved for publication by the global Audits and Reviews Subcommittee on August 29, 2008. It was available at www.semi.org in October 2008 and on CD-ROM in November 2008. Originally published in 1991; previously published July 2006.

TGO – Toxic Gas Ordnance - The purpose of the Toxic Gas Program is to protect public health and property from the hazardous conditions arising from the use, distribution, handling, and dispensing of toxic gas. Toxic gases are gases with lethal concentrations (LC50 <5,000ppm). There are three different classes Class I, II, III. Class I are the most toxic gases. More controls are required for more toxic gases. HMCD oversees the Toxic Gas Program for facilities located in the cities of Los Altos, Los Altos Hills, Monte Sereno, Morgan Hill, Palo Alto, San Jose, Saratoga, and the unincorporated areas of Santa Clara County (including Moffett Field, San Martin, and Stanford).

UL - UL is an American safety consulting and certification company headquartered in Northbrook, Illinois. It maintains offices in 46 countries. Established in 1894 as the Underwriters' Electrical Bureau (a bureau of the National Board of Fire Underwriters), it was known throughout the 20th century as Underwriters Laboratories and participated in the safety analysis of many of that century's new technologies, most notably the public adoption of electricity and the drafting of safety standards for electrical devices and components. UL provides safety-related certification, validation, testing, inspection, auditing, advising and training services to a wide range of clients, including manufacturers, retailers, policymakers, regulators, service companies, and consumers.

APPENDIX C

FMEA

Also called: potential failure modes and effects analysis; failure modes, effects and criticality analysis (FMECA).

Failure modes and effects analysis (FMEA) is a step-by-step approach for identifying all possible failures in a design, a manufacturing or assembly process, or a product or service.

"Failure modes" means the ways, or modes, in which something might fail. Failures are any errors or defects, especially ones that affect the customer, and can be potential or actual.

"Effects analysis" refers to studying the consequences of those failures.

Failures are prioritized according to how serious their consequences are, how frequently they occur and how easily they can be detected. The purpose of the FMEA is to take actions to eliminate or reduce failures, starting with the highest-priority ones.

Failure modes and effects analysis also documents current knowledge and actions about the risks of failures, for use in continuous improvement. FMEA is used during design to prevent failures. Later it's used for control, before and during ongoing operation of the process. Ideally, FMEA begins during the earliest conceptual stages of design and continues throughout the life of the product or service.

Begun in the 1940s by the U.S. military, FMEA was further developed by the aerospace and automotive industries. Several industries maintain formal FMEA standards.

What follows is an overview and reference. Before undertaking an FMEA process, learn more about standards and specific methods in your organization and industry through other references and training.

When to Use FMEA

- When a process, product or service is being designed or redesigned, after quality function deployment.

- When an existing process, product or service is being applied in a new way.

- Before developing control plans for a new or modified process.

- When improvement goals are planned for an existing process, product or service.

- When analyzing failures of an existing process, product or service.

- Periodically throughout the life of the process, product or service

APPENDIX D

HALT and HASS

- HALT Definition- Highly Accelerated Life Test

- HASS Definition- Highly Accelerated Stress Screen

- HALT & HASS are unique, accelerated product reliability testing methods focused on finding defects in products so they can be fixed before becoming expensive field issues.

- Unique because these procedures are different from traditional design verification testing - different goals, different stresses, different results.

- Accelerated, because these procedures reveal product failure modes in a matter of hours or days, as compared to traditional test methods that can take weeks or even months to find, if at all. Using these procedures is an effective way to improve product reliability and increase your revenue. You can achieve the highest level of customer satisfaction by ensuring your products are free from defects and other quality issues. Versum offers Highly Accelerated Stress Screen and Highly Accelerated Life Testing services to help you maintain a solid reputation.

How They Work

- HALT and HASS, collectively referred to as Accelerated Stress Testing (AST), subject a product to a series of overstresses, effectively forcing product weak links to emerge by accelerating fatigue. Unlike traditional single axis vibration test methods or thermal only methods, an AST program requires specialized HALT/HASS equipment to render the required stresses - random six-degree-of-freedom vibration and rapid thermal change rates - in the combined environment necessary to drive out latent failure modes.

- In these procedures, stresses are applied in a controlled, incremental fashion while the unit under test is continuously monitored for failures. Once the weaknesses of the product are uncovered and corrective actions taken, the limits of the product are clearly understood and the operating margins have been extended as far as possible. Result? A much more mature product can be introduced much more quickly with a higher degree of reliability.

Why are They Important?

Reliability testing is necessary to ensure your products meet the standards and the expectations of consumers. HALT & HASS testing gives you peace of mind knowing that your products look and perform well before they reach the market. It's a good way to earn customers' trust and avoid costly effects of quality and reliability issues.

APPENDIX E

MOC

Management of Change, or MOC, is a best practice used to ensure that safety, health and environmental risks are controlled when a company makes changes in their facilities, designs, components, documentation, personnel, or operations.

Management of Change (MOC) is a systematic way to deal with change within an organization in order to effectively deal with the change and to capitalize on change opportunities. Change management includes adapting to the change, controlling the change and effecting new change. Management of change requires an organization to take a proactive approach to change.

Effective management of change is crucial if an organization is to adapt and thrive. All organizations encounter changes that they are unable to control. Developing a structured methodology to deal with change allows businesses to effectively cope with environmental changes. Changes that are likely to impact an organization may include competitive threats, changes to the economy, workplace regulations and governmental policies. Management of change involves the application of a structured system to provide a competitive advantage, as the marketplace is forced to adapt to the changing environment.