White paper

# Make the Safe Choice

Intermec®

**Understanding safety requirements and computing options for hazardous environments**

You can't take any chances when it comes to worker safety. That doesn't mean you need to give up mobile computers and the accuracy and time saving benefits they provide when workers operate in potentially hazardous environments.

Sealed and safe computers have an increasingly important role in industrial automation. Because of growing safety, security, regulatory and reporting requirements, organizations are implementing more sophisticated systems to monitor and manage a variety of work environments. For example, the safety systems market will grow by approximately 50 percent from 2006 to 2010, according to ARC Advisory Group's Safety & Critical Control Systems Worldwide Outlook. Mobile computers can be important components of these systems because they provide the ability to automatically collect and communicate data from remote and challenging environments.

This white paper will provide clear guidance on equipment safety terminology and regulations, and how they apply to mobile computers so you can determine which devices are approved and appropriate for use in your work environments.

**Key Definitions**
Confusion over regulations and certifications has led some organizations to incorrectly conclude they can't use mobile computers to support maintenance, monitoring, data collection and other activity where combustible gases and liquids are present. Much of the confusion centers on the terms "intrinsically safe (I-safe)" and "non-incendive," which have different meanings. Intrinsically safe and non-incendive mobile computers cannot be used interchangeably. There is also confusion about the regulatory bodies and standards for environmental safety and their various coding and designation systems.

Various regulatory, industry and voluntary organizations set safety requirements for computers and other equipment to be used where flammable liquids, gases and other materials could be present. Depending on the likelihood of combustibles in the environment, requirements generally call for electronic devices to be either non-incendive or intrinsically safe. Within these general categories there are many additional classifications, which vary by the organization that sets the requirements. Specific classifications and the organizations who administer them will be described later. Non-incendive and intrinsically safe designations are not synonymous with ingress protection (IP) or NEMA ratings.

Intrinsically safe and non-incendive standards apply to all equipment that can create one or more of a range of defined potential explosion sources:

- Electrical sparks
- Flames
- Hot surfaces
- Static electricity
- Electromagnetic radiation
- Mechanical impact
- Acoustic energy
- Ionizing radiation

Non incendive designation generally means the device does not generate sparks and is incapable of igniting gases, vapors or liquids under normal operation. Non-incendive devices are not necessarily sealed against gases, vapors or liquids. Underwriters Laboratories defines non-incendive as: "A circuit in which any arc or thermal effect produced under intended operating conditions of the equipment is not capable, under the test conditions specified, of igniting the specified flammable gas- or vapor- air mixture." (From UL1604).

Intrinsically safe indicates a higher level of safety and protection. Devices designated as intrinsically safe will not spark or cause ignition of an explosive environment.

The UL definition for intrinsic safety states: The definition of intrinsic safety used in the relevant IEC apparatus standard IEC 60079-11 is a 'type of protection based on the restriction of electrical energy within apparatus and of interconnecting wiring exposed to the potentially explosive atmosphere to a level below that which can cause ignition by either sparking or heating effects'. This is a concise statement of intent to introduce a multi-faceted subject.

Intrinsically safe devices can be used in non-incendive environments, but the reverse is not true. Therefore intrinsically safe devices not only provide more protection, they provide more flexibility, because they can be used in more places. Intrinsically safe mobile computers are a good choice for future-proofing systems because they can be used in potentially hazardous environments without having to be replaced should conditions change.

Ingress protection (IP) ratings primarily apply to device enclosures and are defined by International Electrotechnical Commission (IEC) standards. IP ratings are measures of how well a device is protected or sealed against water, moisture, dust, powder and other substances, which are designated by various letter and number codes. Ratings are typically expressed by the letters "IP" followed by two numbers. The first number indicates the level the device is protected against particles, and the second digit is the protection against water. For example a mobile computer rated IP54 has level five particle protection, which means dust deposits may form on the unit but will not effect performance, and level four water protection, which means the device can function when splashed or exposed to low-pressure spray. Table 1 shows the IP codes that may be applied to mobile computers:

**Table 1: IP Code Designations**

| 1st digit – particle protection level | | 2nd digit – moisture protection level | |
|---|---|---|---|
| 0 | Not protected | 0 | Not protected |
| 1 | Protected against penetration by objects larger than 50 mm | 1 | Protected against dripping water |
| 2 | Protected against objects greater than 12mm | 2 | Protected against dripping water when tilted up to 15° |
| 3 | Protected against objects greater than 2.5mm | 3 | Protected against spraying water |
| 4 | Protected against objects greater than 1.0m | 4 | Protected against splashing water |
| 5 | Dust protected | 5 | Protected against water jets |
| 6 | Dust tight | 6 | Protected against heavy seas |
| | | 7 | Protected against the effects of immersion |
| | | 8 | Protected against submersion |

**Source: IEC 60529**

**NEMA ratings** also apply to enclosures. NEMA ratings protect devices from exposure, damage, explosions, etc., but do not make devices intrinsically safe or non-incendive because they do not limit the energy output or sparking potential of the device itself. Table 2 provides an overview of NEMA ratings and definitions. NEMA 7, 8, 9 and 10 apply to fixed mount equipment.

