

Cathodic Protection — Impressed Current vs Sacrificial Anodes

cBallast · DNV-RP-B401 / NACE SP0176 · Design reference

Two CP methods

Method	Principle	Use
Sacrificial galvanic	More electronegative metal (Zn/Al/Mg) bonded to structure; self-regulating; no power	Ballast tanks, small hulls, buried pipe, indoor tanks
ICCP	Rectifier drives DC current from inert anode; feedback from reference cell	Large hulls, offshore platforms, buried pipelines, large tanks

Sacrificial anode alloys

Alloy	OCP V vs Ag/AgCl	Capacity A·h/kg	Use
Zinc MIL-A-18001K	-1.05	780	Seawater, mild bilge; not > 40 °C
Al-Zn-In	-1.10	2,500	Seawater, ballast tanks, offshore
Galvalum III (Al)	-1.10	2,600	Seawater, ballast tanks (most common)
Magnesium H-1	-1.55	1,230	Fresh/brackish, buried soil, indoor tanks

Current density design (DNV-RP-B401)

Design current density per surface type, environment, coating condition. Initial polarises quickly; average sets anode mass; final verifies delivery at end-of-life. Coated ballast tank North Sea, 3% coating breakdown EOL: initial 6, average 1.5, final 3 mA/m². Bare steel jacket same env: 200 / 90 / 100.

Reference cells

Cell	Std V vs SHE	Use
Ag/AgCl (seawater)	+0.25	Marine — hulls, ballast, offshore
Cu/CuSO ₄ (buried)	+0.318	Buried pipelines, onshore tanks
Zn pure seawater	-0.80	Long-term marine, low-drift

Protection potential criterion

Fully protected: more negative than -0.80 V vs Ag/AgCl (seawater) or -0.85 V vs Cu/CuSO₄ (soil). More negative than -1.10 V vs Ag/AgCl

risks hydrogen embrittlement + coating disbondment — over-protection limit. Measure at anode local zone.

Anode consumption

Life = (avg current density × wetted area × life × utilisation) / capacity. Utilisation ~0.85 (last 15% detaches before delivering current). 30 kg Al-Zn-In at 0.3 A avg lasts ~25 years.

ICCP components

Rectifier — thyristor/IGBT switched, 20-200 A DC at 20-60 V. Anode — MMO-coated titanium (default, 30-yr life). Reference cell — Ag/AgCl marine, Cu/CuSO₄ buried. Anode shield — dielectric coating around anode to prevent hull over-protection. Shaft grounding brush — connects rotating propeller shaft to hull.

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