

WHAT IS A RUGGED HMI?



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INTRODUCTION

The variety of human machine interfaces (HMIs) or operator interface terminals (OITs) in the market that claim “rugged” makes it hard to see what rugged really means. A myriad of ratings, standards and laws are referenced, but what do they entail?



Rugged implies something tough and durable; strongly built and designed to operate in harsh conditions. Truly rugged HMIs are designed, tested and certified to operate in wet, dusty, hot, cold, high vibration, and/or hazardous environments.

The purpose of rugged ratings, standards and laws is to ensure that the equipment will:

- Operate properly for extended periods of time; i.e., years, in the environments they are deployed into
- Not be the source of any safety related incident

In industry, what might be considered rugged to some, may not be to others. The national and international ratings, standards and laws that define rugged electronics, computing, and operating equipment vary and include different aspects, depending on particular operating conditions and country.

This paper will explore the qualifications of what “rugged” specifically means for HMIs in industrial plants and facilities.

NEED FOR “RUGGED”

Not one thing or characteristic makes electrical, network or computing systems rugged. While some may consider certain qualifications, features and capabilities more important than others, to be a ruggedly reliable, the electronics must be designed to meeting critical evaluation criteria, tests and approvals. Most electronics deployed in the world are not rugged to the core.

Equipment that may work fine in a clean, climate-controlled environment may fail quickly in a dirty, outdoor environment. Engineers must specify the components, equipment and computer based on the environments they need to operate into. HMIs are included in this specification process.

An HMI is a touch panel display that is integrated into a machine or computer system that communicates the

operator's desire to manage and control the machine. All HMIs are designed and manufactured based on the environments they will be deployed into. Consider the following classes of HMIs in order of ruggedness:

- Standard HMIs
 - Used for light duty, indoor factory or plant operations.
 - Designed for indoor environments; e.g., dry and moderate (0-50° C) operating temperatures.
 - The most widely deployed HMIs throughout the world.
 - Require basic certifications for emissions, susceptibility, safety, conformity such as CE marking.

Rugged HMI

- Engineered to withstand challenging and abusive environments.
- Does not require supplemental heating or cooling.
- Most often deployed in high-vibration, extreme temperatures, direct sun and/or wash-down environments.
- Often require
 - IP 66, NEMA-4, UL 50E Type 4 outdoor ratings (or higher)
 - NEC/CEC Class I Division 2
 - ATEX Zone 2
 - IECEx Zone 2 certifications
 - ABS, DNV, GL and/or LR certification for marine/maritime deployments.

- Extremely Rugged HMI

- Designed for environments where flammable gases or vapors are expected.
- Often require additional heating and cooling equipment for proper operation.
- Expensive and limited to certain industries and environments requiring extreme protection.
- Often require UL Class I Division 1, ATEX Zone 0/Zone 1, IECEx Zone 0/Zone 1 certifications.

The selection process is streamlined by understanding where a product will be used. The more harsh the deployment environment, the more rugged the components and



technology must be. The HMI must be proven to the extremes.

Rugged deployment scenarios are less common than non-rugged ones. Cost scalability is not as great for rugged HMIs. Components used to build rugged HMIs have a higher cost than standard HMIs. As a general rule, the more rugged an HMI the more expensive it is.

INDUSTRIES

Some industries require much of its electronics and computing equipment to meet certain rugged characteristics. These electronics including HMIs are often deployed outdoors, in direct sun, into hazardous and explosive situations, as well as dusty, wet, and/or corrosive settings. The most common industries that require electronics and HMIs for harsh environmental deployment include:

- Oil and Gas (drilling, refining, processing, distribution)
- Water and Wastewater
- Paper and Pulp
- Chemical
- Maritime and Off-Shore
- Mining
- Agriculture (storage, processing, refining)
- Textiles
- Transportation
- Power Generation & Distribution (coal, biomass, hydro, wind, solar)



Manufacturers that produce HMIs that will be deployed in these environments are aware of the special requirements demanded by these industries. The HMIs that are deployed in these rugged industries are positioned to operate without incident for years. If an HMI that is not designed for the conditions it is installed into, it is likely to fail prematurely.