**Table 2: NEMA Ratings**

| NEMA Rating | Description |
|---|---|
| 1 | Indoor use primarily to provide a degree of protection against limited amounts of falling dirt. |
| 2 | Indoor use primarily to provide a degree of protection against limited amounts of falling water and dirt. |
| 3 | Outdoor use primarily to provide a degree of protection against rain, sleet,wind blown dust and damage from external ice formation. |
| 3R | Outdoor use primarily to provide a degree of protection against rain, sleet, and damage from external ice formation. |
| 3S | Outdoor use primarily to provide a degree of protection against rain, sleet, windblown dust and to provide for operation of external mechanisms when ice laden. |
| 4 | Indoor or outdoor use primarily to provide a degree of protection against windblown dust and rain, splashing water, hose-directed water and damage from external ice formation. |
| 4X | Indoor or outdoor use primarily to provide a degree of protection against corrosion, windblown dust and rain, splashing water, hose-directed water, and damage from external ice formation. |
| 5 | Indoor use primarily to provide a degree of protection against settling airborne dust, falling dirt, and dripping non-corrosive liquids. |
| 6 | Indoor or outdoor use primarily to provide a degree of protection again hose-directed water, and the entry of water during occasional temporary submersion at a limited depth and damage from external ice formation. |
| 6P | Indoor or outdoor use primarily to provide a degree of protection against hose-directed water, the entry of water during prolonged submersion at a limited depth and damage from external ice formation. |
| 7 | Indoor use in locations classified as Class I, Division 1, Groups A, B, C or D hazardous locations as defined in the National Electric Code (NFPA 70) (Commonly referred to as explosion-proof). |
| 8 | Indoor or outdoor use in locations classified as Class I, Division 2, Groups A, B, C or D hazardous locations as defined in the National Electric Code (NFPA 70) (commonly referred to as oil immersed). |
| 9 | Indoor use in locations classified as Class II, Division 1, Groups E, F and G hazardous locations as defined in the National Electric Code (NFPA 70) (commonly referred to as dust-ignition proof). |
| 10 | Intended to meet the applicable requirements of the Mine Safety and Health Administration (MSHA) |
| 12, 12K | Indoor use primarily to provide a degree of protection against circulating dust, falling dirt, and dripping non-corrosive liquids. |
| 13 | Indoor use primarily to provide a degree of protection against dust, spraying of water, oil, and non-corrosive coolant. |

*Source: NEMA 250

**Standards and Regulations**
Various regulatory and standards bodies cite these intrinsically safe, non-incendive, IP and NEMA rating designations in their regulations. Different protections are required for use in different environments, which themselves are codified and identified with various letter and number codes. There are a multitude of certification organizations - the most commonly required certifications are:

- ATEX (European Atmosphères Explosibles Directives) – which covers Europe:
- UL (Underwriters Laboratories) – required throughout North America, and;
- IECEx (International Electrotechnical Commission) – which is required by various countries throughout the world.

There are many specific ATEX, UL and IECEx regulations, which are often based on the same international standards and have equivalents within other organizations. The following sections identify pertinent regulations and standard bodies and describe their definitions and requirements.

**ATEX**
ATEX is a European Commission (EC) directive that standardizes requirements for electrical devices used in mining and other potentially hazardous environments, which it defines as regions. ATEX regulations are based on standards from the IEC and CENELEC (Comité Européen de Normalisation Electrotechnique). Figure 1 outlines ATEX definitions and requirements for hazardous groups, categories and zones. Groups I and II designate a mining or non-mining environment, respectively. ATEX categories apply to the equipment. Zones apply to the hazardous areas. Figure 1 provides more detail about designation codes and Figure 2 presents ATEX approval marking designations and definitions.

