

Chameleon Technical Data Sheet

1. Sensitivity Data

The sensitivity of the Chameleon sensors was determined by exposing individual cassettes to a challenge agent for varying amounts of time. Observers were asked to view the cassettes and provide feedback as to when a color change was visible. The sensitivity was derived from the minimum exposure time needed for all observers to acknowledge a color change.

Table 1A. Chameleon Cassette Sensitivity to Challenge Agents

Cassette	PEL ¹		½ IDLH ²		Multiple IDLH	
	Concentration	Response Time	Concentration	Response Time	Concentration	Response Time
Acid / low pH ³	5 ppm	30 min	25 ppm	5 min	89 ppm	10 sec
Base / high pH ³	50 ppm	3 min	150 ppm	1 min	247 ppm	10 sec
Chlorine/Fluorine	1 ppm	25 min	5 ppm	4 min	28 ppm	12 sec
Diborane	0.1 ppm	10 min	7.5 ppm	1 min	45 ppm	10 sec
Hydrazine	1 ppm	30 min	25 ppm	5 min	400 ppm	55 sec
Hydrogen Cyanide	10 ppm	10 min	25 ppm	2 min	150 ppm	10 sec
Hydrogen Fluoride	3 ppm	15 min	15 ppm	3 min	60 ppm	60 sec
Hydrogen Sulfide	20 ppm	7 min	50 ppm	3 min	610 ppm	5 sec
Iodine	0.1 ppm	20 min	1 ppm	5 min	5 ppm	60 sec
Nitrogen Dioxide	5 ppm	10 min	10 ppm	5 min	60 ppm	10 sec
Phosgene	0.1 ppm	30 min	1 ppm	5 min	55 ppm	4 sec
Phosphine	0.3 ppm	60 min	25 ppm	5 min	150 ppm	10 sec
Sulfur Dioxide	5 ppm	16 min	50 ppm	3 min	109 ppm	55 sec

¹ PEL means Permissible Exposure Limit, as defined by OSHA: “8-hour Time Weighted Average.” - An employee’s exposure to any substance, which shall not exceed the 8-hour Time Weighted Average given for that substance, during any 8-hour work shift of a 40-hour workweek.

² IDLH means Immediately Dangerous to Life or Health: An atmospheric concentration of any toxic, corrosive or asphyxiate substance that poses an immediate threat to life or would cause irreversible or delayed adverse health effects or would interfere with an individual’s ability to escape from a dangerous atmosphere. IDLH values are based on effects that might occur as a consequence of a 30-minute exposure.

³ Reported sensitivity based on Chameleon Acid and Base cassette response to hydrogen chloride and ammonia vapor, respectively.

Additionally, the Chameleon Acid/low pH cassette detects the vapor of other strong acids including hydrogen bromide, nitric acid and fuming white nitric acid. The sensitivity of the cassette to each acid vapor is shown in Table 1B.

Table 1B. Chameleon Cassette Sensitivity to Various Acids

Acid Vapor	PEL		½ IDLH	
	Concentration	Response Time	Concentration	Response Time
Nitric Acid	2 ppm	30 min	12.5 ppm	4 min
Fuming Nitric Acid	2 ppm	30 min	12.5 ppm	5 min
Hydrogen Bromide	3 ppm	30 min	15 ppm	5 min

2. Stability Data

An accelerated aging study was conducted to determine the shelf life of Chameleon sensors. The purpose of this study was to accelerate the effects of long-term storage in order to predict the shelf life at various temperatures. Individually packaged sensors were stored in a 60 °C oven and the performance was tested at regular intervals for response to a challenge agent. The results were correlated to results at 25 °C using the Q10 rule⁴. All Chameleon cassettes passed performance testing after being aged for at least 65 days at 60 °C. Using the Q10-rule, this equates to a 2-year shelf life at 25 °C.

3. Service Life Data

Table 2 summarizes the test conditions used to determine the service life of each type of sensor. The sensors were stored under these conditions unpackaged. At the end of 24 hours, the samples were exposed to challenge agent and compared to unconditioned samples. The results indicate that the Chameleon sensors are fully functional for a minimum of 24 hours even under harsh environmental conditions.

Table 2. Service Life Test Parameters

Service Life Condition	Temperature	Relative Humidity
Desert	50 °C	20 %
Tropical	50 °C	95 %
Arctic	-30 °C	60 %

⁴ Q10 Rule: An accelerated aging technique based on assumptions that the chemical reactions involved in the deterioration of materials follow the Arrhenius function; for every 10 °C increase in temperature, the reaction rate (or rate of degradation) doubles.

4. Interference Test Results

Cassettes were exposed for one hour to static concentrations of toluene, N,N-diethyl-*m*-toluamide (DEET), bleach, diesel, jet fuel (JP-8) and gasoline. Following exposure to the field interferent, the sensors were exposed to the challenge agent and compared to controls.

