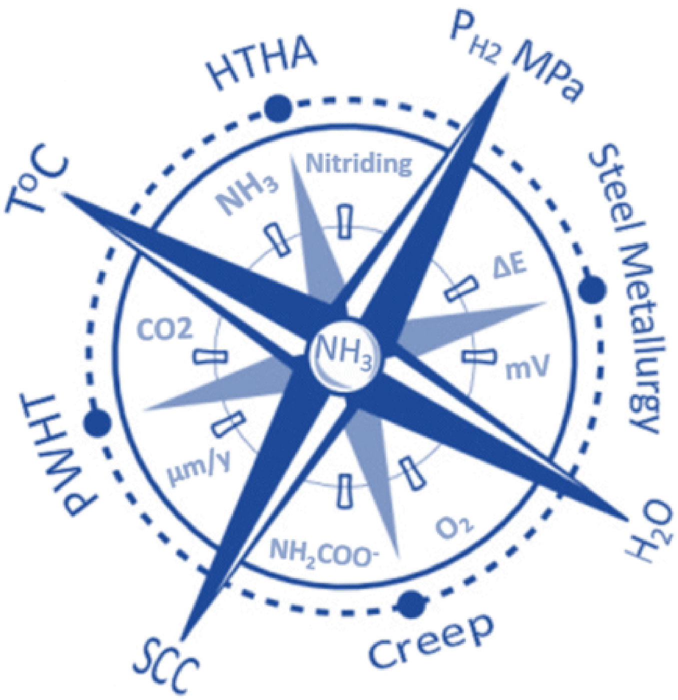

Corrosion Modeling Software and Corrosion Prediction Software Series

NH3Compass®: Modeling and Prediction of Corrosion in Ammonia Production and Services

Version 9.20

Overview and Application Examples of NH3Compass

Anhydrous ammonia is manufactured by combining hydrogen and nitrogen in a molar ratio of 3:1, compressing the gas and then cooling it to about -27°F (-33°C). Corrosion at high temperatures in H2 and N2 environment include: (1) high temperature hydrogen attack (HTHA), (3) creep and stress rupture, and (3) nitriding. Corrosion at low temperatures include: (1) ammonia stress corrosion cracking (SCC), (2) ammonia carbamate formation, (3) general corrosion, (4) galvanic corrosion and other damage mechanisms.

NH3Compass is the only device and OS independent software tool on the market for the modeling and prediction of corrosion in ammonia production, storage, transport, and other services. NH3Compass is a cloud-based software that works on any device running any OS without the need for users to install or download anything. Designers, OEM engineers, consultants, operation personnel, maintenance and inspection engineers can quickly and accurately determine:

(1) the risk of high temperature hydrogen attack (HTHA) under the prevailing operating condition;
(2) the risk of ammonia stress corrosion cracking (SCC) under the prevailing operating condition;
(3) the risk of creep and stress rupture under the prevailing operating condition;
(4) the risk of nitriding under the prevailing operating condition;
(5) the risk of ammonia carbamate formation;
(6) the metal loss due to general corrosion in anhydrous liquid ammonia;
(7) the galvanic effect of coupling different alloys in anhydrous liquid ammonia;
(8) materials selection as affected by the changes in process parameters.

NH3Compass®: Modeling & Prediction of Corrosion in Ammonia Production & Services

Equipment Name/Location	Line #5	
Component Nominal ID	mm	20.000
Nominal Wall Thickness	mm	7.000
Spent Operating Hours	hours	8,760
High Temperature Corrosion (Gas Phase)	ASTM 517 Grade F Steel	
Operating Temperature	°C	500.000
Operating Pressure	MPa	13.800
H2 Partial Pressure	MPa	6.900
N2 Partial Pressure	MPa	5.520
Risk of High Temperature Hydrogen Attack (HTHA)	**High risk**	as per API 581
Creep and Stress Rupture (Remaining Life)	years	23.924
Risk of Nitriding	**High risk of nitriding**	
Low Temperature Corrosion (Liquid Phase)	Carbon Steel welded no PWHT	
Operating Temperature	°C	25.000
Water Content in Liquid Ammonia	wt%	0.1000
Oxygen Content in Liquid Ammonia	ppmw	100.000
CO2 Content in Liquid Ammonia	ppmw	4.000
General Corrosion Rate in Anhydrous Ammonia	µm/y	0.582
Galvanic Effect When Coupled to	AISI 316L	
Galvanic Cell Potential, $\Delta E = E_B - E_A$	mV	-45
Risk of Ammonia Stress Corrosion Cracking (SCC)	**High risk of ammonia SCC**	
Risk of Ammonium Carbamate Corrosion	No risk of corrosion by carbamate	

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Figure 1 NH3Compass predicts corrosion at high temperatures and low temperatures.

