

Duplex Systems Generate Excellent Return on Investment

Life-Cycle Savings Justifies Initial 'Premium'

Duplex systems, painting or powder coating over hot-dip galvanizing, have steadily grown in popularity over the last decade. Specifiers often utilize duplex systems on projects where corrosion protection is pertinent, but aesthetics, namely color selection, is also a high priority. The combination of hot-dip galvanizing and paint ensures the designer does not have to sacrifice either desire. But to consider a duplex system as merely a cosmetic extra to the durability of hot-dip galvanizing is a gross misrepresentation. In addition to visual benefits, duplex systems provide cost savings and extended service life. To calculate how you can save money over the life of your next project by utilizing a duplex system, visit our life-cycle cost calculator at lccc.galvanizeit.org.

How Duplex Systems Work

Used independently, both paint/powder coatings and galvanizing provide corrosion protection to steel. However, when utilized together, the two coatings work in synergy. Paint/powder coatings applied on top of the zinc of the galvanized coating act as an additional barrier coating for the steel, creating a synergistic effect whereby the substrate steel is afforded corrosion protection for 1.5 to 2.3 times the sum of the expected life of each system alone. For example, if a galvanized coating alone on black steel would provide 50 years of maintenance-free protection and a paint coating would not require any maintenance for 10 years, the combination duplex system would provide maintenance-free protection for 90 to 138 years in the same environment.

In mathematical form, the synergistic effect would be defined:

$$M_{duplex} = 1.5 \text{ to } 2.3 (M_{galvanizing} + M_{paint})$$

M = time to first maintenance

This equation assumes no maintenance will be performed on the paint or powder coating, and as it naturally wears away the underlying galvanizing would provide the majority of the corrosion protection. This is only likely to be applied in theory as in practice; the project owner will maintain the paint system to keep the aesthetic appearance intact. Therefore, in practical terms, the synergistic effect is realized in the delayed maintenance cycle (touch-up, maintenance repaint, and full repaint) of the paint/powder coating of the duplex system. This delay of approximately 1.5 to 2.3 times for each of the three elements of the maintenance cycle means holding capital set aside for maintenance longer and fewer maintenance cycles over the project life. To illustrate the significant cost savings, consider the sample project case study:



Case Study

Project Specifications

- Two-coat epoxy/polyurethane paint system (6 mil dry film thickness) applied over HDG steel (3.9 mil minimum thickness)
- 50,000 ft² of steel comprised of a mix of large, medium, and small structural steel shapes (250 ft²/ton)
- Surface preparation of the galvanized coating equivalent to SSPC SP-16
- Planned project life of 60 years in an industrial service life environment (ISO C3)

Initial Cost

Using nationwide cost data collected from the galvanizing industry in a 2014 survey and paint industry manufacturers¹, the initial cost for applying the duplex system is the sum of the two costs (*Table 1*). Included is the galvanized coating surface preparation for painting and excluded is any transportation cost associated with trucking.

Table 1: Initial Cost	
Hot-Dip Galvanizing	\$1.76/ft ²
Two-coat epoxy/polyurethane paint	\$3.46/ft ²
Duplex System Total Cost	\$5.22/ft²



Maintenance Cycle

Every paint manufacturer has an ideal and practical time in specific environmental exposure conditions when touch-up, maintenance repainting, and full repainting should be performed for each paint system which may be repeated depending on the planned useful life of a project. *Table 2* below indicates the specified maintenance years for the two-coat epoxy/polyurethane for this project example if applied over black steel and the extended maintenance cycle, due to the synergistic effect, when applied over HDG steel.

	Over black steel	Over HDG steel [2.0x]
Original Painting	0	0
Touch-up Repaint	11	22
Maintenance Repaint	14	29
Full Repaint	20	51
Touch-up Repaint	31	58
Maintenance Repaint	34	Not Required
Full Repaint	40	Not Required
Touch-up Repaint	51	Not Required
Maintenance Repaint	54	Not Required

In economic terms, the delay in required maintenance means a project owner has a longer time to earn interest on money dedicated toward future maintenance. Assuming a savings interest rate of 4% and an inflation rate of 3% during the 11 years of delay for the first touch-up and the 15 years of delay for the maintenance repaint, etc., the calculated net present value (NPV) savings is provided in *Table 3*. Additionally, the dollars associated with the maintenance cycle required for paint over black steel and planned for year 34, 40, 51, and 54 now remain in the project owner's account.



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Table 3: Time to Practical Maintenance of Paint

	Paint over Black Steel			Paint over HDG		
	Year	Today's Cost	NPV	Year	Today's Cost	NPV
Hot-Dip Galvanizing	0	\$0	\$0	0	\$1.76	\$1.76
Original Painting	0	\$2.82	\$2.82	0	\$3.46	\$3.46
Touch-up Repaint	11	\$1.69	\$1.52	22	\$2.07	\$1.68
Maintenance Repaint	14	\$2.97	\$2.57	29	\$3.63	\$2.73
Full Repaint	20	\$5.79	\$4.77	51	\$2.07	\$1.26
Touch-up Repaint	31	\$1.69	\$1.25	58	\$3.63	\$2.06
Maintenance Repaint	34	\$2.97	\$2.12			
Full Repaint	40	\$5.79	\$3.92			
Touch-up Repaint	51	\$1.69	\$1.03			
Maintenance Repaint	54	\$2.97	\$1.74			
Total Life-Cycle Cost/ft²			\$21.76			\$12.95

Table 4: Life-Cycle Cost

	NPV/ft ² x Project Size	Total LCC
Paint over Black Steel	\$21.76/ft ² x 50,000 ft ²	\$1,088,000
Paint over HDG Steel (Duplex)	\$12.95/ft ² x 50,000 ft ²	\$647,500
40% Cost Savings		

Life-Cycle Cost

Summarizing, the life-cycle cost (LCC) savings for this duplex system is \$308,000, arithmetically determined in *Table 4*:

Due to the synergistic effect of delayed and even eliminated maintenance over a project's planned, useful life cost savings of a duplex system are often significantly greater than the initial 'premium' cost of the galvanizing and paint combination. To easily calculate the cost of duplexing your next project, visit lccc.galvanizeit.org. Therefore, utilizing a duplex system for corrosion protection pays for itself – delivering maximum value and aesthetic appeal to project owners throughout the design life. This is very important information for designers, architects, and specifiers seeking to justify the corrosion protection method to owners who will in turn shrink maintenance budgets and be free to dedicate that previously earmarked capital to expand their business.



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¹NACE Paper #C2014-4088 KTA Tator, Helsen, Lanterman, Reina, 2014