MSA ALTAIR® Gas Detectors: **Cold Weather Performance**

Technical Brief

As energy, construction and industrial activities are increasingly present within colder climates, seasonal temperatures can make user conditions nothing short of extreme. Questions related to proper use and performance of portable gas detectors in cold temperatures arise frequently among users and those responsible for safety programs. While older detection technologies may have suffered from sensor signal shifts brought about by large downward temperature swings, modern gas detectors have become much more robust. Sophisticated real-time temperature compensation results in improved sensor readings and detector performance across a wider range of environmental conditions.

Electrochemical Sensor Performance

Chemical reactions are temperature-dependent, meaning that at lower temperatures, the rate of reaction decreases. Temperatures can affect sensor response in one of two ways:

1. **Transient Temperature**—Temperature transients are significant temperature changes that occur within relatively short time periods, such as walking from a heated indoor office to wintery outdoor conditions. These rapid changes can cause temporary sensor shift, but that shift will stabilize when the sensor has completely cooled or heated to ambient conditions. Many of MSA's XCell® Sensors have an onboard, mounted temperature sensor that helps to mitigate rapid temperature change effects.
2. **Steady State Temperature**—When a sensor has completely acclimated to match that of the surrounding air temperature, the sensor is considered to be in a steady state. In this condition, the rate of reaction is stable and sensor output is steady.

Temperature Compensation—For electrochemical sensors such as XCell O_2 Sensors and other toxic gas sensors, the rate of reaction principle highlights the importance of temperature compensation for stable sensor output to improve performance while within both steady state and transient temperature changes. With the introduction of MSA XCell Sensor technology, each sensor is manufactured with an ASIC (Application Specific Integrated Circuit) that controls sensor functions, digitizes sensor output to reduce electrical interference and may provide vital sensor-specific temperature compensation.

Electrolyte Freezing Point—Electrochemical sensors typically rely upon liquid electrolyte to support the sensing chemical reaction. Historically, sensors have relied upon a formulation to freeze at typically -28° C (-18° F). MSA XCell Sensors however, use a different formulation that allows sensors to continue to perform when temperatures drop as low as -45° C (-49° F).

Instrument Performance

In addition to sensor chemistry, gas detector units can be susceptible to extreme temperatures.

Battery Performance—The rate of reaction principle also applies to an instrument's power system: the battery. As alkaline batteries can easily lose 90% of capacity or more at cold temperatures, MSA's ALTAIR Detectors operate using lithium-based battery technology that provides much improved cold weather performance over traditional battery chemistries such as NiCd, alkaline and NiMh technologies.

In addition to battery depletion, charging rate and depth can be affected by temperature effects. It is recommended that rechargeable instruments such as ALTAIR 4X and 5X Detectors be allowed to warm up at room temperature for one hour prior to charging. Although charging at extremely low temperatures can damage certain batteries, MSA instruments are designed with thermal protection circuits that prevent charging from occurring at extreme temperatures.

LCD Performance—LCDs (liquid crystal displays) appear to be dimmer and refresh more slowly at cold temperatures. This change can affect standard monochrome displays that may require additional time for display changes to appear, and may become unreadable at temperatures below -20° C (-4° F). In this situation, although the screen may be impaired, sensors and the remainder of the detector do function (including alarm horn, alarm lights and alarm vibration) and will not be affected. If gas readings from this time period are required, the periodic data log may be downloaded from ALTAIR Pro, 4X and 5X Detectors.

Pump Performance—Cold temperature can also affect pump mechanisms in pumped instruments such as the ALTAIR 5X Detector. Typically, a running pump will continue to operate as the temperature decreases; however attempting to cold-start a pump in extremely low temperatures may cause the motor to stall and result in a pump failure error. This scenario has been observed in temperatures approaching -20° C (-4° F). Should this event occur in use, perform startup at higher temperatures.

ALTAIR Detector Instrument Temperature Ranges

Instrument	ALTAIR/ALTAIR Pro Detector	ALTAIR 2X Detector	ALTAIR 4X Detector	ALTAIR 5X Detector Color Display	ALTAIR 5X Detector Monochrome Display
NORMAL OPERATING TEMPERATURE	-20° C to +50° C (-4° F to +122° F)	-10° to 40° C (14° F to +104° F)	-10° C to +40° C (14° F to +104° F)	-10° C to +40° C (14° F to +104° F)	-10° C to +40° C (14° F to +104° F)
EXTENDED OPERATING TEMPERATURE		-20° to 50° C (-4° F to +122° F)	-20° C to +50° C (-4° F to +122° F)	-20° C to +50° C typical (-4° F to +122° F typical) max 40° C/104° F for instruments with ClO_2 sensors	-10° C to 50° C typical (14° F to 122° F typical) max 40° C/104° F for instruments with ClO_2 sensors
SHORT TERM OPERATION TEMPERATURE (15 MINUTES)		-40° to +60° C (-40° F to +140° F)	-40° C to +50° C (-40° F to +122° F)	-40° C to +50° C (-40° F to +122° F)	-40° C to +50° C (-40° F to +122° F)
INTRINSIC SAFETY CERTIFICATION TEMPERATURE	-40° C to +50° C (-40° F to +122° F)	-40C to +60C (-40° F to +140° F)	-40° C to +60° C ATEX/IEC (-40° F to +140° F ATEX/IEC) -40° C to +54° C ETL/CSA (-40° F to +129° F ETL/CSA)	-40° C to +50° C (-40° F to +122° F)	-40° C to +50° C (-40° F to +122° F)

Environmental Factors

In addition to instrument and sensor performance, environmental factors can affect sensor readings that are unrelated to the instrument itself. For operation at extended or short term temperatures, MSA recommends that instrument startup be performed while within normal temperature range.

Vapor Pressure—Vapor pressure is dependent upon a number of factors: temperature is one of the more significant factors. At lower temperatures, vapor pressure is reduced and is reflected in lower sensor readings. Jet or diesel fuels are combustible liquids that emit detectable vapors. During cold pre-dawn hours on the tarmac, vapor pressure may be so low that no readings will be indicated; however when the sun rises and the tarmac warms up, jet fuel vapors will increase, producing a hazard not present hours prior.

Boiling Point—Some gases will simply turn into liquid at sufficiently cold temperatures and no longer present a gaseous hazard. Hydrogen sulfide is a toxic gas that at -60° C (-76° F) will turn into liquid and no longer present a gaseous hazard.

Condensation/Freezing in Sample Lines—Be aware when remote sampling from an area that is higher in temperature than the instrument location (such as an underground storage tank), moisture from the sample area may then condense or freeze in the sample line, reducing performance and potentially stopping flow to a pumped instrument.

Storage—Ideal storage conditions are at room temperature with ambient humidity. If instruments are stored within extreme temperature environments, battery longevity may be affected.

For additional questions or clarifications, please contact MSA Customer Service at (800).MSA.2222 or info.us@MSAsafety.com.

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