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XIOM COATING MANUAL

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1.0 INTRODUCTION

History of Powder Coating:

- Late 1940's: Flame coating of thermoplastic powders.
- 1953: Fluidized bed applications.
- 1962-1964: Electrostatic powder spray (EPS) application introduced.
- 1966-1973: Introduction of 4 original thermoset powders.
- 1970-2005: Rapid growth of powder coating.
- 2005-Present: Xiom thermoplastic spray powder coating method introduced.

Today:

- Powder coating is a huge business today as thermoplastic and thermoset polymer coatings are applied to a variety of substrates.
- They can be applied to cold surfaces before curing to film thickness typically between 1-10 mils (50- 254 microns).
- There are little VOC's (Volatile Organic Compounds) and reduced HAP's (Hazardous Air Pollutants).
- For this reason powder coating is the fastest growing industrial finishing method in North America representing about 15 to 20 percent of the total market.

EPS applied thermoset plastic coatings are further characterized by their wide use in production applications for decorative purposes where appearance and durability are required. Large numbers of relatively small components can best take advantage of the economic benefits from EPS powder processing thus conforming to the limits of batch processing and oven size restrictions.

1.1 Thermoset Powders

Thermoset Powders chemically react during the cure process. This means once the cure temperature is attained the coating is set. These resins can be ground to a very fine particle necessary for thin paint –like coatings.

Thermoset powders are derived from three generic types of resins:

1. Epoxy
2. Polyester
3. Acrylic
4. Urethane

These lead to five generally used coating formulations:

1. Epoxy
2. Epoxy/polyester hybrid
3. TGIC polyester-TGIC free polyester
4. Polyester urethane
5. Acrylic urethane

1.2 Thermoplastic Powders

Thermoplastic Powders do not chemically react during the cure process, which allows them to be reheated several times over.

Thermoplastic powders come in various formulations, some of the most popular are:

- Polyethylene
- Polypropylene
- Nylon
- Polyvinylchloride
- Thermoplastic polyesters

1.3 Flame Spray Thermoplastic Powders

Flame spraying thermoplastic powders, now called “Thermal Spraying” has been around for some time. It was marketed as an on-site process for applying thick polymer coatings but to date, there has been little market impact.

Two reasons can be sited for the past lack of success of **Thermal Spraying Polymers:**

1. Thermal Spray equipment used was designed primarily for spraying high melting point metal powders and then adjusted to handle polymer powders.
    - These modifications did not adequately prevent polymer powders from over heating and burning.
    - Thus, coatings did not always achieve their intended physical and chemical function.

2. Plastic powders sprayed were the same as those used for the EPS process.
    - No effort was made to modify powder particle size distribution to meet requirements of Thermal Spraying and no effort was made to design new polymer coating formulations required for on-site thermal spraying.
    - Coating adhesion, function and decorative value suffered because there was no material innovation.

2.0 XIOM'S THERMAL SPRAY TECHNOLOGY

XIOM's powder spray process uses the rich history of EPS Powder Coatings and then takes the coating technology a step further to meet the field requirements of on-site liquid painting, thus bridging the gap between in-house EPS processing and on-site liquid painting thereby achieving a true portable on-site thermal spray polymer coating system.

Two major innovations account for XIOM's coating technology leap.

2.1 On-site Powder Coating Applications the First Innovation

XIOM'S 1000 Thermal Spray system was designed from the ground up for on-site application.

- The system controls temperature of the heat source by introducing cooling air at critical points and providing for efficient transfer of a reduced temperature heat source to the plastic powder material.
- This avoids burning and emission of plastic combustion products. Thereby minimizing the potential generation of VOC's into the atmosphere.

Others have tried for many years to develop similar equipment, but all prior attempts have failed for one major reason:

- Plastic powders often act as a fuel source, and a short three-inch flame can become a two-to-three foot flame if the heat source temperature is too high for the powder material being applied.
- Early prior attempts consumed up to 50 percent of the plastic powder materials, and in many cases were detrimental to the substrate.

The Xiom 1000 plastic powder coating system has:

- Full control of the heat source which applies plastic powder materials at close to 100 percent deposit efficiency and at deposition rates some two-to-three times faster then early thermal spray systems.
- Coatings can now be applied to temperature sensitive substrates such as plastics, cardboard, paper, wood, gypsum wall board, some closed-cell Styrofoam, rubber, painted surfaces, and Poly-urea/Poly-urethane coatings.
- Complimenting the Xiom thermal gun and control console is the dual venturi 1000 fluidized bed powder feeder.
- All other powder feeders are based on a single venturi. But, metering for feed rate and material delivery are separate functions needing separate venturi. The first is feed rate, and the second is powder suspension in the feed hose.
- Single venturi systems are always a compromise between these separate functions and are prone to pulsation.

2.2 New Powder Coating Materials

New Powder Coating Materials were developed for the Second Innovation. XIOM plastic powders are designed specifically for Thermal Spraying.

- New materials technology utilizing multiple combinations, blends, additives and composites has been developed.
- Producing exceptionally high adhesion to most substrates and functional properties here-to-for not possible with polymers.
- Powder innovation allows for coating adhesion to various substrates without the need for liquid primers.
- Surface preparation requires only cleaning and roughing to achieve reliable and reproducible bonding to the substrate.

2.3 XIOM Thermal Powder Coating Technology

XIOM was the first to produce Thermal Sprayed Epoxy/zinc primer bond coats delivering very high quantities of zinc to the substrate for corrosion control.

- These Epoxy/zinc primer coatings were designed for secure bonding to steel substrates.
- To enhance bonding of sprayed plastic top coatings by leaving a suitably rough surface profile for proper adhesion.
- Many XIOM powders are unique and therefore patent pending. Substrates such as wood, plastic, masonry and fiberglass - not possible with EPS - are now readily sprayed with the XIOM thermal system, along with steel, aluminum and non-ferrous substrates.
- By combining technology innovations afforded with the XIOM thermal gun and powder feeder with a rigorous materials development (feedstock powders) program, XIOM engineers have produced a broad family of polymer coatings.
- This family includes thermoset polyesters and epoxies plus thermoplastic polyamide and polyolefin's, both modified and unmodified.
- The properties and physical characteristics provided by the coatings in the XIOM family are ideally positioned to meet the needs of a broad spectrum of industrial applications.