PRODUCT DESIGN AND TESTING

There is an engineering core competency that comes with designing, producing and testing HMIs for rugged environments. Few HMI manufacturers have this expertise. Most manufacturers design HMIs for non-rugged deployments. They do so because that is the largest HMI market. It is very common for these manufacturers to source components from spec sheets and do no verification that parts actually meet those specs. For example, a range of

components that go into an HMI may claim 0°-50° C operating temperature but without verification (placed in temperature chambers for extended periods of time), there is no assurance that those temperatures are accurate. The HMI could fail in a production environment where the temperatures push up against those minimums and maximums.

Companies that design HMIs for rugged deployments go to extremes in sourcing components – the circuit board and CPU, memory and storage, connectors, resistors, display, touch screen, and enclosure. This helps ensure the collective product will meet the deployment characteristics and the rugged testing and certification requirements.

Engineers building rugged HMIs will verify the specifications claimed by the manufacturer of the components and will continue this throughout the development process. It is a recipe for failure to wait until the product is “complete” before testing the HMI for rugged compliance. It must be core to the development process. It should support the adage “test early, test often.”

Rugged HMIs will take the abuse that standard HMIs cannot, while still functioning properly, reliably and efficiently. While there are some indoor environments that demand rugged HMIs (dusty, high vibration, wet), it is the outdoor environment that is the key driver for ruggedness. Outdoor deployments dictate the need for unique features, capabilities and enduring qualities not found in off-the-shelf terminals. The following addresses the important design and testing areas of rugged HMIs.

Temperature

The most common issue and qualifier are extended operating and storage temperature ranges. Over half the applications that call for a rugged HMI demand a solution capable of performing while exposed to extreme heat and/or extreme cold temperatures.

In the oil fields of the Middle East and Gulf of Mexico and the mines of South America and Africa, the temperatures regularly reach 50° C and higher, especially in direct sun. In Canada, Scandinavia and Russia, energy and mining operations have extended periods of -30° C or colder,

especially during dark winter nights. These environmental conditions will stress the most rugged HMIs. Standard HMIs may be adequate for most factory or indoor environments, but will fail quickly in extreme hot or cold environments. Rugged HMIs are designed to handle both temperature extremes and thermal shock over long periods of time.

	Typical Operating Range	Typical Storage Range
Standard HMIs	0° to +50° C (32° to +122° F)	-20° to +70° C (-4° to +158° F)
Rugged HMIs	-30° to +70° C (-22° to +158° F)	-40° to + 85° C (-40° to +185° F)

Storage temperatures define the range where the HMI can exist when the temperature moderates to the specified operating temperature, the HMI will operate properly. If stored beyond the specified ranges, there is no assurance the HMI will operate when the temperature reaches the specified operating ranges. For example, extreme cold may ruin the HMI's LCD display. The storage and operating temperatures are those the manufacturer is comfortable claiming. Many HMIs will tolerate temperatures beyond those specified.

Thermal shock describes how equipment handles quick temperature changes. An HMI might be required to operate in hot, direct sun in late afternoon, then when the sun goes down the temperature drops severely – a 35° C change in 2-4 hours. Rugged HMIs are designed to handle this change.

Moisture, Rain & Snow

As with all electronics, moisture is a serious and often fatal issue. The slightest amount of moisture can ruin electrical components, shortening the life of the device or making it fail entirely. Protection against rain, sleet and snow require the housing and mounting to be designed to withstand water ingress.

Electronics, including HMIs have none, some or complete protection against harmful water ingress. Understanding where an HMI will be installed and used will determine how much protection should be designed into the unit. What volume and application of water is likely – dripping water, splashing water, water jets, high-powered water jets, hot water jets, or immersion? Does the HMI require water protection on the front and rear or just the front? Most HMIs are mounted in control panels and usually only require extensive water protection on the front.

Dust and Particles

Dust causes harm and reliability issues for electronics. Excess dust can clog air flow, short circuits, cause overheating and scratch the touch panel. Dust impacts performance, reliability and longevity of the HMI.

