

6.2.2 EC Sensor Performance Data, Factory Mutual Verified (see Section 6.3)

Gas		Cartridge P/N	Selectable Full Scale Range (Display and 4-20mA Full Scale)	Default Range	Range Increments	Lower Alarm Limit	Lower Detection Limit	Lower Explosive Limit (% Vol)	Zero Deviation	Selectable Cal Gas Range	Default Cal Point	Response Time (T50) sec	Response Time (T90) sec	Accuracy	Operating Temperature		Operating Humidity	
															Min	Max	Min	Max
O ₂	Oxygen	XNXXS01FM	n/a	23.0% Vol	n/a	5.0%Vol	5% Vol	n/a	n/a	20.9 %Vol (fixed)	20.9 %Vol	T20 <10	<30	<+/-0.5 %Vol	-30°C / -34°F	55°C / 131°F	15% RH	90% RH
H ₂ S	Hydrogen Sulfide	XNXXSH1FM	10.0 to 50.0 ppm	15.0 ppm	0.1 ppm	5.0 ppm	1.5 ppm	n/a	-2.5 ppm	30 to 70% of the selected full scale range	10 ppm	<20	<30	2 ppm or 10% of reading, whichever is greater	-40°C / -40°F	55°C / 131°F	15% RH	90% RH
CO	Carbon Monoxide	XNXXSC1FM ¹	100 to 1000 ppm	300 ppm	100 ppm	30 ppm	15 ppm	na/	-25 ppm		100 ppm	<15	<30		See footnote 1	-40°C / -40°F	55°C / 131°F	15% RH

FOOTNOTES:

- XNXXSC1FM accuracy over temperature $\leq \pm 10\%$ of reading 20°C/68°F to 55°C/131°F, $\leq \pm 20\%$ of reading 20°C/68°F to -10°C/14°F, $\leq \pm 30\%$ of reading -10°C/14°F to -20°C/-4°F. Recalibration is recommended if the temperature of the local environment has varied by more than -30°C.

NOTES:

- Performance figures are measured by test units calibrated at 50% of full scale, at ambient conditions of 20°C, 50% RH, with the EC weatherproof cover attached
- IP rating of FM Cartridges is IP63.
- Barometric pressure effects on the O₂ sensor: The output from the O₂ sensor has pressure effects of <0.1% change of output per % change in pressure. When the barometric pressure changes by $\pm 20\%$ the output from the O₂ sensor changes $\leq \pm 0.4\%$ Vol. However, the oxygen sensor shows transient behavior when subjected to a rapid change in ambient pressure due to either weather or altitude. For example, a 10KPa instantaneous positive pressure step change may cause an overscale alarm condition for a period of about 12 seconds.
- Operating the XNX EC sensor at extended temperature ranges for a prolonged time period exceeding 12 hours may cause deterioration in the sensor performance and shorten sensor life. Extended temperature range for XNX EC sensors is -40°C to -20°C.
- Response times may increase at lower temperatures.
- FM performance verification is limited to the requirements of the standards identified in Table 6.3 for each cartridge.
- Contact Honeywell Analytics for additional data or details.

6.2.3 EC Sensor Performance Data, DEKRA EXAM verified (see Section 6.3)

Gas		Cartridge P/N	Selectable Full Scale Range (Display and 4-20mA Full Scale)	Default Range	Range Increments	Lower Alarm Limit	Lower Detection Limit	Zero Variation	Selectable Cal Gas Range	Default Cal Point	Response Time (T50) (sec)	T90 Response T10 Recovery Time (sec)	Accuracy ¹	Operating Temperature		Operating Humidity	
														Min	Max	Min	Max
O ₂	Oxygen	XNXXSO1SS	n/a	25.0 %Vol	n/a	5.0%Vol	3.5 %Vol	n/a	20.9 %Vol (fixed)	20.9 %Vol	T20 <10	<30	<+/-0.6 %Vol	-30°C / -34°F	55°C /131°F	15% RH	90% RH
H ₂ S	Hydrogen Sulfide	XNXXSH1SS	10.0 to 50.0 ppm	15.0 ppm	0.1ppm	3.0 ppm	1.0 ppm	2.0 ppm	30 to 70% of the selected full scale range	10 ppm	<20	<30	<+/-0.3 ppm	-40°C / -40°F	55°C / 131°F	15% RH	90% RH
H ₂ S (High)	Hydrogen Sulfide	XNXXSH2SS	50 to 500 ppm	100 ppm	10 ppm	5 ppm	1 ppm	2 ppm		50 ppm	<20	<30	<+/-5 ppm	-40°C / -40°F	55°C / 131°F	15% RH	90% RH
CO	Carbon Monoxide	XNXXSC1SS	100 to 500 ppm	300 ppm	100 ppm	15 ppm	5 ppm	10 ppm		100 ppm	<15	<30	<+/-2 ppm	-40°C / -40°F	55°C / 131°F	15% RH	90% RH