**Figure 1: ATEX Groups, Categories & Zones**

**ATEX Hazardous Region Categories**

| Equipment Group II Non-Mining | Equipment Group I Mining | Dust |
|---|---|---|
| Category I<br>Equipment suitable where explosive atmospheres are present continuously or for lengthy periods | Zone 0: A place in which an explosive atmosphere consisting of a mixture of air and flammable substances (gas, vapor, or mist) is present continuously or for long periods or frequently. | Zone 20 (Dust): A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is present continuously, or for long periods or frequently. |
| Category II<br>Equipment suitable where explosive atmospheres are likely to occur | Zone 1: A place in which an explosive atmosphere consisting of a mixture of air and flammable substances is likely to occur occasionally in normal operation. | Zone 20 (Dust): A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is likely to occur occasionally in normal operation. |
| Category III<br>Equipment suitable where explosive atmospheres are likely to occur infrequently and be of short duration | Zone 2: A place in which an explosive atmosphere consisting of a mixture of air and flammable substances is not likely to occur in normal operation but, if it does occur, will persist for a short period only. | Zone 22 (Dust): A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is not likely to occur in normal operation but, if it does occur, will persist for a short period only. |

| Group II - Gasses | | |
|---|---|---|
| Group IIC (acetylene & hydrogen) | Group IIB (ethylene) | Group IIA (propane) |

| Temperature Class | | | | | |
|---|---|---|---|---|---|
| T1 | T2 | T3 | T4 | T5 | T6 |
| 450° C | 300° C | 200° C | 135° C | 100° C | 85° C |

**Figure 2 ATEX Definitions**

| | | |
|---|---|---|
| **Approval Marking** | | **The ATEX examination mark. This sign is required on all devices used in European hazardous areas.** |
| Classification of Zones | II 1 G<br>II 3 G<br>I M 1 | The classification of zones. For the first certification "string" "II" designates the equipment is approved for all non-mining areas, (Group "I" is for mining areas) "0" represents the CENELEC Group of the device. In this case the device is rated for the most hazardous or Zone 0 areas, "G" designates the nature of the hazard. In this case gas, vapors, and mist. The second certification string designates that the unit is approved for use in similar application as the first string but the 3 indicates it is for use in Zone 2 rated areas. The third string "I" and "MI" designates that the device is suitable for use in mining applications subject to fire damp (methane gas). |
| Regulation | Ex | Explosion protection based on the CENELEC European ex-regulations. |
| Type of Protection | ia<br>nL | The type of protection from explosion. In the first instance the protection method is intristic safety using two fault analysis, which qualified the device for use in Zone 0 applications. In the second instance the protection method is type "n" and specifically non-sparking. |
| Explosion Groups | IIB<br>I<br>IIC | Non-mining equipment, gas group. "IB" are rated safe for areas where gas groups IIB or IIA are present. "I" are rated safe for mining applications subject to fire damp. "IIC" are rated safe for areas where gas groups IIC, IIB or IIA are present. |
| Temperature Class | T4 | Temperature class gives the user the maximum temperature of a surface that may be in contact to the Ex-atmosphere. T4 is rated 135°C. |

**North American Systems**

Several organizations in North America write their standards to meet the requirements of the National Electrical Code (NEC) and the Commission for Environmental Cooperation (CEC). The NEC for the U.S. and the CEC for Canada are the overriding bodies that dictate the requirements for potentially hazardous environments in North America. These organizations include:

- UL (Underwriters Laboratories) - required throughout North America
- FM - Factory Mutal
- NFPA - National Fire Protection Association
- ISA - International Society for Measurement and Control

One of the most highly respected of the certifications is UL. UL designations and certifications are the basis of many North American regulations, including the National Fire Protection Association (NFPA) standard. UL can certify products in the U.S. and Canada.

The traditional hazardous location scheme consists of a system of divisions, classes and groups, as shown in Figure 3. The divisions indicate the level of potential hazard. Division 1 indicates the hazard could constantly be present and Division 2 indicates that the hazard is only rarely present. Products that are rated for use in Division 1 locations are referred to as I-safe. Products qualified as I-safe are also suitable for use in Division 2 locations. Products which have a lesser degree of protection, but which are rated for use in Division 2 locations, are referred to as non-incendive. This level protection is much easier to achieve because the relative risks are much less. Products rated as non-incendive are not suitable for use in Division 1 locations, which require intrinsically safe products.

**Figure 3 – North American Hazardous Region Categories**

| North America Hazardous Region Categories | | | | | | | |
|---|---|---|---|---|---|---|---|
| Division 1: Hazard expected to always be present. Requires I-Safe equipment. | | | | | | | |
| Division 2: Hazard not expected to be present, except as a result of a malfunction. I-Safe or NI equipment can be used. | | | | | | | |
| | Class 1 Gasses | | | Class 2 Dust | | | Class III Fibers |
| Group A (Acetylene) | Group B Hydrogen, Butadlene, Ethylene Oxide, Propylene Oxide, Acrolein, or similar | Group C Ethyl Ether, Ethylene, Carbon Monoxide, Nitromethane, or similar | Group D Acetone, Ammonia, Butane, Ethanol, Methane, Natural Gas, Propane, Gasoline or similar | Group E Metal dust (Aluminum, Magnesium, or similar) | Group F Carbonaousous dust (Carbon Black, Charcol, Coal, or similar) | Group G Other dusts (corn, skimmed milk, wheat flour, sorbic acid, sulfur, aspirin, vitamin B1, vitamin C, plastic resin, or | |
| Temperature Classes (similar to ATEX, but with subgroups for classes T2, T3 & T4) | | | | | | | |
| Type of protection | | | | | | | |
| N.I. Non-incendive apparatus, Internal energy is limited so a spark will not be generated by its use | | | | I.S. Intrinsically Safe apparatus, will not spark or cause ignition of an explosive environment. | | | |