Mines, granaries, mills, certain food processing plants (candy, spice, sugar), coal plants, and paper plants can produce dust in the concentrations that under certain conditions can become explosive. The HMI must not be the source of a spark that could ignite the pulverized material. Rugged HMIs should be able to deal with dust from an operational perspective.

Vibration

Mechanical vibration is a common issue with industrial machinery and equipment. For HMIs, the vibration of the machinery and equipment it is installed on can cause a host of problems. Vibration can damage internal components by causing wires to chafe; large components on PC boards are susceptible to break off; and connectors, pins and mounting posts can shake loose and cause intermittent connections. Vibration will reduce the life of the operator interface terminal if not addressed in the hardware design stage.

Mechanical vibration can also create problems for the seals of the HMI unit. If seals are compromised from vibration, dust, rain or moisture may seep into the housing and damage components.

Terminal Type	Vibration Testing
Standard HMI	None to 2 G
Rugged HMIs	4 G

Vibration testing is the process of applying a controlled amount of vibration to an HMI, usually with some type of shaker table or actuator. Vibration testing is performed to examine the response of a device under test to a defined vibration environment. The measured response may be fatigue life, resonant frequencies or squeaking sounds.

Standard HMIs undergo none or minimal vibration testing. Rugged HMI panels are tested with various methods which may include swept-sine and random testing (acceleration or power spectral density testing).

Shock

Shock occurs when an HMI is mechanically dropped, hit or struck. Depending on the scope of the shock, an HMI's display can be broken; the touch panel partially or completely

rendered inoperable; electronics broken or loosened; or the integrity of the sealing compromised. Rugged HMIs are designed to withstand reasonable shock given the targeted operating environments.

Shock testing attempts to replicate what might happen in actual installations where an HMI is physically impacted. Shock designs and tests are there to ensure an HMI will continue operating after infrequent and non-repetitive impacts. These occur during transportation, operation and service.

Rugged shock tests; e.g., MIL-STD-810G, examine the impact on the HMI's electronics, the display, the touch screen in a variety of scenarios and conditions:

- Material failure as a result of increased or decreased friction between parts
- Changes in material strength, loss of insulation resistance, variations in magnetic and electrostatic field strength
- Electronic circuit card malfunction, electronic circuit card damage, and electronic connector failure
- Mechanical deformation of the material as a result of overstress of structural and non-structural members
- Collapse of mechanical elements of the material as a result of the ultimate strength of the component being exceeded
- Accelerated fatiguing of materials
- Material failure as a result of cracks in fracturing crystals, ceramics, epoxies, or glass envelopes

These provide excellent guidelines for HMI designers and testers.



Sunlight

In outdoor applications, sunlight presents a few issues for HMIs. The first issue is simply read-ability or view-ability of the display. Typically, standard HMI displays are designed for indoor applications. Those same displays used outdoors will be difficult if not impossible to read in direct sun. Rugged HMI backlights are sufficiently bright to enable the HMI to be read in direct sunlight. A standard HMI has a screen brightness of 300-500 cd/m²; a rugged HMI display that will be deployed in direct sun environments requires a backlight of 1,000 cd/m² or greater.

Direct sun on an HMI introduces additional heat. The ambient temperature may be fine for human operation but direct sun may increase the temperature of the HMI significantly. This is an important reason rugged HMIs are designed to operate in the 60°-70° C range.

Direct sun introduces the damaging effects of ultraviolet (UV) rays. If left unprotected, UV rays cause a yellowing and degradation of the touch screen. Unprotected HMIs can be rendered useless in a matter of months in direct sun deployments. Rugged HMI touch screens and displays often include a special UV coating to reduce the effects of these harmful rays.

Power Source Issues

Outdoor environments often have volatile power sources which are dangerous to electronic devices and equipment. If the power isn't clean or conditioned, power line transients such as load dumps, reverse polarity and spikes can cause electrical havoc for standard HMIs. Rugged HMIs are designed to operate with unreliable, inconsistent or "dirty" power conditions.