3.0 XIOM COATING APPLICATIONS and FUNCTIONS

Below is a list of some of the generic uses for XIOM coatings. Note that many applications require both function and appearance. This listing is not limiting but is intended to highlight areas where Thermal Sprayed plastic coatings are recommended or currently used or both.

- Architectural
- Corrosion protection for iron and steel, atmospheric and immersion
- Traction and release
- Marine environment protection from oils and salt.
- Electric insulation
- Ink transfer
- Anti microbial coatings both, clear and colors
- Anti graffiti coatings
- Marine Vessel Hull Protective coatings
- Outdoor weathering combined with appearance
- Potable water systems
- Food handling
- Glow-in-the-dark coatings
- Non-stick (without traction)
- Low coefficient friction (with some wear resistance)
- Non-slip surfaces
- Auto body repair
- Chemical corrosion control

4.0 METAL SUBSTRATE PREPARATION

No matter what coating we use the surface must be clean.
Why do we need a clean surface?

- Appearance
- Adhesion
- Corrosion resistance

If the surface to be coated is contaminated with: dirt, oil, grease, loose coatings, substrate materials, chemicals, acids, alkaline, oxides, salt or moisture than *no coating of any type can be made to adhere properly.*

4.1 Metal Surface Potential Problems

When a metal surface needs to be coated the surface must be examined closely for the following:

1. Metal surfaces that are reactive will have an oxide layer on them at all times. A layer of moisture is on the surface held there by the oxide film.
2. That oxide film and the moisture must be removed in order to convert the metal surface to non-reactive condition.
3. Another factor is the base metal itself. The components that make up the metal can cause contamination on the surface that will interfere with good coating adhesion and corrosion resistance. For example higher carbon content in steel will create more smut, difficult to remove chemically, and will interfere with adhesion.

The majority of the metal substrates that industrial finishers deal with are either cold rolled steel, hot rolled steel, aluminum, zinc die-cast or galvanized steel.

4.1.1 Most Common Metals Used

The following is a brief definition of some of the most common metals that are powder coated today.

- **Aluminum:** is a silvery metallic chemical element. It is known for lightness, malleability and resistant to oxidation.
- **Aluminum Casting:** aluminum in the molten state is poured into a form and allowed to solidify and form the desired part configuration. Special care in processing is required as the casting material has trapped contaminants or air pockets.
- **Die–casting and sand casting:** die casting is normally done under pressure where a sand casting is poured into a sand impression mold. The pressure injected die-casting process is less porous than sand casting thus producing fewer problems like out-gassing during the post curing cycle of powder coating.
- **Cold Rolled Steel:** the most common metal encountered by coaters. The product is roll formed to a close tolerance and fine surface finish, suitable for stamping, forming some drawing operations. Good base for phosphate conversion coating. Pretreatment process is usually clean, phosphate, rinse and seal, in this order.
- **Hot rolled steel:** low carbon steel suitable for forming, punching, welding, and shallow drawing. Surface has normal mill scale that must be removed mechanically or chemically prior to application of any conversion coating or organic topcoat.
- **Hot rolled steel, pickled and oiled:** is a low carbon material form which the mill scale has been removed by acid pickling. Light oil is than applied to prevent corrosion from forming on the surface. Mechanical or chemical pretreatment is required prior to coating.
- **Cast Iron:** a hard un-malleable pig iron made by casting: contains between 6-8 % impurities, including a high amount of carbon which is very fluid and fusible when molten.
- **Brass:** a yellowish metal that is an alloy made up of copper and zinc. Problems often are encountered when a clear finish of powder coating is applied. One should seek advice from your powder material tech manger before starting this project.

- **Copper:** a reddish brown malleable, ductile, metallic element is an excellent conductor of electricity and heat.
- **Lead:** a heavy soft, malleable, bluish-gray metallic chemical element used for piping and numerous alloys and compounds. Has a very low melt temperature. This metal is not very good for powder coating cure operations.
- **Zinc:** a bluish-white metallic chemical element usually found as a protective coating for iron. Example, zinc is main ingredient in electrodes for batteries.
- **Zinc casting:** zinc in the molten state is poured into a form and allowed to solidify and form the required part configuration. Material usually used in this process is sometimes a poor quality and can cause out-gassing problems. Also air entrapment in the casting will cause out-gassing and blistering when the air expands under the heated cure cycle.
- **Zinc plating:** many types of zinc plating surfaces are available in variety of thicknesses some will readily accept the organic coating, some will not. Usually the cause is brighteners, wax seals, and/or products when applied reduce surface oxidation.
- **Paint lock-electro galvanized:** produced by electrolytically deposited zinc on cold rolled steel sheets, than chemically treated to assure maximum coating adherence to the surface. The smooth light gray thin pliable coating of zinc permits forming and fabricating operations without peeling and flaking. This material is excellent for powder coating applications.
- **Hot dipped galvanizing:** this is the lowest quality zinc alloy, with thickness being hard to control. It is common for the manufacture to melt wax on the surface of the molten zinc to reduce the amount of harmful vapor fumes that are given off from the zinc. This wax must be removed, usually by mechanical or chemical means before thermal spray coating.

