American Galvanizers Association
Galvanize the Future
Essay Contest

An Edgar K. Schutz Scholarship

Written by
Ryan Thomas, University of Alabama
Undergraduate Senior of Mechanical Engineering

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Thomas Engineering Consultants

Project Proposal
:Solar Farm Structural Coating

Prepared for: Trenz Pruca, Vice President Operations, Paradise Power Company
Prepared by: Ryan Thomas, Paradise Solar Farm Project Chief Engineer, Thomas Engineering Consultants

March 31, 2010

Thomas Engineering Consultants Thomas Drive, Tuscaloosa, Alabama 35405 **T** 205 792-2526 www.ThomasEng.net

Executive Summary

Proposal Objective

Both paint and hot-dip galvanizing are being considered for the protection of steel structural members supporting solar panels and other all other critical components at Paradise Power Company's Paradise Solar Farm project. The objective of this proposal is to substantiate the consultant's structural coating of choice.

Goals

Paradise Power Company has been the forerunner in sustainable development by means of renewable-source power generation throughout the United States. Thomas Engineering Consultants seeks to provide consultation services that support the social, economic, and environmental qualities of sustainable development consistent with Paradise Power Sustainable Development standards. Therefore, the goal is this evaluation is to justify a structural coating that will reinforces the Paradise Solar Farm project as the most sustainable project possible.

Considerations

Steel, though a superior substructure material, does not have an indefinite life-cycle. Rust and corrosion compromise the steel's structural purpose and necessitate maintenance and replacement often before the life-cycle of the project has been complete.

There are two primary methods of protecting the structural steel members on the Solar Farm to defer the maintenance of the steel until the full life-cycle of the project: painting and hot dip galvanization.

PAINTING

Industrial paints are often sprayed onto steel members by skilled professionals. Treating steel members with industrial paint-based coating system is inferior to hot-dip galvanization in corrosive protection, abrasion protection, as well as environmental impact and economic value as demonstrated in the rest of this proposal.

HOT-DIP GALVANIZATION

Hot-dip galvanizing (HDG) is the process of coating steel by immersing it in a bath of molten zinc through a three step process: surface preparation, galvanization and inspection (see *Figure 1*). This process is most often applied to fabricated steel at a galvanization facility before it arrives on site for construction.

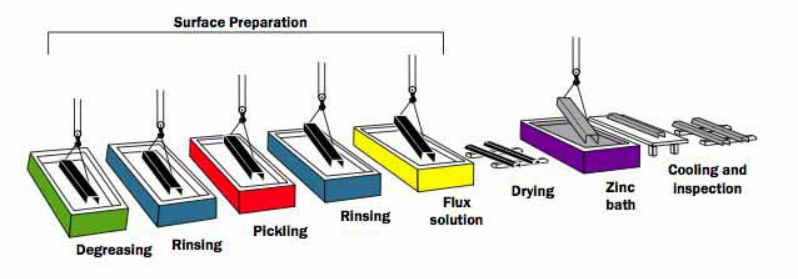


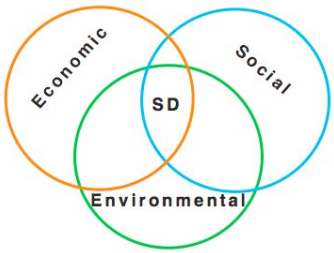
Figure 1. The Hot-Dip Galvanization Process

Paint-based coatings temporarily shield the steel substrate by creating a barrier from the corrosive elements in the environment. Zinc based galvanization is a sacrificial metal coating that also provides a second level of defense through cathodic protection: a chemical quality that facilitates any corrosive reaction on itself (as the anode) instead of the steel member (as the cathode). The sacrificial cathodic quality of the zinc will even protect bare steel with 1/4" of an exposed area of steel should the zinc coating become damaged.

The bonding behavior of the zinc in the HDG process is far superior to the bonding qualities of any paint-based coating system since the iron in the steel metallurgically reacts with the zinc to form a series of zinc-iron layers and an outer layer of pure zinc. This intermetallically bonded layering has a bond strength of approximately 3,600 psi. The intermetallic layers are harder than the steel itself providing substantial abrasion resistance to the steel member and a significant unlikelihood of the coating being damaged or otherwise compromised..

The HDG process insures a stronger and more thorough coating than using zinc-rich paints. The quality and thoroughness which zinc-rich paints can be applied is highly dependent on the surface preparation of the steel which is difficult to achieve in a uncontrolled environment outside a galvanizing facility. Zinc-rich paints, by their nature, have a lower zinc content than the 98% pure zinc coating of the HDG process. The application of zinc-rich paints is inaccurately referred to as "cold galvanization": still an inferior coating process though it uses a significant amount of zinc.

HDG Contributions to Sustainable Development



Sustainable development (SD) is a pattern of resource use with an economic, environmental and social commitment to meet present demands without compromising future generations' ability to meet their needs. HDG strongly supports the Sustainable Development standards that Paradise Power Company faithfully implements.

ECONOMIC CONTRIBUTION

The overall economy of the Solar Farm project can be determined in part by it's life-cycle cost: the project's life-time expenses including initial and maintenance costs. The initial cost of galvanizing is comparable with those of paint-based coating systems, but the HDG process delivers substantial savings through deferred maintenance events and repairs. The results of a case study of a life-cycle cost comparison between a paint-based coating system verses the HDG process can be seen in Figure 2. The case study was over a 60-year service life. The HDG process reduces the projected total cost over the life of the structure by 88%.