Whereas 24 volts DC may be the specified input power for the standard HMI, rugged HMIs are designed to handle broader voltage fluctuations. Rugged HMIs will frequently provide input power ranging from 10 to 32 volts (DC). Also, many rugged HMIs support 12 volt power input in addition to 24 volts. Twelve volt power supplies are required in or on transportation equipment or associated with solar charging stations.

Electromagnetic Compatibility

Electromagnetic compatibility (EMC) is the understanding of interference between electrical equipment including HMIs due to electromagnetic disturbances generated and received by the equipment. HMIs must be immune from a certain level of electromagnetic interference (EMI) in order to operate properly. They also must not emit electromagnetic disturbance that will impact the operation of nearby electrical equipment. There are mandatory immunity and emissions standards which HMIs must comply. Products are EMC verified either by the manufacturers where self-declaration is allowed or certified by independent laboratories.

Rugged HMIs are often designed to broader EMC specifications than standard HMIs. For example, rugged HMIs will withstand a higher electrostatic discharge (ESD). This helps minimize problems of ungrounded personnel coming in contact with the HMI, important in hazardous locations. Rugged HMIs will also be designed (or hardened) to tolerate higher radiation emissions from adjacent machinery or sources. Rugged HMIs will have low electromagnetic susceptibility and high immunity.

CERTIFICATIONS

Certifications are extremely important on most rugged-type applications. By definition, a certification is confirmation usually provided by some form of external review, assessment or audit. In the industrial manufacturing segment, certifications specify and dictate electrical, mechanical, emissions, environmental, safety requirements and conditions for acceptable installation and usage. Typically, certifications are specific to industries, individual countries and/or established global standards where the products will be installed and operated. Certifications are often the result of legislation mandated and passed by countries as electrical safety laws and regulations. Governing bodies and testing agencies on a regional and international level establish guidelines and standards for manufacturers to follow for

manufacturing, testing and approval. This section explores many of the certifications or standards rugged HMIs are designed to meet.

Level	Object size protected against...	Effective Against
1	>50 mm	Any large surface of the body, such as the back of a hand, but no protection against deliberate contact with a body part
2	>12.5 mm	Fingers or similar objects
3	>2.5 mm	Tools, thick wires, etc.
4	>1 mm	Wires, screws, etc.
5	Dust protected	Ingress of dust is not entirely prevented, but it must not enter in sufficient quantity to interfere with the satisfactory operation of the equipment; complete protection against contact (dust proof)
6	Dust tight	No ingress of dust; complete protection against contact (dust tight)

Solid Particles (IP“x”y)

water

IP Code

IP Code International Protection Marking classifies and rates the degree of protection provided by a device. The IP Code originates from the *IEC 60529 – Degrees of Protection Provided by Enclosures* standard. The rating uses two numbers to represent the protection of mechanical casings and electrical equipment against i) solid particles (such as fingers, dirt, sand and dust) and ii) liquid. It is represented by the “IP $\underline{x}\underline{y}$ ” format where:

- the first digit “ \underline{x} ” represents the degree of protection against solid particles
- the second number “ \underline{y} ” represents the degree of protection against liquids, namely