FOOTNOTE:

1. Accuracy of reading at default Alarm 1 concentration (typically 10% FS or defined minimum alarm level setting, whichever is greater) when operated at default full scale.

NOTES:

- Sensor drift between LDL and negative drift fault limits (typically > negative zero variation) appear as 0 on the display and outputs of the device.
- Long-term drift: XNXXSC1SS <5%/year, XNXXSO1SS <4%/year, XNXXSH1SS and XNXXSH2SS <2%/month.
- Performance figures are measured by test units calibrated at 50% of full scale, at ambient conditions of 20°C, 50% RH, with the EC weatherproof cover attached.
- Operating the XNX EC sensor at extended temperature ranges for a prolonged time period exceeding 12 hours may cause deterioration in sensor performance and shorten sensor life. Extended temperature ranges for XNX EC sensor cartridges are -40°C to -20°C.
- Barometric pressure effects on the O₂ sensor: The output from the O₂ sensor has pressure effects of <0.1% change of output per % change in pressure. When the barometric pressure changes by ±20%, the output from the O₂ sensor changes <±0.4%Vol. However, the oxygen sensor shows transient behavior when subjected to a rapid change in ambient pressure due to either weather or altitude. For example, a 10kPa instantaneous positive pressure step change may cause an overscale alarm condition for a period of about 12 seconds.
- Response times may increase at lower temperatures.
- Contact Honeywell Analytics for any additional data or details.