Under the prevailing operating conditions shown in Figure 1 above, the selected metallurgy, ASTM A517 Grade F steel, is predicted to have high risk of high temperature hydrogen attack (HTHA), as per API 581 risk ranking methodology. The remaining life due to creep and stress rupture is 23.924 years. The selected metallurgy has high risk of nitriding under the the prevailing operating conditions. At low temperatures, the selected carbon steel (no PWHT) is highly susceptible to ammonia stress corrosion cracking (SCC) under the specified operating conditions. When the carbon steel is coupled to another metal, AISI 316L, NH3Compass predicts the galvanic cell potential of -45 mV than can cause accelerated corrosion of the anode metal. NH3Compass predicts that there is no risk of corrosion caused by ammonia carbamate formation, as shown in Figure 1.

Under the prevailing temperature and hydrogen partial pressure shown in Figure 1 above, 1Cr0.5Mo is not susceptible to high temperature hydrogen attack (HTHA). However, if the hydrogen partial pressure increases to 10 MPa, this metallurgy becomes susceptible to high temperature hydrogen attack, as shown in Figure 3. NH3Compass recommends to reduce operating temperature, or pressure, or change the metallurgy. NH3Compass accounts for the cumulative effect of exposure time when determining the remaining time to incipient attack (or the remaining incubation period) and the HTHA risk ranking of a component in high temperature hydrogen services. NH3Compass also predicts the expected form of HTHA and the requirement for HTHA inspection and assessment under the prevailing operating conditions.

Figures 2 and 3 below show the materials selection for both high temperature and low temperature services in ammonia production, storage, and transport.

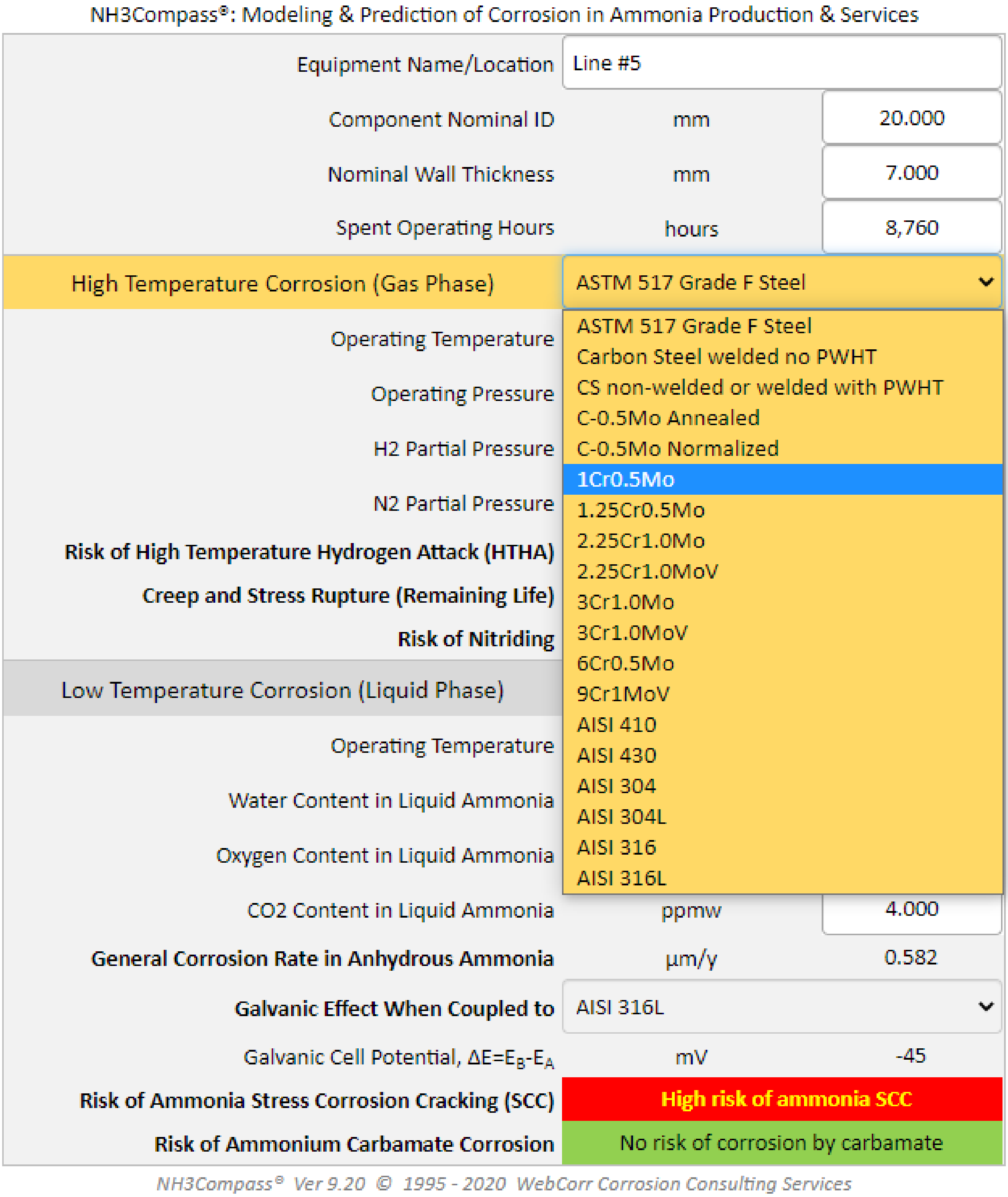

Figure 2 Materials selection for high temperature services in ammonia production.