Level	Protected against...	Testing for...	Details
0	No protected	-	-
1	Dripping water	Dripping water (vertically falling drops) shall have no harmful effect	Test duration: 10 minutes Water equivalent to 1 mm rainfall per minute
2	Dripping water when tilted up to 15°	Vertically dripping water shall have no harmful effect when the enclosure is tilted at an angle up to 15° from its normal position.	Test duration: 10 minutes Water equivalent to 3 mm rainfall per minute
3	Spraying water	Water falling as a spray at any angle up to 60° from the vertical shall have no harmful effect.	Test duration: 5 minutes Water volume: 0.7 litres per min. Pressure: 80–100 kPa
4	Splashing of water	Water splashing against the enclosure from any direction shall have no harmful effect.	Test duration: 5 minutes Water volume: 10 litres per minute Pressure: 80–100 kPa
5	Water jets	Water projected by a nozzle (6.3 mm) against enclosure from any direction shall have no harmful effects.	Test duration: at least 15 minutes Water volume: 12.5 litres per min. Pressure: 30 kPa at distance of 3 m
6	Powerful water jets	Water projected in powerful jets (12.5 mm nozzle) against the enclosure from any direction shall have no harmful effects.	Test duration: at least 3 minutes Water volume: 100 litres per minute Pressure: 100 kPa at distance of 3 m
6K	Powerful water jets with increased pressure	Water projected in powerful jets (12.5 mm nozzle) against the enclosure from any direction, under elevated pressure, shall have no harmful effects.	Test duration: at least 3 minutes Water volume: 75 litres per minute Pressure: 1000 kPa at distance of 3 m
7	Immersion up to 1 m	Ingress of water in harmful quantity shall not be possible when the enclosure is immersed in water under defined conditions of pressure and time (up to 1 m of submersion).	Test duration: 30 minutes Immersion at depth of at most 1 m measured at bottom of device, and at least 15 cm measured at top of device
8	Immersion beyond 1 m	The equipment is suitable for continuous immersion in water under conditions which shall be specified by the manufacturer. Normally, this will mean that the equipment is hermetically sealed. However, with certain types of equipment, it can mean that water can enter but only in such a manner that it produces no harmful effects. Test duration: continuous immersion in water.	Depth specified by manufacturer, generally up to 3 m
9k	Powerful high temperature water jets	Protected against close-range high pressure, high temperature spray downs.	-

Liquid (IPX“y”)

There is no IP Code certification agency. Some HMI manufacturers claim compliant without actually doing any testing. They may state that the product was designed to comply. Other manufacturers will design and test to specific IP Code testing details. Rugged HMIs will have an IP rating of IP66 or higher. Standard HMIs are rated at IP65 or lower.

NEMA

National Electrical Manufacturers Association (NEMA) creates standards and application guides related to a product, process, or procedure commercially standardized and subject to repetitive manufacture. The scope of NEMA's product coverage include industrial automation, lighting, electronics, security, building systems, insulation, power equipment, and medical equipment. The standards applicable to HMIs are found in the enclosure area of the standards. *NEMA 250 Enclosure for Electrical Equipment* enclosure type definitions

NEMA Type	Definition
1	General-purpose. Protects against dust, light, and indirect splashing but is not dust-tight; primarily prevents contact with live parts; used indoors and under normal atmospheric conditions.
2	Drip-tight. Similar to Type 1 but with addition of drip shields; used where condensation may be severe (as in cooling and laundry rooms).
3, 3S, 3X	Weather-resistant. Protects against weather hazards such as rain and sleet; used outdoors on ship docks, in construction work, and in tunnels and subways. 3X includes corrosions.
3R	Intended for outdoor use. Provides a degree of protection against falling rain and ice formation. Meets rod entry, rain, external icing, and rust-resistance design tests.
4 and 4X	Watertight (weatherproof). Must exclude at least 65 GPM of water from 1-in. nozzle delivered from a distance not less than 10 ft for 5 min. Used outdoors on ship docks, in dairies, and in breweries. The 4X model has corrosion resistance.
5	Dust-tight. Provided with gaskets or equivalent to exclude dust; used in steel mills and cement plants.
6 and 6P	Submersible. Design depends on specified conditions of pressure and time; submersible in water or oil; used in quarries, mines, and manholes.
7	Hazardous. For indoor use in Class I, Groups A, B, C, and D environments as defined in the NEC*.
8	Hazardous. For indoor and outdoor use in locations classified as Class I, Groups A, B, C, and D as defined in the NEC.
9	Hazardous. For indoor and outdoor use in locations classified as Class II, Groups E, F, or G as defined in the NEC.
10	MSHA. Meets the requirements of the Mine Safety and Health Administration, 30 CFR Part 18 (1978).
11	General-purpose. Protects against the corrosive effects of liquids and gases. Meets drip and corrosion-resistance tests.
12 and 12K	General-purpose. Intended for indoor use, provides some protection against dust, falling dirt, and dripping noncorrosive liquids. Meets drip, dust, and rust resistance tests.
13	General-purpose. Primarily used to provide protection against dust, spraying of water and noncorrosive coolants. Meets oil exclusion and rust resistance design tests.