6.2.4 Other EC Sensors

Gas		Cartridge P/N	Selectable Full Scale Range (Display and 4-20mA Full Scale)	Default Range	Range Increments	Lower Alarm Limit	Lower Detection Limit	Zero Deviation	Selectable Cal Gas Range	Default Cal Point	Response Time (T50) sec	Response Time (T90) sec	Accuracy ¹	Typical Accuracy @ Lowest Alarm Level	Operating Temperature		Operating Humidity	
															Min	Max	Min	Max
HCl	Hydrogen Chloride	XNXXSR1SS	10.0 to 20.0 ppm	10.0 ppm	1.0 ppm	5.0 ppm	0.6 ppm	-1.0 ppm	30 to 70% of the selected full scale range	5.0 ppm	<45 ^{2,3}	<150 ^{2,3}	<+/-1.0 ppm or 20% of applied gas ^{2,3}	<+/-1.0 @ 3 ppm	-20°C/-4°F	40°C/104°F	15% RH	90% RH
H ₂ S (Low)	Hydrogen Sulfide	XNXXSH3SS	n/a	15.0 ppm	n/a	3.0 ppm	1.0 ppm	-2.5 ppm		10 ppm	<20	<40	<+/-0.3 ppm	<+/-0.3 @ 3 ppm	-40°C / -40°F	55°C / 131°F	15% RH	90% RH
SO ₂	Sulfur Dioxide	XNXXSS1SS	5.0 to 20.0 ppm	15.0 ppm	5.0 ppm	2.0 ppm	0.6 ppm	-1.0 ppm		5.0 ppm	<15	<30	<+/-0.3 ppm	<+/-0.3 @ 2 ppm	-40°C / -40°F	55°C / 131°F	15% RH	90% RH
SO ₂ (High)	Sulfur Dioxide	XNXXSS2SS	20.0 to 50.0 ppm	50.0 ppm	10.0 ppm	5.0 ppm	1.5 ppm	-2.5 ppm		25 ppm	<15	<30	<+/-0.6 ppm	<+/-0.6 @ 5 ppm	-40°C / -40°F	55°C / 131°F	15% RH	90% RH
NH ₃	Ammonia	XNXXSA1SS	50 to 200 ppm	200 ppm	50 ppm	20 ppm	6 ppm	-10 ppm		100 ppm	<60	<180	<+/-4 ppm	<+/-4 @ 20 ppm	-20°C / -4°F	40°C / 104°F	15% RH	90% RH
NH ₃ (High)	Ammonia	XNXXSA2SS	200 to 1000 ppm	1,000 ppm	50 ppm	100 ppm	30 ppm	-50 ppm		300 ppm	<60	<180	<+/-20 ppm	<+/-20 @ 100 ppm	-20°C / -4°F	40°C / 104°F	15% RH	90% RH
Cl ₂	Chlorine	XNXXSL2SS	n/a	5.00 ppm	n/a	0.50 ppm	0.15 ppm	-0.25 ppm		2.0 ppm	<20	<60	<+/-0.2 ppm	<+/-0.20 @ 0.50 ppm	-10°C / 14°F	55°C / 131°F	15% RH	90% RH
Cl ₂ (High)	Chlorine	XNXXSL1SS	5.0 to 20.0 ppm	5.0 ppm	5.0 ppm	1.0 ppm	0.6 ppm	-1.0 ppm		2.0 ppm	<20	<30	<+/-0.2 ppm	<+/-0.2 @ 1 ppm	-10°C / 14°F	55°C / 131°F	15% RH	90% RH
ClO ₂	Chlorine Dioxide	XNXXSX1SS	n/a	1.00 ppm	n/a	0.10 ppm	0.03 ppm	-0.05 ppm		0.5 ppm	<30	<120	<+/-30%	<+/-0.03 @ 0.1 ppm	-20°C / -4°F	55°C / 131°F	15% RH	90% RH
NO	Nitrogen Monoxide	XNXXSM1SS	n/a	100 ppm	n/a	10 ppm	3 ppm	-5 ppm		50 ppm	<15	<30	<+/-2 ppm	<+/-2.0 @ 10 ppm	-20°C / -4°F	55°C / 131°F	15% RH	90% RH
NO ₂	Nitrogen Dioxide	XNXXSN1SS	5.0 to 50.0 ppm	10.0 ppm	5.0 ppm	5.0 ppm	1.5 ppm	-2.5 ppm		5 ppm	<15	<30	<+/-0.2 ppm	<+/-0.2 @ 5 ppm	-20°C / -4°F	55°C / 131°F	15% RH	90% RH
H ₂	Hydrogen	XNXXSG1SS	n/a	1,000 ppm	n/a	100 ppm	30 ppm	-50 ppm		500 ppm	<60	<90 ²	<+/-8 ppm	<+/-8 @ 100 ppm	-20°C / -4°F	55°C / 131°F	15% RH	90% RH
H ₂ (High)	Hydrogen	XNXXSG2SS	n/a	10,000 ppm	n/a	1000 ppm	300 ppm	-500 ppm		5000 ppm	<15	<30	<+/-150 ppm	<+/-150 @ 1000 ppm	-20°C / -4°F	55°C / 131°F	15% RH	90% RH
HF	Hydrogen Fluoride	XNXXSF1SS	n/a	12.0 ppm	n/a	1.5 ppm	0.4 ppm	-0.6 ppm		5.0 ppm	120	<240	<+/-0.5 ppm	<+/-0.5 @ 1.5 ppm	-20°C / -4°F	55°C / 131°F	20% RH	75% RH
PH ₃	Phosphine	XNXXSP1SS	n/a	1.20 ppm	n/a	0.15 ppm	0.04 ppm	-0.06 ppm		0.5ppm	<15	<30	<+/- 0.02 ppm	<+/-0.02 @ 0.15 ppm	-20°C / -4°F	40°C / 104°F	10% RH	90% RH

see footnotes and notes on following page

FOOTNOTES (SEE TABLE ON PREVIOUS PAGE):

1. Accuracy of reading at default Alarm 1 concentration (typically 10%FS or defined minimum alarm level setting, whichever greater) when operated at default full scale.
2. System conditioning may be required to achieve stated results. Contact Honeywell Analytics for details.
3. Measured using calibration flow housing at calibration flow rate (300-375 ml/min) with dry gas.