4.2 Cleaning Methods for Metals (Iron and steel)

4.2.1 Mechanical Cleaning

- Mechanical cleaning can be something as ordinary as wiping dust from the surface with a clean cloth. However when firmly attached metal scale or heavy rust must be removed, vigorous cleaning methods are required.
- Abrasive removal using a sanding belt or disk or a manually applied abrasive pad can be effective.
- Equally beneficial may be the use of a wire brush or wheel to remove rust.
- Very high pressure water alone is also effective for surface cleaning.
- When very large areas are to be cleaning, it is often efficient to use sand or other abrasive material blasting with grit propelled in a high pressure air or water blast.
- The grits used in this technique can include sand, steel shot, plastics, glass beads, aluminum oxides, and soft–cutting organic materials such as ground walnut hulls or ground corncobs.
- Ice, carbon dioxide and sodium bicarbonate (baking soda) pellets are used as well for their ease of cleanup.
- With grit cleaning or blasting, care must taken to avoid leaving grit particles embedded in the surfaces these can cause poor paint adhesion and possible corrosion under the paint coating.
- When recirculation grit is used care must be taken to separate and remove accumulated fines and debris.
- Mechanical cleaning may be coupled with liquid cleaners using cushioned plastic wool pads, which have the advantage of not loading up and dirt embedded.
- As with sanding cloths and papers, the pads are available in a range of physical sizes from coarse to fine. Scotch-Brite, Blade-Ex and Brushlon are common brand names for these abrasive materials.
- Most XIOM coatings will require surface preparation beyond normal cleaning solutions.

- When applying an XIOM coating to metals, sanding or grit blasting should be to a near-white metal SPPC 10 level, thus removing paint and other contaminants.
- The grit selected must produce a 2 mil (.002) profile.
- XIOM recommends against using a blasting grit that leaves chemical acid, oil, or alkaline residue.
- On steel metals avoid grit material that does not provide a surface texture pattern. These include dry ice, sodium bicarbonate, agricultural products and wet blasting, these are for cleaning only.

An excellent source for blasting equipment is www.clemcoindustries.com

A source for all types of abrasive cleaning media is www.blast-it-all.com

4.2.2 Solvent Cleaning

- Despite the high labor and possibilities for missed spots, hand wipe cleaning is still best for some metal parts.
- Solvent cleaning can be done by spray, vapor or dip and can be coupled with wiping with a solvent-saturated sponge or cloth.
- The wiping material and any solvents used in spraying, dipping, or wiping must be clean or else dirt, oil, or grease will be left on the part being cleaned.
- The equipment and maintenance expense of these methods in most cases exceeds most budgets, which usually directs us to other less costly methods.
- Solvent cleaning needs to be done in a confined, well-ventilated space to keep vapors away from people and other processes in the vicinity.
- Flammable solvents should be used with extreme care.

4.2.3 Aqueous Cleaning

Aqueous cleaning – water plus detergent and frequently also light solution of acid or alkali, are the most popular cleaning systems for industrial finishing. Two main advantages of these systems are the absence of solvent emissions and the ready adaptability to practically every cleaning requirement and every type of substrate.

- The basic types of aqueous cleaning are spray and dip (immersion) either with parts conveyed on a hook, carried on a mesh belt, or place in a wire basket to hold them during the cleaning operation.
- Parts may be lowered into and out of the cleaning liquid or carried through the cleaning spray or dip zone.
- Spray cleaning is most commonly used and is faster because of the scrubbing action of the impingement of cleaning solutions.
- Spraying normally cannot reach into areas which are not readily accessible.
- Dip cleaning is much slower, but the solution will reach into areas not accessible to the spray method.
- To increase cleaning rates, the dip cleaner solutions are often higher in detergent concentrations than spray cleaner solutions.
- Low volume operations commonly use manual spray or dip; high volume manufacturing usually uses automatic spray or dip.
- The choices of manual or automatic and whether to use spray, dip or a combination of spray and dip are often determined by the nature of the soils on the parts and the size or configuration of the products to be cleaned. Parts volume is another important factor.
- Dip cleaning can be done with small parts by placing them in a wire basket that can be lowered into the cleaner tank.
- Large bulky low-volume items are often cleaned manually with aqueous solutions.
- The use of Tri-sodium Phosphate is an environmentally friendly alternative to most alkaline or acid solutions; follow by thorough rinsing.

Tri-sodium phosphate can be purchased from a number of local sources. Home Depot, Lowes, and Wal-Mart. Manual spray is usually accomplished with a spray nozzle attached to end of a wand and hose connected to the container of solutions, with moderate high pressure (75-200 psi) to create the impingement action.

This allows the operator to reach into sizable cavities and yet stay a safe distance from the nozzle in order to avoid getting splash back by hot detergent solutions.

The choice of the nozzle type is dependent on the stage in which it is used and what chemicals are being sprayed.

- **Whirl-jet** nozzle gives a flood pattern with low impingement force but lots of fluid volume.
- A **V-jet** style nozzle combines high volume and high surface impingement in a flat wide spray.
- The **K-jet and Fan jet** nozzles are similarly flat but result in less overspray and allow better containment of chemicals. They are low in volume and impingement force.

The use of high pressure steam is an excellent way to clean all surfaces. A source for this equipment is the Electro Steam Generator Corp. www.electrosteam.com

4.2.4 Acid Cleaning

- Rust, scale and oxides can be removed rapidly from parts to be painted by using acid pickling solution.
- Although the oxides react with acid faster than the metal itself, the pickling will also to some degree etch the surface of the metal.
- The acid should have an inhibitor in it to slow the etching action to desired rate most suited to the part being cleaned and type of soil to be removed.
- Both hydrochloric acid and sulfuric acid can be used on steel.
- Aluminum is frequently cleaned with nitric acid solutions.
- All of these solutions required careful handling, it is suggested that a solution be obtained from the manufacturer formulated for the type of method required to remove the soils on the metal surface.

4.2.5 Alkaline Detergent Cleaning

Aqueous alkaline detergent cleaning solutions are used to clean all types of metals. They are the preferred agent since they include little or no material harmful to the environment.

- In general the stronger the alkali, the faster the soil is removed and longer the cleaning solution will last.
- Just enough alkalinity is used in the detergent formulation for good soil removal; too much will slow and cause incomplete rinsing.
- This is important because thorough rinsing of alkaline cleaners is needed or required for good painting.

4.2.6 Emulsion Cleaners

- Emulsion cleaners that have kerosene or similar organic solvents in them have been available for some time.
- Some are so high in solvent that they are flammable.
- They work well for removing greases but not for the removals of a wide range of soils and contaminants.
- Emulsion cleansers also tend to cost more than ordinary aqueous cleaners and so they are less used.
- Some of the citrus oil-containing cleaners have found good acceptance, however the smell of citrus is evident when they are used.