* See NEC described in the National Electrical Code section



provide architects, engineers, installers and inspectors an understanding of the degree of protection required by electrical equipment enclosures for the industrial environments they will be installed. The installation areas include both hazardous and non-hazardous locations. For example, an enclosure might be rated to provide protection against environmental hazards such as water, dust, oil, coolant or atmospheres containing corrosive agents such as acetylene or gasoline. The types and definitions are provided in the table.

NEMA is not a testing agency. It does not provide testing type labels. It is not affiliated with any testing laboratories. NEMA testing and type claims are the responsibility of each manufacturer. Some may state that the product was designed to comply without actually testing. Other manufacturers will design and test to specific NEMA types. Some will test in-house; others will use third-party testing labs. Rugged HMIs will have a NEMA rating of 4 or 4X. Though not exact, for comparison purposes, IP66 and NEMA 4 are similar.

UL has a NEMA-like similar set of standards. UL 50E standard applies to enclosures for electrical equipment intended to be installed and used in non-hazardous locations in accordance the Canadian Electrical Code, Part I, CSA C22.1, the provisions of the National Electrical Code, NFPA 70, and the provisions of Mexico's Electrical Installations, NOM-001-SEDE. The UL 50E Types parallel the non-hazardous NEMA Types as follows:

- Enclosures for indoor locations, Types 1, 2, 5, 12, 12K, and 13
- Enclosures for indoor or outdoor locations, Types 3, 3R, 3S, 4, 4X, 6, and 6P

Rugged HMIs typically have a UL 50E Type 4 or 4X outdoor approval.

Hazardous Areas

A hazardous location is an area where flammable liquids, gases or vapors, or combustible dusts exist in sufficient quantities to produce an explosion or fire. In addition to the potential of damaging equipment and facilities, hazardous areas put employees at risk. In order for equipment to be deployed into hazardous areas, they must pass specific certifications. These certifications come from various government bodies including the National Electrical Code (NEC) in the USA, Canadian

Electrical Code, ATEX in Europe, and IECEx from a global perspective.

Hazardous areas and locations certification testing and approval pose an enormous investment, human resource effort and expense on behalf of the HMI manufacturers seeking these standards, ratings and marks of approval. Only HMI manufacturing companies dedicated to the industries requiring the most rugged HMIs will make the effort to design, test and certify for these approvals.

Depending on the hazardous areas and locations, certain Class/Division and Zone certifications need to be met in order to be specified for use in these industries. While some applications require Zone 0 or 1 testing, these are highly specialized segments. The majority of applications for rugged HMIs in hazardous areas at plants and industrial facilities demand Class 1/Division 2 for North America, ATEX Zone 2 for Europe and IECEx Zone 2 for the remainder of the world. The next sections will examine these certifications.

National Electrical Code (USA) and Canadian Electrical Code (Hazardous/Classified Locations)

The USA National Electrical Code (NEC) and Canadian Electrical Code (CEC) define hazardous locations as those areas where fire or explosion hazards may exist due to flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings.

The targeted deployment location will determine the HMI design and mandatory certification testing. If an HMI is to be deployed in an oil refinery, it must meet Class I requirements; if into a grain elevator, it must meet Class II requirements; if into a textile mill, it must meet Class III requirements. The table summarizes the classes, locations, groups and divisions of hazardous locations applicable in North America.