Classes identify the nature of the hazard. Class I refers to flammable gases and vapors, Class II are combustible dusts, Class III refers to ignitable fibers and similar substances that are mostly associated with the textile industry.

Groups subdivide Classes I and II. Class I consists of Groups A, B, C & D. Groups A and B represent the most significant hazards. Class II consists of Groups E, F & G (Group E does not exist as a Division 2 location).

The reference to North America may be a bit misleading because the Canadian requirements do have some minor differences that mandate approvals to both the U.S. and Canadian requirements. The IEC or CENELEC system is more conservative than that used in North America, so a product qualified to one set of requirements is not necessarily compliant with their international counterparts.

Most existing North American hazardous environments are classified using the Division system because it is currently the primary system. The international Zone system is an emerging standard. Groupings under the Zone system are exactly the same as under the ATEX rules - mining applications are not covered under this system. Products classified only to the Zone system in North America would find very limited market acceptance. In excess of 95% of existing sites are classified using the Division system.

**IECex**

The ultimate intent of the IECex standard is for there to beone certification for worldwide use of equipment in hazardous locations. Currently a few countries will accept the IECex report and certificate as a legal passport for sale of product - most notably Australia, New Zealand and Singapore. There are many member countries of the IECex scheme, but most of them require national certifications that are based on an IECex report.

**Specifying the Right Products**

The various letter and number codes, plus zone, region, class and category descriptions can be confusing and make it difficult for organizations to determine which ratings, approvals and certifications they need. It is important to first consult your company's safety engineer to identify specific hazards that are present in your operation so you can be ensured you are evaluating products that can meet all your needs, on a global basis.

There are a couple guiding principles that can be followed when making a product selection. First, remember that intrinsically safe is the highest level of certification, so intrinsically safe devices can be used in environments where others (including non-incendive) can't. Intrinsically safe devices are the only option for Zone 0 operations – where ignitable concentrations of flammable gases, liquids or vapors are always present.

Intrinsically safe computers are always the safe choice, and are also often financially practical. When it is difficult to determine what classification your operating conditions fall under, or if conditions could change, intrinsically safe computers can provide peace of mind. They can also provide investment protection. Mobile computers can't be upgraded or retrofit to a higher safety certification if needs change. This can be an overlooked aspect during equipment evaluation because mobile computer users are used to being able to conveniently upgrade their application

software, data collection peripherals, wireless connectivity, security and even mobile operating systems. If working conditions change and higher safety standards are required, mobile computers will need to be replaced. Consider changes in processes when evaluating products for today and in the future.

Sealed, rugged mobile computers also protect against common forms of failure and damage resulting from drops, spills and scratches. There is a strong, inverse correlation between device ruggedness and total cost of ownership. Investing in higher-grade equipment typically results in few devices that need to be repaired and replaced, reduced support time and costs, lower out-of-warranty expenses, and most significantly, less lost productivity in the field.

Use the tables and descriptions from this white paper and additional information from Underwriters Laboratories (www.ul.com), the IEC (www.iec.ch) and the European Commission (http://ec.europa.eu/enterprise/atex/index_en.htm) to assess your requirements.

Intermec has a complete range of intrinsically safe and non-incendive mobile and wireless computers certified for use around the world in a variety of environments. Intermec's rugged and durable computers offer a variety of integrated data collection and communication options so organizations don't need to investigate, specify, purchase and maintain separate devices for image capture, bar code reading, RFID, and speech input. Integrated, safety-certified 802.11b/g and Bluetooth wireless communication capability eliminates the need for cables and connectors while providing real-time communication. Intermec products are built for use in rugged and potentially hazardous environments using components and housings designed to minimize heat and emissions and withstand shock, vibration and exposure.

Intermec Inc. (NYSE:IN) develops, manufactures and integrates technologies that identify, track and manage supply chain assets. Intermec's other core technologies include RFID, mobile computing and data collection systems, bar code printers and label media. The company's products and services are used by customers in many industries worldwide to improve the productivity, quality and responsiveness of business operations. For more information about Intermec, visit www.intermec.com or call 800-347-2636. Contact Intermec Investor Relations Director Kevin McCarty at kevin.mccarty@intermec.com, 425-265-2472.

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