4.3 Preparation Procedures for iron and steel

Before Thermal spraying steel components first determine if process temperatures of 200 to 300 deg F (93-149 C) will affect the steel's heat treat history. For instance, will heating cause annealing or softening?

1. Power wash with tri-sodium phosphate to remove all chemicals, dirt, grease, oil, salt, acids, and alkaline followed by a fresh waterpower wash rinse. Alternately, use Acetone or aqueous washer solutions containing acetic acids.

2. For thin coatings, less than 0.005 mils (125) um), the surface can be chemically treated or sanded or both to less than 100 micro inches roughness.
3. For thick coatings, greater than 0.005 mils thick use pressure or vacuum blasting at about 40 psi with 200 mesh (75 um) sand or steel grit. A correctly blasted surface should be between 100 micro inch and 200 micro inch roughness, or by paint standards, near white SSPC 10. Remove surface debris and dust with clean air blast or by vacuuming.
4. Apply a primer to the grit blasted surface before spraying as this film promotes bonding and provides some corrosion resistance. A zinc phosphate primer (such as Devoe, Cathacoat) or iron phosphate primer (X55) may be used. However, zinc primers contain VOCs. Iron phosphate primers do not contain VOCs. Therefore, X55 may be the better choice under certain situations.

Steps 1, 2, 3, and 4 are the basis of good surface preparation producing the best conditions for achieving the most reliable bond.

NOTE: XIOM RECOMMENDS THIS SURFACE PREPARATION WHEN EVER POSSIBLE.

4.4 Procedure for Stainless steel

1. Stainless steel is relatively free of the iron hydrates that are common components on the surface of regular grades of carbon steel.
2. Stainless steel should be cleaned to remove the surface oils and dirt from the manufacturing and handling operations.
3. The passive oxide layer on stainless steel is relatively inert to the alkaline cleaners and other chemical products that are commonly used on carbon steel.
4. Normal cleaning will remove lose soils, but it will not create a surface that is receptive to iron phosphate.
5. Acid etching with nitric acid or mechanical abrasion process or grit blasting are sometimes used to remove the oxide layer and create a slightly-roughed surface that is better for adhesion of the coating. These processes help promote adhesion, but will not provide any additional resistance to moisture penetration.

4.5 Procedure for new hot dipped galvanized steel

1. Remove all drainage spikes and surface defects.
2. Powder coat within 12 hours of galvanizing. Do not get the surface wet.
3. Keep the surface clean.
4. If surface contamination has occurred or is suspected, clean surface with appropriate solvent.
5. Use iron phosphate (X55) pretreatment for best adhesion and corrosion resistance.
6. Acid etching with tri-sodium phosphate (TSP).

4.6 Procedure for old galvanized surfaces

Make sure surface is clean and free of oil, dirt and grease by:

1. Acid etching with tri-sodium phosphate (TSP).
2. Rinse with clean water.
3. Apply X-55 conversion coatings per Xiom instruction.
4. Apply Xiom top coating material.

4.7 Procedure for surfaces with rust and/or paint

Check to make sure the old paint is still securely bonded as the Xiom coating bond will only be as good as the old paint.

4.7.1 Procedure for paint on substrate

a) If the old paint is loose and flaky, stop, the surface must be grit blasted;
b) If still tightly adhering, power wash with tri-sodium phosphate followed by a fresh water rinse;
c) The surface may now be spray coated.

4.7.2 Procedure for rust on substrate

a) Use mechanical cleaning process ranging from light sanding to abrasive blasting to remove all rust to expose substrate down to bare metal as described in section 4.3;
b) Apply appropriate bond coat if desired;
c) The surface may now be spray coated.

4.8 Procedure for Aluminum Surfaces

Surface preparation to aluminum surfaces prior to application of XIOM powder coatings should be as follows. Make sure surface is free of oil, grease, paint etc. See acid cleaning section 4.2.4.

1. If grit blasting is required use alumina grit only and keep blast pressures below 40 psi.
2. Apply Xiom X55 one step iron phosphate conversion primer.

4.9 Procedure for Magnesium Pretreatment

1. Alkaline cleaning - Caustic soda.
2. Water rinsing.
3. Organo –metallic composite coating - Fluorozirconate conversion coating.
4. Water rinsing -deionized water.

5.0 OTHER MATERIAL SUBSTRATES PREPARATION

5.1 Concrete and Masonry surfaces

1. Power wash with tri-sodium phosphate or an environmentally friendly alternative to remove all chemicals, dirt, grease, oil, salt, acids, and alkaline followed by a fresh water power wash rinse.
2. Use pressure or vacuum blasting at about 40 psi with sand or steel grit at 200 mesh (75 um). A correctly blasted surface will be near white SSPC 10. Blow or vacuum dust from the surface.
3. Fill pores with X-40 epoxy primer if not greater than 4 mm. All cracks greater than 4 mm should be repaired.
4. Apply X-40 epoxy primer. See section 6.4 for instructions.

5.2 Glazed Ceramic Tile

1. Power wash with hot water or other safe solvent to clean soap residue from the surface. All soap must be removed before going to the next step.
2. Rough up the tile glaze by washing with muriatic acid. (Not supplied by Xiom, but available in most hardware and home building stores. Tile glaze must be etched to create a rough surface for best topcoat application adhesion.
3. Inspect the tile surface. Sand the surface for further roughening and clean as require.
4. Make sure the surface is dry and vacuum off any loose dust before spraying.
5. Surface is now ready for coating.
6. See Xiom tech data sheet.

5.3 SURFACE PREPARATION FOR SUBSTRATES REQUIRING MARINE EXPOSURE

5.3.1 Steel substrates above the waterline

For steel substrates exposed above the waterline including piers, ship superstructures and buoys there are two steps:

d) Before spraying Xiom coatings the surface must be cleaned by removing old paint and rust by grit blasting, soda blasting or high pressure water jetting (Refer to SSPC-SP 12 for water jetting) to achieve surface conditions meeting SSPC-SP 1, i.e. clean steel free of rust and scale;

e) Apply a liquid zinc primer (not recommended for surfaces below the water line) or a iron phosphate solution (X 55).