Summary of Class I, II, III Hazardous Locations*				
Classes	Typical Locations	Groups	Division	
			1	2
I - Gases, vapors and liquids	<ul style="list-style-type: none"> Petroleum refineries, gasoline storage and dispensing areas Dry cleaning plants where vapors from cleaning fluids can be present Spray finishing areas Aircraft hangars and fuel servicing areas Utility gas plants and operations involving storage and handling of liquefied petroleum gas or natural gas 	A: Acetylene B: Hydrogen, etc. C: Ether, etc. D: Hydrocarbons, fuels, solvents, etc.	Normally explosive and hazardous	Not normally present in an explosive concentration (but may accidentally exist)
II - Dusts	<ul style="list-style-type: none"> Grain elevators Flour and feed mills Plants that manufacture, use or store magnesium or aluminum powders Producers of plastics, medicines and fireworks Producers of starch or candies Spice-grinding plants, sugar plants and cocoa plants Coal preparation plants and other carbon handling or processing areas 	E: Metal dusts (conductive and explosive) F: Carbon dusts (some are conductive and all are explosive) G: Flour, starch, grain, combustible plastic or chemical dust (explosive)	Ignitable quantities of dust normally are or may be in suspension, or conductive dust may be present	Dust not normally suspended in an ignitable concentration (but may accidentally exist). Dust layers are present.
III - Fibers and flyings	<ul style="list-style-type: none"> Textile mills, cotton gins Cotton seed mills, flax processing plants Plants that shape, pulverize or cut wood and create sawdust or flyings 	Textiles, wood-working, etc. (easily ignitable, but not likely to be explosive)	Handled or used in manufacturing	Stored or handled in storage (exclusive of manufacturing)

*Source: United States Department of Labor, Occupational Safety & Health Administration (www.osha.gov)

Few manufacturers build HMIs for all hazardous classes. Most focus on specific industries and deployment scenarios. Most HMIs that will be installed in hazardous locations meet Class I Division 2. Opportunities for Class I Division 1 exist, are limited and the products very expensive, 4-6 times higher than Class I Division 2 products. Opportunities for Class II and Class III products also exist but are also limited.

ATEX (Hazardous/Classified Locations)

ATEX is the European Union's Directive 94/9/EC on equipment and protective systems intended for use in potentially explosive atmospheres. It provides the technical requirements to be applied and the relevant conformity assessment procedures before installing equipment in



European member states. ATEX derives its name from a

Zone Classification		
European and IEC* Classification	Definition of Zone or Division	North American Classification
Gases		
Zone 0	An area in which an explosive mixture is continuously present or present for long periods	Class I Division 1
Zone 1	An area in which an explosive mixture is likely to occur in normal operation	Class I Division 1
Zone 2	An area in which an explosive mixture is not likely to occur in normal operation and if it occurs it will exist only for a short time.	Class I Division 2
Dusts		
Zone 20	An area in which an explosive mixture is continuously present or present for long periods	Class II Division 1
Zone 21	An area in which an explosive mixture is likely to occur in normal operation	Class II Division 1
Zone 22	An area in which an explosive mixture is not likely to occur in normal operation and if it occurs it will exist only for a short time.	Class II Division 2

similar French directive that includes the words ATmosphères EXplosibles. The objective of ATEX is to simplify the movement of goods that will be used in potentially explosive atmospheres throughout the EU according to a standard accepted by all members. The ATEX zone classification is presented in the table.

Most HMIs carry a hazardous rating of ATEX Zone 2. The business opportunities for

*See IECEx section

others zones exist but have less economic potential for manufacturers.

IECEx (Hazardous/Classified Locations)

The International Electrotechnical Commission (IEC) has a certification area – an Ex area – that provides standards for equipment used in explosive atmospheres or hazardous locations. The objective of the IECEx system is to facilitate international trade in equipment and services for use in explosive atmospheres, while maintaining the required level of safety:

- reduced testing and certification costs to manufacturer
- reduced time to market
- international confidence in the product assessment process
- one international database listing
- maintaining International Confidence in equipment and services covered by IECEx Certification



IECEX member bodies and officers are found throughout the world. The IECEX does not perform the tests, rather allow approved IECEX Certification Bodies (ExCBs) to handle this for them. Most developed nations have IECEX-approved organizations that can test and issue IECEX Test Reports, IECEX Quality Assessment Reports, and the Certificate of Conformity. The zone classification for IECEX is identical to the zone classification for ATEX.

HMI manufacturers that design products that will be deployed into hazardous locations typically design and test to IECEX 60079 (explosive atmospheres) Part 15 (equipment protection by type of protection ‘nA’ non-sparking.)