Coating System	Initial Cost		Life-Cycle Cost		AEAC[a]
	Per ft^2	Total	Per ft^2	Total	Per ft^2
Hot-Dip Galvanizing	$1.10	$ 462	$1.10	$ 462	$0.05
IOZ/Epoxy/Polyurethane	$3.10	$1,289	$9.69	$4,070	$0.43
[a]Average Equivalent Annual Cost per ft^2					

Figure 2. Life-Cycle Cost Case Study Results

Figure 3 illustrates the service life of HDG. The service life displayed on the vertical axis is the time to first maintenance for HDG steel parts for several environmental conditions. Utilizing hot-dip galvanization will protect the project and save direct and indirect maintenance costs for decades.

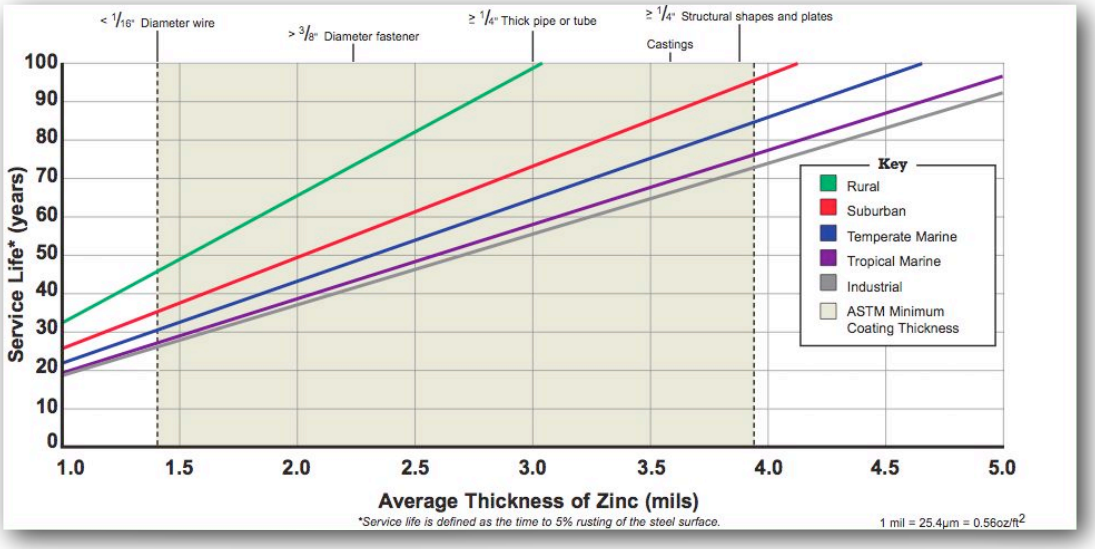
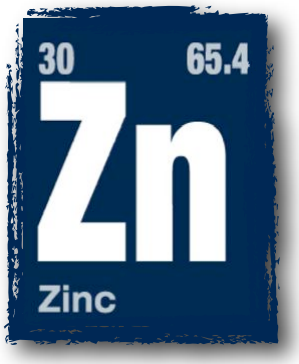


Figure 3. Time to First Service for HDG Steel Parts

ENVIRONMENTAL CONTRIBUTION

Steel is the most recyclable building material available. The HDG process adds a protective layer of zinc to the steel members prolonging their useful life. Zinc is a healthy metal that exists abundantly in its natural state and is a critical element in our ecosystem. Zinc is common in household items like sunscreen, tires, and cosmetics to treat diaper rash, acne, dandruff, and medicine for common colds.



Infinitely recyclable, 30% of the world's zinc comes from recycled sources. Both the zinc and steel of a member treated with the HDG process are 100% recyclable at end-of-life while the coating products used in paint-based systems contribute to solid waste during it's life and emissions at it's end-of-life if burned.

The mass of the coating and it's own environmental effect may seem relatively small compared to the steel it protects, but the overall environmental impact it has is hugely significant because the choice of coating greatly effects the life-cycle of the entire steel structure. Longer life-cycles mean less energy spent on recycling and rebuilding. HDG coatings can last 75 years or more with no maintenance, meaning fewer materials are used and lower emissions and wastes created once the structure is in use.

SOCIAL CONTRIBUTION

The growing awareness of human impact on the environment has increased the social demand for environmentally acceptable methods of human development. Power generation is the prime target of social negativity towards human development because of it's significant historical contribution to pollution.

This warrants greater attention to important details that make the Paradise Solar Farm as sustainable and environmentally neutral as possible. Developing a power generation facility that maximizes it's effectiveness through a low maintenance infrastructure produces a positive new enthusiasm towards the power generation industry making Paradise Power Company a social proponent of sustainable human development.

Solution and Conclusion

The Paradise Solar Farm Project is a multi-hundred-million dollar investment and, if working at full capacity, will recoup the costs of the investment into the project. In order to insure full functionality at full capacity, measures must be taken to guarentee minimum maintenance expenses.

Hot-dip galvanizing ensures the Paradise Solar Farm project will have the longest service life possible by eliminating steel member maintenance for the life of the project. The hot-dip galvanization method of coating also strongly supports the Sustainable Development standards of Paradise Power Company. Therefore hot-dip galvanization is the coating of choice strongly recommended by Thomas Engineering Consulting for the Paradise Solar Farm Project.