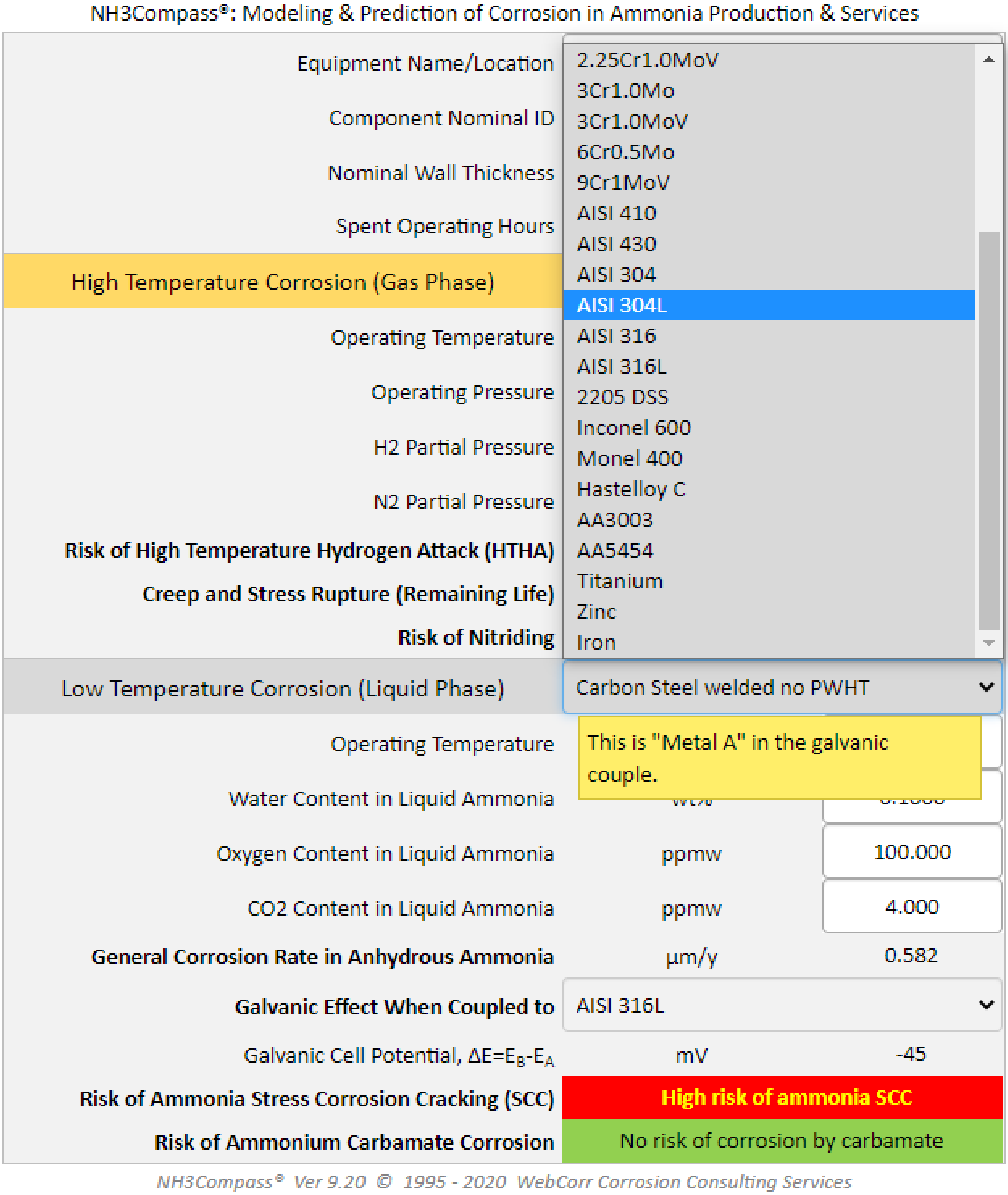

Figure 3 Materials selection for low temperature services in ammonia production, storage, and transport.

The powerful applications of NH3Compass are truly unlimited in engineering design, materials selection, process operation, inspection and maintenance, modeling and prediction of corrosion ammonia production, storage, transport, and other services.

Click here to contact us for licensing details and experience the power of NH3Compass.

NH3Compass, giving you the right directions in the Modeling and Prediction of Corrosion in Ammonia Production, Storage, and Transport.

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