Marine Certifications

Maritime certifications are established to ensure that ships and offshore structures are designed, engineered, constructed and managed safely. There are dozens of certifying agencies around the world. Thirteen of the larger ones are members of the International Association of Classification Societies (IACS).

IACS Members
American Bureau of Shipping (ABS)
Bureau Veritas (BV)
China Classification Society (CCS)
Croatian Register of Shipping (CRS)
Det Norske Veritas (DNV)
Germanischer Lloyd (GL)
Indian Register of Shipping (IRS)
Korean Register of Shipping (KR)
Lloyd's Register (LR)
Nippon Kaiji Kyokai (NK/ClassNK)
Polish Register of Shipping (PRS)
Registro Italiano Navale (RINA)
Russian Maritime Register of Shipping (RS)

Most HMI manufacturers that produce products for ships or off-shore deployments focus on the agencies and certifications that are recognized in Europe, the Middle East and Americas – the largest consumers of maritime HMIs – namely:

- ABS (American Bureau of Shipping) is a North American certification that promotes security of life, property and the natural environment.
- DNV (Det Norske Veritas) is a Norwegian certification that helps manage risk in all phases of the ships life. Their stated objective is “Safeguarding life, property, and the environment”
- GL (Germanischer Lloyd) is a German certifying agency setting standards in technology, safety and quality in the maritime industry. In 2012 it merged with DNV.
- LR (Lloyd’s Register) is a UK-based organization that governs materials used, structures, machinery and control systems used in marine applications.

Rugged HMI manufacturers will produce products that can be deployed in most locations in a ship or off-shore rig including the bridge, engine rooms, ballast control, ground tackle, cranes and cargo booms, even galleys. An HMI that may be certified to operate on a bridge may not have the

design characteristics and certifications to operate in the engine room. Rugged HMIs will be designed to meet certain location classes and specifications for the DNV, ABS, GL and LR certifications such as:



- Temperature Class D (open deck and mast locations; ambient temperatures -25°C to $+70^{\circ}\text{C}$)
- Humidity Class B (all locations; relative humidity up to 100% at all relevant temperatures)
- Vibration Class B (on machinery such as engines, compressors, pumps; frequency range 3-25 Hz, amplitude 1.0 mm peak value, frequency range 25-100 Hz, accelerated amplitude 2.1g)
- EMC Class B (all locations including the bridge and open deck; immunity – conducted low frequency, electrical fast transient/burst, electrical slow transient/surge, conducted radio frequency, radiated electromagnetic field, electrostatic discharge; emission – radiated and conducted)
- Enclosure Class C (per IEC 60529) (open deck, mast below floor plates in engine room locations; IP 56)

CONCLUSION

Rugged is more than tough or durable. A rugged HMI must be rugged to the core – designed to operate in wet, dusty, extreme temperatures, direct sun, high vibration, unreliable power, and hazardous environments. Oil and gas, mining, water and wastewater, and marine industries demand HMIs that have been proven to the extremes. The HMIs must be tested and certified against some of the world's most rigid standards. The process of designing, engineering, testing and certifying rugged HMIs is a core competency. Those companies that build rugged HMIs understand the industries and environments the HMIs will be deployed into. They want their products to be ruggedly reliable and operational for years. "Test early, test often" is not just an adage, it is fundamental to the culture of those manufacturers.

SOURCES and REFERENCES

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- UL – www.ul.com and www.ul.com/hazloc
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- National Electrical Code (NEC) – www.nfpa.org
- Canadian Electrical Code (CEC) – www.csagroup.org
- National Electrical Manufacturers Association (NEMA) – www.nema.org
- IECEx – www.iecex.com
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- Germanischer Lloyd (GL) – www.dnvgl.com
- Lloyd’s Register – www.lr.org

ABOUT BEIJER ELECTRONICS

For over thirty years, Beijer Electronics has designed and manufactured human machine interface (HMI) products for industrial OEMs. Products include automation software, operator panels, panel/industrial PCs and environmentally-rugged HMIs. Beijer Electronics is a fast growing technology company with extensive experience of industrial automation and data communication. The company develops and markets competitive products and solutions that focus on the user.



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