5.3.2 Procedure for applying zinc primer coats

Typically zinc bearing primer pre-treatments applied to steel attach by etching, leaving residual zinc thus enabling the substrate to resist harsh marine environments. Two primers were tested and both are recommended each with certain provisions according to the topcoat and application.

a) Devoe, Cathacoat 302K plus 302K Converter, Reinforced inorganic zinc primer. (302B0250 and 302C0910). This primer may be used on all steel components and will readily accept XT700 series bond coats as well as X500, X200, X205 or XT600 series coatings. Procedure for application is as follows:

   I. Mix primer according to manufacturers instructions and apply by brush or spray in accordance with SSPC-PA 1, “Shop, Field and Maintenance Painting of Steel”. This primer can be used on steel with slight amounts of rust. An attractive property as perfect cleaning of old marine exposed steel is difficult;

   II. Primer coat will dry in 15 to 30 minutes. It is preferred that thermal spraying begins as soon as possible after drying and not to exceed 4 hours after the primer is dry. For instance, the primer can be applied in the morning and spraying done in the afternoon;

III. Preheat the dry primer as high as possible, do not to exceed 400F (190C). Preheating to 180F (82C) is okay but higher is better;

IV. Spray Xiom coatings on to the heated primer.

b) Basic Zinc Chromate-vinyl Butyral Wash Primer (AKA Navy Formula 17: one supplier of which is Interlux 353 Vinyl-Lux Prime Wash Base and reducer). This primer is intended for clean steel but can be used on steel with slight amounts of rust. X500 series and XT 600 series coatings readily bond to this wash primer. This primer does not accept X700 bond coats.

I. Following surface prep steps 1) and 2) in 5.3.1 above;

II. Apply X200, X500 or XT 600 series coatings directly to this primer;

III. Preheat to about 150F (65C) and commence spraying.

NOTE: XIOM's phosphate solution (X 55) is water based and serves to condition steel to retard oxidation and provide high bond strength.

5.3.3 Steel substrates below the waterline

For Steel substrates requiring protective coatings, including steel hulls and components below the waterline and intended for sea water immersion, XIOM does not recommend using zinc primers. Since Xiom's X 145 Marine Vessel Protective Coating (MVPC) is a polyamide elastomeric coating containing cuprous oxide it must be separated from the steel hull by a non conductive coating.

a) Clean as per above to meet SSPC-SP 1, clean steel free of rust and scale.
b) A bond coat of XT 750 epoxy must be applied. This will serve as a barrier coat between the X 145 and the steel component.
c) Grit blast the hull to achieve roughness of 200 microns. Begin preheating and spray as soon as possible after blasting to minimize time for rust flashing.
d) Preheat to 200F and apply XT750, use two or more passes to achieve between 10 mils and 15 mils coating thickness.

e) Spray X 145 MVPC any time after XT750 bond coat is applied. Using Xiom's torch or ancillary heating device bring the surface temp of XT750 up to about 200F (65C), it will appear glossy as thermoplastic particles begin to soften. This is the point to begin spraying X 145 MVPC.

5.3.4 Surface preparation for fiberglass hulls and components.

For surface preparation for fiberglass hulls and components. XIOM recommends following the surface prep steps below. This is XIOM's recommendation for the best possible performance of the MVPC system onto fiberglass hulls and components.

a) On boat bottoms previously coated and exposed to sea water, remove all evidence of previous surface treatment and return surface to original gelcote condition. Use water jetting, grit blasting, soda blasting or sanding to accomplish this task.
b) Dry the surface if wet and remove dust by using clean air blast or vacuum.
c) Preheat the gelcote surface to 300F to 350F. (150C to 175C), the surface should not show brown staining. If there is a color change you have exceeded 350F.
d) Apply bond coat XT 750 in one pass (3 to 4 mils), prior to applying X 145.
e) Spray X145 directly to the preheated fiberglass in two passes to achieve 6 to 8 mils thickness.

In certain cases, XIOM 145 MVPC is a polyamide elastomeric and can be applied directly to fiberglass hulls, by following steps a, b, c and e.

5.4 Fiberglass Non-Marine applications

1. Power wash with tri-sodium phosphate or an environmentally friendly alternative to remove all chemicals, dirt, grease, oil, salt, acids, and alkaline followed by a fresh water power wash rinse.
2. Remove all adhering contaminants by blasting with walnut shells or other non-aggressive media. Using compressed air blow off or vacuum dust from the surface. Use 100 grit wet or dry sandpaper.

3. Remove all sanding residue by power washing with fresh water or by blowing or vacuuming the surface.
4. For thin coatings, i.e. less than 0.008 inches (200 microns) apply top coatings directly to the fiberglass.
5. For thick coatings or to rebuild boat hulls apply XT 750 BOND COAT up 0.025 inches max. (1250 microns) thick. XT750 is an epoxy/polyamide coating which bonds to fiberglass and replaces two-part liquid epoxies. Note: It is also designed to accept topcoats from both XT600 and X500 series coatings.
6. Apply Xiom intermediate and topcoats as required immediately after XT750 is applied. No cure time required as XT750 is cured when deposited.

See section 5.3.4 for surface preparation for components in marine applications.

5.5 Treated Plywood, MDF, pine, and other wood applicable materials

1. If surface is painted and contaminated, first power wash with tri-sodium phosphate or an environmentally friendly alternative to remove all chemicals, dirt, grease, oil, salt, acids, and alkaline followed by a fresh water power wash rinse.
2. Allow surface to dry.
3. Fill all cracks, pores, and voids.
4. Sand the surface to remove loose paint and to smooth edges and filler.
5. Sand to desired surface roughness.
6. Blow off all loose particles.
7. Apply Xiom coatings designed for application to wood surfaces.

5.6 Cardboard Materials

1. Using compressed air blow dust and debris from the surface.
2. Surface must be free of oils and grease.
3. Do not preheat.
4. Apply per Xiom tech data sheet.