Table 3. Field Interferent Study Observations

Cassette	Field Interferent					
	Toluene	DEET	Chlorine Bleach	Diesel Fuel	Gasoline	JP-8 Jet Fuel
Acid / Low pH	n/e	- interference	false +	n/e	n/e	n/e
Base / High pH	n/e	n/e	n/e	n/e	n/e	n/e
Chlorine/Fluorine	n/e	n/e	n/e	n/e	n/e	n/e
Diborane	n/e	n/e	n/e	n/e	n/e	n/e
Hydrazine	n/e	n/e	n/e	n/e	n/e	n/e
Hydrogen Cyanide	n/e	n/e	n/e	n/e	n/e	n/e
Hydrogen Fluoride	n/e	n/e	n/e	n/e	n/e	n/e
Hydrogen Sulfide	n/e	n/e	n/e	n/e	n/e	n/e
Iodine	n/e	n/e	n/e	n/e	n/e	n/e
Nitrogen Dioxide	n/e	n/e	false +	n/e	n/e	n/e
Phosgene	n/e	n/e	n/e	n/e	n/e	n/e
Phosphine	n/e	n/e	n/e	n/e	n/e	n/e
Sulfur Dioxide	n/e	n/e	n/e	n/e	n/e	n/e

n/e – no effect, no interference

- interference – resulted in a 1-minute delay in sensor response

false + - visible color change in viewing window

5. Chameleon Water Immersion Testing

One hundred samples of each Chameleon sensor were immersed in salt water for a minimum of one hour. Following immersion, the cassettes were evaluated for any detrimental effects. The samples were then exposed to challenge agent and compared to control samples. The performance of all the Chameleon sensors was satisfactory and no effects from water immersion were observed.

As part of our ongoing commitment to continuous improvement, we routinely perform tests on Chameleon sensors to ensure that they operate under conditions that might be encountered in the field. After Hurricanes Rita and Katrina made landfall, for example, Morphix conducted testing to verify that Chameleon sensors would still detect agent in areas that were flooded and contaminated with oil, fuel and chemicals from plants that were severely damaged. Performance data for those sensors subjected to these tests are provided in Sections 6 and 7 of this technical data sheet.

6. Chameleon Oil/Fuel on Water Immersion Testing

- Oil/Fuel mixture:** Equal parts of commercial 10W-30 motor oil, gasoline, and diesel fuel were mixed and dispersed in salt water to form an oil/fuel on water system.
- Procedure:** Chameleon sensor cassettes in Chameleon armbands were immersed in the oil/fuel on water system at 10-minute intervals over a period of one hour (7 immersions total). Each immersion event consisted of three 10-second immersions through the film on water system followed by a resting period in air. The oil/fuel film on water was replenished following each immersion. The performance of the Chameleon when exposed to agent vapor challenge was evaluated relative to a control Chameleon system.
- Cosmetic effects:** No deleterious effects were noted on the performance of the cassette snap mechanism, the cassette and badge body labels, or the badge body materials.
- Test conditions:** Chameleon systems were challenged with ½ IDLH agent vapor concentrations at 70-80 %RH (22-23 °C).

Table 4. Sensor Test Results – Oil/fuel on Water Immersion

Cassette	Challenge Agent (concentration)	Response Time
Acid / Low pH	Hydrogen Chloride (25 ppm)	30 seconds
Base / High pH	Ammonia (150 ppm)	3 minutes
Chlorine/Fluorine	Fluorine (12.5 ppm)	> 9 minutes
Hydrogen Sulfide	Hydrogen Sulfide (50 ppm)	3 minutes
Phosgene	Phosgene (1 ppm)	3 minutes

7. Chameleon Liquid Challenge Results

The following Chameleon sensors were challenged with solutions using two methods:

1. The cassettes were immersed in 100 ml of each solution.
2. A drop of solution was applied to the back of the cassette.

The visible response time was the same for each method and the response time can be found in Table 5.

Table 5. Sensor Liquid Challenge Results

Cassette	Solution Concentration (w/v)	Response Time (min)
Acid / Low pH	7.4 %	3
Base / High pH	0.004 %	1
Chlorine/Fluorine	0.005 %	3-4
Hydrogen Sulfide	0.4 %	4-5
Hydrazine	0.25 %	4-5
Iodine	0.002 %	4

Solution preparation for liquid challenges:

1. Acid/low pH sensor

A 100 ml solution was prepared by diluting 20 ml of a 37 % stock solution of hydrochloric acid (HCl) with de-ionized water.

2. Base/high pH sensor

A 39 ppm solution of ammonium hydroxide in de-ionized water was prepared by adding 15 μ l of 29 % stock solution to 100 ml de-ionized water.

3. Chlorine/Fluorine

0.0049 g of trichloro-s-triazinetrione (pool tablets, 90 % available chlorine) was dissolved in 100 ml of de-ionized water to prepare a 0.005 % solution.

4. Hydrazine

A 0.25% hydrazine solution was prepared by diluting 0.6 ml of hydrazine in a 250 ml volumetric flask of de-ionized water.

5. Hydrogen Sulfide

Hydrogen sulfide gas (6,086 ppm) was bubbled into 100 ml of de-ionized for approximately 3 hours, resulting in a final solution concentration of 4,100 ppm (assuming saturation, solubility = 0.41 g in 100 ml water).

6. Iodine

An iodine solution was prepared by dissolving 0.0020 g of iodine crystals in 100 ml of de-ionized water.