NOTES (SEE TABLE ON PREVIOUS PAGE):

- Data taken at ambient conditions of 20°C, 50% RH.
- Data represents typical values of freshly calibrated sensors without optional accessories attached.
- Performance figures are measured by test units calibrated at 50% of full scale.
- Standard temperature range for XNX EC Sensors is -20°C to +55°C; ATEX, IECEx.
- Extended temperature ranges for the XNX EC Sensors are -40°C to -20°C
- Accuracy between the temperatures of -40°C and -20°C is $\pm 30\%$ at the applied gas concentration.
- Operating the XNX EC Sensors at extended temperature ranges for a prolonged time period exceeding 12 hours may cause deterioration in sensor performance and shorter sensor life.
- Barometric pressure effects on the O₂ sensor: The output from the O₂ sensor has pressure effects of <0.1% change of output per % change in pressure. When the barometric pressure changes by $\pm 20\%$ the output from the O₂ sensor changes $< \pm 0.4\%$ Vol. However, the oxygen sensor shows transient behavior when subjected to a rapid change in ambient pressure due to either weather or altitude. For example, a 10KPa instantaneous positive pressure step change may cause an overscale alarm condition for a period of about 12 seconds.
- Recalibration is recommended if the temperature of local environment has varied by more than $\pm 15^\circ\text{C}$ from the temperature of calibration.
- Response times may increase at lower temperatures.
- Contact Honeywell Analytics for any additional data or details.

6.2.5 XNX EC Sensor Cross-sensitivity

Gas type	Part Number	Gas Type Applied	Concentration	Unit	Reading	Unit
O ₂	XNXXS01SS XNXXS01FM	Carbon Dioxide	5	%vol	0.1	%vol (change O ₂ reading) per %vol CO ₂
HCl	XNXXSR1SS	Carbon monoxide	2000	ppm	0	ppm HCl
		Hydrogen	20000		0	
		Chlorine	5		5.6	
		Nitrogen dioxide	5		0.9	
		Propan-2-ol	500		0	
		Methanol	500		0	
		Hydrogen fluoride	5		6.7	
		Hydrogen sulfide	25		-3.6	
		Sulphur dioxide	50		22.4	
		Arsine	1		0	
		Phosphine	1		-0.14	
		Diborane	1		-1.3	
		H ₂ S (Low Range)	XNXXSH3SS		Ammonia	
Carbon Monoxide	100			<2	ppm H ₂ S	
Carbon Dioxide	5000			0	ppm H ₂ S	
Chlorine	0.5			0	ppm H ₂ S	
Ethylene	100			0	ppm H ₂ S	
Hydrogen	100			0	ppm H ₂ S	
Hydrogen Sulfide	10			10	ppm H ₂ S	
Nitrogen Monoxide	25			0	ppm H ₂ S	
Nitrogen Dioxide	3			0	ppm H ₂ S	
Sulfur Dioxide	2			0	ppm H ₂ S	

Gas type	Part Number	Gas Type Applied	Concentration	Unit	Reading	Unit
H ₂ S	XNXXSH1SS XNXXSH1FM	Ammonia	50	ppm	0	ppm H ₂ S
		Carbon Monoxide	100		<2	ppm H ₂ S
		Carbon Dioxide	5000		0	ppm H ₂ S
		Chlorine	0.5		0	ppm H ₂ S
		Ethylene	100		0	ppm H ₂ S
		Hydrogen	100		0	ppm H ₂ S
		Hydrogen Sulfide	10		10	ppm H ₂ S
		Nitrogen Monoxide	25		0	ppm H ₂ S
		Nitrogen Dioxide	3		0	ppm H ₂ S
		Sulfur Dioxide	2		0	ppm H ₂ S
H ₂ S (High Range)	XNXXSH2SS	Ammonia	50	ppm	0	ppm H ₂ S
		Carbon Monoxide	100		<2	ppm H ₂ S
		Carbon Dioxide	5000		0	ppm H ₂ S
		Chlorine	0.5		0	ppm H ₂ S
		Ethylene	100		0	ppm H ₂ S
		Hydrogen	100		0	ppm H ₂ S
		Hydrogen Sulfide	10		10	ppm H ₂ S
		Nitrogen Monoxide	25		0	ppm H ₂ S
		Nitrogen Dioxide	3		0	ppm H ₂ S
		Sulfur Dioxide	2		0	ppm H ₂ S