6.0 HOW TO APPLY SPECIFIC XIOM PRODUCTS

6.1 Exterior Metal Applications

Note: Apply the Xiom XT 765 zinc metal primer after completing steps 1, 2, and 3. Top coatings can be applied later with less urgency as the Zinc metal primers prevent steel corrosion during transit or extended delays before spraying.

Use the following guidelines:

1. When steel substrates are large and prepared off-site rapid zinc priming is recommended before shipment to the spray station.
   - Use any of the approved wet zinc primers and follow the manufacturer's directions for application. These primers are typically painted within 3 hours after completing step 2.
   - Less if the relative humidity is high. And then allow at least ten (10) hours drying before the top coating can be applied by Thermal Spraying.
   - Our tests prove that XIOM topcoats adhere to most wet zinc primers, but we recommend some bond testing to confirm your results before proceeding.
   - XIOM's XT 765 Thermal Sprayed Zinc /epoxy bond coatings can be used as the primer instead of current wet zinc paint systems.
   - If you choose to use XIOM's Thermal Sprayed Zinc/epoxy bond coat primers, refer to step "B" below.

2. For the greatest delivery of Zinc to the substrate and for the opportunity to spray the top coat immediately after priming, use XIOM's thermal sprayed epoxy bond coating as the primer. Follow these guidelines:
   - Apply XT BOND COAT 765 at 5 to 10 Mils (0.005 in. to 0.010 in) as soon as possible after cleaning and roughening the substrate to prevent flash rusting.
   - XT 765 is designed for XT 600 and 500 series top coatings.
   - Apply XT BOND COAT 765 at 5 to 10 Mils (0.005 in. to 0.010 in) as soon as

possible after cleaning and roughening the substrate to prevent flash rusting.

Note: this section addresses the preparation of steel that has been in service and shows rust prior to application of Xiom coatings.

3. Any steel component can be readied for the application of Xiom coatings by following section 4.3, steps 1, 2, 3, and 4.
    - This usually means removing rust, dirt, old paint and perhaps some mil scale. If this is done no other considerations are required.
    - Sometimes rust and old paint can be handled without grit blasting but can be risky so use section 5.6 sparingly and only when grit blasting is not possible.

6.2 Application of XT 765 (zinc bond coat)

1. Prepare the steel surface by thoroughly cleaning and then roughing with grit.
2. See Section 4.0 on “Substrate Preparation” for surface preparation techniques.
3. Preheat to about 200 deg F (93 C) and then initiate spray.
4. Apply first pass allowing the epoxy/zinc bond coat to melt and flow out.
5. It will appear wet and dull.
6. Apply the second pass at increased spray distance.
7. The layer will appear dry and rough thus establishing a rough profile for top coating adhesion. Total thickness to be 6-10 mils.
8. Apply the top coating by first preheating the bond coating surface up to at least 200 deg F (93 C).
9. Begin top coat spraying, allowing both zinc bond coat and top coat to melt together and wet out.
10. This protocol will establish excellent adhesion to the steel substrate as well as contiguous alloying with the top coating.
11. After two passes, apply XT-765 Epoxy/zinc bond coat, between 0.006 and 0.010 inches thick.

6.3 Application of Xiom 25 (emulsion coating)

XIOM 25 is a water based emulsion designed to enhance the surface properties of thermal Sprayed polymer coatings. Properly applied XIOM 25 will embellish surface characteristics including, easy removal of graffiti, anti fouling and non-stick properties.

1. Apply XIOM 25 with a brush or by air spraying directly to the coating.
2. Apply liberally to saturate the surface, it may drip or run but do not wipe clean.
3. The emulsion can be applied directly to the coating while it is still hot from thermal spraying and the surface temperature is preferably below 225 deg F (107 C).
4. Begin heating the emulsion saturated polymer coating to its melting point.
5. At-or-close to the polymer melting point the coating takes on a shine and the emulsion turns clear as the two components combine chemically. This is a visual sign that the post treatment is finished.
6. If the coating has cooled or the application of XIOM 25 is planned for another day, you may apply XIOM 25 to the cold surface and then reheat to about 300 to 400 deg f (148-205 C) to chemically combine XIOM 25 with the polymer coating.
7. As the treated surface cools an oily residue remains. This is normal and indicates that the emulsion has cured. Remove the oily residue by wiping with a clean cloth. If the residue is not objectionable leave it alone as it will dry over time.
8. A second application of XIOM 25 is often advisable to insure full surface coverage and thorough chemical reaction. The second application may be done while the coating and emulsion are hot from the first application.
9. Applying the first and second treatment of XIOM 25 while the coating is hot saves time and cost of reheating.

6.4 Application of XIOM 40 (concrete and masonry sealer coat)

X40 is a two component solvent free high build epoxy resin, silane modified to bond to concrete and provide a surface for the application of Xiom thermal sprayed polymer coatings. It also serves as a barrier to seepage of water and water vapor. It may be applied to green and damp concrete substrates to facilitate fast track top coating. When dried X40 appears glossy and feels tacky, it is ready for a thermal sprayed polymer top coat. The product exhibits excellent adhesion to concrete under most conditions, it is easy to mix and apply and permits early over-layment.

1. Concrete substrates must be clean, sound and free of oil, grease and any other surface contamination that could impair adhesion. All residues of old coverings must be fully removed.
2. Prior to application the entire surface should be vacuumed of all dust and loose materials.
3. Existing floor areas will require mechanical abrasion to reveal clean concrete. Enclosed vacuum blasting equipment or vonarx type scabblers should be used. Any areas that have been contaminated with oil or grease should be treated with hot compressed air blasting equipment.
4. Any areas of damaged concrete should be broken out and repaired. For small areas of thin section repairs less than 0.40 inches (10mm) in depth, use epoxy resin repair mortar. For larger areas requiring thicker section repairs, a polymer modified cementations repair mortar should be used.
5. Any cracks in the substrate in excess of 0.04 inches (1mm) wide should be chased out to a minimum width and depth of 0.20 inches (5mm) and repaired with crack filler or an epoxy resin mortar. Finer cracks do not normally require pre-treatment and can be flooded with X40 epoxy.
6. For newly laid concrete substrates a light pass with enclosed vacuum blasting equipment is required. Note that ground supported concrete should incorporate an integral damp proof membrane in accordance with building regulations.