Gas type	Part Number	Gas Type Applied	Concentration	Unit	Reading	Unit
CO	XNXXSC1SS XNXXSC1FM	Acetone	1000	ppm	0	ppm CO
		Acetylene	40		80	ppm CO
		Ammonia	100		0	ppm CO
		Carbon Monoxide	100		100	ppm CO
		Chlorine	2		0	ppm CO
		Ethanol	2000		3	ppm CO
		Ethylene	100		85	ppm CO
		Hydrogen	100		20	ppm CO
		Hydrogen Sulfide	25		0	ppm CO
		Iso-Propanol	200		0	ppm CO
		Nitrogen Monoxide	50		8	ppm CO
		Nitrogen Dioxide	800		20	ppm CO
		Sulfur Dioxide	50		0.5	ppm CO
		SO ₂	XNXXSS1SS		Carbon Monoxide	300
Hydrogen Sulfide	15			0	ppm SO ₂	
Nitrogen Monoxide	35			0	ppm SO ₂	
Nitrogen Dioxide	5			~-5	ppm SO ₂	
SO ₂	XNXXSS2SS	Carbon Monoxide	300	ppm	<3	ppm SO ₂
		Hydrogen Sulfide	15		0	ppm SO ₂
		Nitrogen Monoxide	35		0	ppm SO ₂
		Nitrogen Dioxide	5		~-5	ppm SO ₂

Gas type	Part Number	Gas Type Applied	Concentration	Unit	Reading	Unit
NH ₃	XNXXSA1SS	Alcohols	1000	ppm	0	ppm NH ₃
		Carbon Dioxide	5000		0	ppm NH ₃
		Carbon Monoxide	100		0	ppm NH ₃
		Hydrocarbons		% range	0	ppm NH ₃
		Hydrogen	10000	ppm	0	ppm NH ₃
		Hydrogen Sulfide	20		2	ppm NH ₃
NH ₃ (High Range)	XNXXSA2SS	Alcohols	1000	ppm	0	ppm NH ₃
		Carbon Monoxide	100		0	ppm NH ₃
		Chlorine	5		0	ppm NH ₃
		Nitrogen Dioxide	10		0	ppm NH ₃
		Sulfur Dioxide	20		-40	ppm NH ₃
		Hydrogen	3000		0	ppm NH ₃
		Hydrogen Sulfide	20		20	ppm NH ₃
Cl ₂	XNXXSL2SS	Carbon Dioxide	20000	ppm	0	ppm Cl ₂
		Hydrogen Chloride	9		1.25	ppm Cl ₂
		Hydrogen Sulfide	25		-16.3	ppm Cl ₂
		Nitrogen Dioxide	50		1.25 (transient)	ppm Cl ₂
		Sulfur Dioxide	50		9.1	ppm Cl ₂
Cl ₂ (High Range)	XNXXSL1SS	Carbon Dioxide	20000	ppm	0	ppm Cl ₂
		Hydrogen Chloride	9		1.25	ppm Cl ₂
		Hydrogen Sulfide	25		-16.3	ppm Cl ₂
		Nitrogen Dioxide	50		1.25 (transient)	ppm Cl ₂
		Sulfur Dioxide	50		9.1	ppm Cl ₂
ClO ₂	XNXXSX1SS	Refer To Cl ₂	Refer to Cl ₂	Refer to Cl ₂	Refer to Cl ₂	Refer to Cl ₂

Gas type	Part Number	Gas Type Applied	Concentration	Unit	Reading	Unit
NO	XNXXSM1SS	Carbon Monoxide	300	ppm	0	ppm NO
		Sulfur Dioxide	5		0	ppm NO
		Nitrogen Dioxide	5		<1.5	ppm NO
		Hydrogen Sulfide	15		~1.5	ppm NO
NO ₂	XNXXSN1SS	Carbon Monoxide	300	ppm	0	ppm NO ₂
		Hydrogen Sulfide	15		~ -1.2	ppm NO ₂
		Sulfur Dioxide	5		0	ppm NO ₂
		Nitrogen Monoxide	35		0	ppm NO ₂
		Chlorine	1		~1	ppm NO ₂
H ₂	XNXXSG1SS	Carbon Monoxide	300	ppm	≤ 60	ppm H ₂
		Hydrogen Sulfide	15		<3	ppm H ₂
		Sulfur Dioxide	5		0	ppm H ₂
		Nitrogen Monoxide	35		»10	ppm H ₂
		Nitrogen Dioxide	5		0	ppm H ₂
		Chlorine	1		0	ppm H ₂
		Hydrogen Cyanide	10		»3	ppm H ₂
		Hydrogen Chloride	5		0	ppm H ₂
		Ethylene	100		»80	ppm H ₂

Gas type	Part Number	Gas Type Applied	Concentration	Unit	Reading	Unit
H ₂ (High Range)	XNXXSG2SS	Ammonia	100	ppm	0	ppm H ₂
		Arsine	0.2	ppm	0	ppm H ₂
		Carbon Dioxide	1000	ppm	0	ppm H ₂
		Carbon Monoxide	100	ppm	150	ppm H ₂
		Chlorine	1	ppm	0	ppm H ₂
		Ethylene	500	ppm	yes; n/d	ppm H ₂
		Hydrogen Cyanide	20	ppm	0	ppm H ₂
		Hydrogen Sulfide	20	ppm	4	ppm H ₂
		Iso-Propanol	1100	ppm	yes; n/d	ppm H ₂
		Methane	1	%	0	ppm H ₂
		Nitrogen Dioxide	10	ppm	-40	ppm H ₂
		Ozone	0.25	ppm	0	ppm H ₂
		Sulfur Dioxide	5	ppm	0	ppm H ₂
HF	XNXXSF1SS	Carbon Monoxide	2000	ppm	0	ppm HF
		Hydrogen	20000	ppm	0	ppm HF
		Chlorine	5	ppm	5.8	ppm HF
		Nitrogen Dioxide	5	ppm	0.65	ppm HF
		Iso-Propanol	500	ppm	0	ppm HF
		Methanol	500	ppm	0	ppm HF
		Hydrogen Fluoride	5	ppm	7	ppm HF
		Hydrogen Sulfide	25	ppm	-3.6	ppm HF
		Sulfur Dioxide	50	ppm	28.3	ppm HF
		Arsine	1	ppm	0	ppm HF
		Phosphine	1	ppm	-0.14	ppm HF
		Diborane	1	ppm	-1.3	ppm HF

Gas type	Part Number	Gas Type Applied	Concentration	Unit	Reading	Unit
PH ₃	XNXXSP1SS	Carbon Monoxide	2000	ppm	<10	ppm PH ₃
		Hydrogen	5000	ppm	<10	ppm PH ₃
		Chlorine	1	ppm	-70	ppm PH ₃
		Nitrogen Dioxide	8	ppm	-860	ppm PH ₃
		Ethanol	2000	ppm	<10	ppm PH ₃
		Iso-Propanol	1000	ppm	<10	ppm PH ₃
		Hydrogen Chloride	10	ppm	<10	ppm PH ₃
		Hydrogen Fluoride	10	ppm	<10	ppm PH ₃
		Hydrogen Sulfide	0.5	ppm	70	ppm PH ₃
		Ammonia	100	ppm	1050 (transient)	ppm PH ₃
		Sulfur Dioxide	50	ppm	550 (transient)	ppm PH ₃
		Silane	1	ppm	364	ppm PH ₃
		Arsine	1	ppm	680	ppm PH ₃
		Diborane	1	ppm	454	ppm PH ₃
		Germane	1	ppm	454	ppm PH ₃

NOTES:

- The figures of cross-sensitivity are typical values and should not be used as a basis for cross calibration.
- Cross-sensitivities may not be linear and should not be scaled.
- For some cross-interferents breakthrough may occur if gas is applied a longer time period.
- There are many gases and vapors that can poison electrochemical cells. It is difficult to give a complete and exclusive list of all species which will have an effect on the sensors. However, these are some common substances which should be avoided:
- Airborne greases - These may block gas access into the sensors and therefore reduce sensitivity.
- Silicone compounds - These are often found in sprays, aerosols, lubricants, polishes, adhesives, sealants, zebra strip, cleaning agents, and floor waxes. These compounds tend to reduce the sensitivity of the sensors and generally will have a permanent effect.
- Solvents and organic vapors - Many organic vapors will damage the sensors. Some common ones are IPA, toluene, xylene, other benzene derivatives, petrol, and diesel. It is difficult to give a full list of organic vapors, as there are so many of them. Generally, any organic vapor should be avoided.