7. Expansion/contraction joints should be treated individually with joint sealant as required and the Xiom X40 bond coating should be a discontinued at the location of these joints.
8. New concrete slabs should be a minimum of 14 days old prior to application.
9. Roughing of the concrete surface should be carried out with care as it can result in a rough profile that could compromise the integrity of the X40 bond. It is however accepted that difficult inaccessible areas will need to be treated individually using a needle gun or similar device.
10. X40 is supplied in pre-weighed packages. It is essential that the entire curing agent component A is added to the entire resin component B and mixed thoroughly for 60 seconds using a mechanical paint stirrer.
11. The fully-blended system is immediately applied to the substrate with brush or roller at an average rate of 48 square feet/liter (care should be taken not to exceed this coverage rate). Care should also be taken to avoid excessive mixing and the possibility of air entrapment compromising membrane integrity. Following the cure, the surface should be inspected for air holes.
12. For relative humidity above 85% and below 97% further coat of X40 will be required and application will follow the same procedures.
13. Curing takes approximately 6 hours at 20C (68F) and 8 hours at 10C (50F).
14. Following a successful application the material should be allowed to cure for minimum 8 and maximum 24 hours prior to thermal spraying Xiom polymer top coats.
15. Substrate should be preheated to approximately 68C (154F) before applying Xiom polymer top coats. Allow top polymer coat to cool before handling.

6.5 Application of XIOM 55

X55 is a one step iron phosphate conversion coating for steel, iron, aluminum, and galvanized steel. A low temperature, low foaming spray that conditions the surface in one easy step. Environmentally friendly as it does not contain solvents, molybdenum or HF activators.

Use X55 on steel, iron, aluminum and galvanized steel before spraying Xiom polymer coatings to achieve high integrity bonding with enhanced corrosion protection.

NOTE: MEETS FEDERAL SPECIFICATION TT-C-490E ON CHEMICAL CONVERSION COATINGS.

Procedure:

Prior to application the substrate must be clean. All oil, grease and other surface contaminates that could impair adhesion must be removed. For this purpose you can use warm alkaline cleaner. After cleaning, roughen the surface with grit blasting.

To the cleaned surface proceed as follows:

1. Preheat to 120F and then spray X55 solution on the surface. Apply liberally to ensure full wetting.
2. Allow 15 to 20sec. to dry. You will notice some surface discoloration as the iron phosphate conditions the substrate.
3. Continue heating to the desired preheat temperature, usually 150F to 200F for application of the powder coating.
4. Spray the powder coating directly to the iron phosphate conditioned surface.

7.0 Quality Testing Methods

There are several levels of cleanliness that can be achieved on a substrate surface and just as many ways to check for those conditions. Some very simple ways are listed below.

7.1 Clean Surface

One which is free of oil and other unwanted contaminants, which if left on the surface will cause problems later in the process. The level of cleanliness is based on operation or process to which the part or product will pass.

7.2 Water Break-Free Surface

This condition will indicate whether or not you have removed all organic soils. When the parts complete the last pretreatment or rinsing stage, prior to drying, there should be a uniform sheeting of the rinse water. If you see beads of water, which resemble organic soil contaminants still present they must be removed.

7.3 White Towel Test

Wiping a white towel across the surface of the part or product will show if there are any contaminated areas left.

7.4 Tape Pull Test

Applying scotch tape to a clean and dry surface will indicate the whether any contaminated soils are still there. The method is done by placing the tape on the surface and removing and placing it on a white piece of paper. The contrast of the white paper will show remaining soils.

7.5 Finishing Coating Test

There are several simple ways to test if the finished powder coating will perform as required. Some examples of tests that are commonly performed on products that have been powder coated are described below. These examples are of actual tests that companies have been or are now performing on powder coating surfaces in actual production.

7.5.1 Film thickness

Every applicator of coatings must have a means of evaluating the applied film thickness. There are a number of different manufacturers of thickness testing equipment for ferrous and non –ferrous metals. Without the ability to test the thickness of the applied coating quality, transfer efficiencies and costing are simply a guess.

7.5.2 Chemical resistance test

Place 10 drops of test solvent on the surface of the coating. Allow to stand for 30 seconds. Wipe off with soft dry white cloth. Coating should have no more than a slight circular mark.

7.5.3 Cross Hatch adhesion test

Scribe parallel lines through coating to substrate, ¼" apart over a distance of one inch. Scribe another set of parallel lines ¼" apart and perpendicular to the first set. Apply 3M 4-9239 tape or equivalent then remove slowly. Results should be no lifting of film between scribe lines.

7.5.4 Bend test

Coating on .036 inch thick phosphate steel panel shall withstand 180 degree bend over ¼" mandrel. No crazing or loss of adhesion and finish at the bend should be allowed after removal with 3-M's Y-9239 tape or equivalent.

7.5.5 Hardness test

Hardness test according to ASTM D3363 Faber Castell wood pencils are used in hardness of 1,2,3,4. Coating shall show no marks from 2H pencil.

7.5.6 Impact test

Coating on .036 inch thick phosphate steel panel shall with stand impact with ½" Gardner impact tester ball at 26 inch pounds direct and reverse. No grazing or loss of adhesion. Finish shall not to be able to be removed at impact area with 3M Y -9239 tape or equivalent.

7.5.7 Accelerated Weathering Test

Use a 5% salt solution at 92-97 deg F (33-36 C) degrees in sealed weather cabinet. Scribe X in steel zinc phosphate test panel to bare metal. Inspect every 24 hours. End test and total hours after ¼" creepage from scribed area. Creepage shall not exceed ¼" in either direction from scribe line after 500 hours exposure.

7.5.8 Gloss Test

Test coated flat panel with Gardener 60 degree gloss meter. Coating shall not vary + or – 5% from data sheet requirements on each material supplied.

Sample test panels are available from several companies, listed below are two.

ACT Test Panels Inc. www.acttestpanels.com

Q-Lab Corporation www.q-labl.com

8.0 Safety Considerations

8.1 Xiom Safety Measures

The Xiom Thermal Plastic Spray System is not dangerous.

1. Remember, however, that thermal spraying is potentially hazardous because it involves the use of combustible gases, high pressure containers and hoses, and potentially irritating or toxic materials.
2. It is possible for dusts and mists to contaminate the air.
3. Thermal spraying can be completely safe when a competent operator understands thermal spraying practices and has knowledge of the equipment and its operation.
4. All equipment must be maintained in first-class condition.
5. To further ensure safe working conditions, adhere to the following precautionary measures.

8.2 Avoid Fire

The flame of the gun is hot enough to burn almost any material.

The stream of plastic spray particles is also hot.

Remember:

1. Keep the gun pointed away from your body and any material that will burn.
2. Wear fireproof or flame resistant clothing if possible.
3. Extreme care must be taken when lighting the gun or adjusting the regulators.
4. Keep hoses completely out of the way.
5. Do not spray on them. Hose will burn.
6. Keep the work place free of combustible materials.
7. Paper, wood or oily rags will ignite rapidly if the gun is pointed toward them.
8. Fans, pipes, dust arrestors and motors should be electrically grounded.
9. Motors should be external to the duct system.
10. Use only non-sparking tools during cleaning and repair operation.

8.3 Guard against gas hazards

Charged gas cylinders are potentially dangerous.

Be sure to:

1. Regularly inspect all hoses, regulators and gas cylinders for leaks or loose connections that might cause a fire or present the hazard of explosion.
2. Do not hang a thermal spray gun or its hoses on regulator or cylinder valves; a fire or explosion may result.
3. Always keep gas cylinders away from water and direct sources of heat.
4. Prevent cylinders from falling over by securing them with chains.
5. Comply with all local, state and federal regulations regarding the storage of gas cylinders.
6. Before moving any cylinder, close the cylinder valve, discharge and remove the regulator. Put on the cylinder cap.
7. Put valve caps on cylinders when they are not in use.

8.4 Avoid Dust Build-up

Thermal spraying produces plastic dust; sufficient quantities of any dust can pose the risk of explosion as well as health hazards.

Remember:

1. When cleaning the work area, the ventilating fan should be kept running to prevent the accumulation of fumes or dust within the system.
2. Prevent accumulation of fumes and dust. Prompt and regular clean up of the work area is essential.

Ensure Adequate Ventilation:

1. Any form of dust may damage a person's respiratory system.
2. Adequate ventilation in spray booths and other confined areas will minimize the danger of dust explosion and prevent the toxic or noxious effects of dust, fumes, and mists that may be generated by thermal spraying.

8.5 Minimize Noise Hazard

1. Noise Level at any location depends on a variety of factors.
2. Equipment operating parameters and background noise are only part of the picture.
3. The size of the room as well as wall, floor and ceiling materials, also affects noise levels.
4. Determining the exact level requires measurement equipment.
5. When used for extended for any time, the Xiom Thermal Spray System may exceed the maximum noise levels permitted by the OSHA.
6. The operator and other personnel close to the heat spray operation must be protected form excessive noise levels.
    - Hearing protection such as Xiom hearing protection should always be worn.
    - Wads of cotton are ineffective in protecting the ears from high intensity noise and should not be used.

8.6 Protect Your Person

The possibility of allergic reactions to dust, fumes and other materials cannot, in most cases, be predicted. Common sense measures can help you avoid negative consequences of contact.

Remember:

1. Do not allow spray dust to enter eyes, mouth, open wounds, cuts or scratches.
2. Be sure to wash hands thoroughly after spraying, especially before eating or handling foods.
3. Always wear eye protection when operating or watching the flame spraying process.
4. Inspect eye protectors frequently. Scratched, pitted or otherwise damaged lenses or cover plates can seriously reduce protection and impair vision.

DEFECTS OF COATINGS	CAUSE OF DEFECTS	HOW TO CORRECT
Contaminations inside the film	Contaminations inside the powder Contaminations inside compressed air	Change or screen the powder Improve quality of air
Orange Peel	High temperature of application Very thin coat	Increase gun air Increase film thickness
Fish Eyes	Surface not properly cleaned Compressed air not clean	Check your cleaning chemicals Check compressed air
Pinholes	Defects on surface of substrate (pores craters, cracks) Temperature of application too high Gas is coming during curing process	Recommend preheating for longer time Increase gun air Check conditions of powder room Keep thickness of coat not more than 75 microns
Powder coating sagging down	Powder coating too thick	Decrease material feed rate
Powder coating color changes	Temperature of application too high Powder feeder not cleaned thoroughly	Increase gun air Clean powder feeder better
Powder coating too bright	Powder contaminated by incompatible particles Moisture of powder too high or trace of moisture on the substrate	Clean powder feeder very thoroughly Check moisture of the powder and substrate Dry if necessary
Matte powder coating too bright	Powder coating too thin	Apply thicker coating
Unstable level of brightness	Contamination of powder Temperature of application is wrong	Clean powder feeder, all hoses, gun Correct temperature of application
Unstable level of thickness	Flare of paint is broken by wind	Check speed of the wind and change direction of application or put protection
Poor durability or flexibility	Powder coating not under cured Poor surface preparation Powder coating too thick	Decrease gun air Check quality of surface preparation Decrease material feed rate
Poor adhesion, poor corrosion and chemical resistance	Poor surface preparation Powder coating under cured	Check quality of surface preparation and conversion coating application Check on control samples degree of coating curing
Poor material delivery on substrate	Hoses for powder delivery dirty or bended Hoses for air delivery are bent Poor fluidized bed	Check and clean hose or unbend it Check air hoses Increase pressure and flow on fluidized bed regulators
Poor fluidized bed in powder feeder	Low air pressure on fluidized bed regulator and flow meter High moisture concentration in compressed air Powder has moisture	Increase air pressure Add another air filter on main air line Check condition of powder room
Material pulsing during application	Low air pressure Powder has moisture	Increase air pressure Check condition of powder room