STEEL

All hollow metal doors and frames manufactured in North America are produced from the identical base cold rolled steel, which conforms to ASTM A366.

The galvanneal process begins in the Hot Strip Mill where a billet is reduced in thickness to a coil of steel.

The hot rolled steel, meeting ASTM A569, is then moved to a Cold Strip Mill.

The hot rolled is uncoiled, pickled, cleaned and rinsed. The steel is heated, passed through dimensioning rolls to reduce it to the exact thickness required, the edges are trimmed for tension leveling and the product is oiled to prevent rusting of the now Cold Rolled Steel, meeting ASTM A366. It is then recoiled or slit into sheets.

It is how the cold-rolled steel is further processed that creates galvanized and paintable galvanneal.
For galvanneal and galvanized steel, the cold-rolled coil is processed through a Galvanizing Mill. It is uncoiled, degreased and run into a continuous hot-dip zinc coating bath. For galvanized steel the free zinc is removed by a series of mechanical wipers. For galvanneal, the excess molten zinc is removed using air knives. The galvanneal coil enters an annealing furnace and heat converts the zinc coating to a zinc-iron alloy. Next the galvanneal goes through a chromate and phosphate passivation wash to retard storage stain. Finally both galvanized and galvanneal steels are recoiled or slit into sheet stock.

**ASTM STANDARDS FOR STEEL**

The process of steel making is a highly sophisticated one, relying on leading edge technology and is covered by a multitude of ASTM Standards. ASTM Standards for steel have evolved drastically over the past few years. The changes reflect the availability of steels with improved base metal characteristics, as well as terminology revisions that are intended to provide a better understanding of steel sheet formability for hot-dip products.

In the late eighties hot-dip steel products were covered by the following ASTM Standards: ASTM A366 for the base cold-rolled steel, ASTM A525 for the general requirements of zinc coated hot-dip steels and ASTM A526 through A528 for the specific forming qualities of zinc coated steels.

In 1994 A525, together with a number of associated standards, were withdrawn and replaced by A924-94 which covers all hot-dip coated steels. At the same time A526 through A528 were discontinued and amalgamated under A653.

In 1996 and 1997 ASTM made further changes to A653 where the description of steels with the “Quality” designations have been made obsolete and a new system of designations has been developed. Future uses of the “Quality” term are intended for reference to levels of surface and shape parameters.

ASTM A653-97 designations are for the “Type” of steel, with categories ranging from Commercial Steel (CS) through to High Strength Low Alloy Steel (HSLAS). Several “Types” have further designations, the letters “A”, “B”, and “C”.

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**Galvanizing Mill Process**

- **DECOILER**
- **DEGREASER**
- **HOT DIP ZINC BATH**
  - (Zinc, Nickel, Chromium & Copper)
- **COOLING TOWER**
- **CLEANER**
- **ANNEALING FURNACE**
- **PASSIVATION TANK**
  - (Chromate & Phosphate)
- **OILER**
- **RECOILER**

**ASTM A366** Cold Rolled Steel

**ASTM A653** Galvanneal Steel To Steel Service Center
The ASTM Standards currently applicable to all Fleming paintable Galvanneal are as follows:


This standard describes the general chemical and mechanical properties of cold-rolled steel.


This standard describes the permitted tolerances for chemical composition, mechanical properties, coating thickness, widths, lengths, camber, square and flatness of cold-rolled sheet steels which are metallic-coated by a hot-dip process. The metallic coatings referenced in this standard include zinc, zinc-iron alloy, aluminum, aluminum-zinc alloy, and lead-tin alloy (terne).


ASTM A653 specifically covers zinc and zinc-iron alloy coated steel. Zinc coated steel, known as “galvanized”, is a full spangled finish product. Zinc-iron alloy coated or “galvannealed” steel is a spangle-free, matte-gray, uniform finish. This standard describes six (6) types of steel based on formability. A653 details the nominal and minimum weight of each type of coating by recognized designations. Galvanized steel coating designations are prefixed with “G” (“Z” for their metric equivalents) and galvanneal coating designations are prefixed with “A” (“ZF” for the metric counter-part). Chemical and mechanical property requirements for both the base steel and the coating are also included in this standard.

SPECIFICATIONS

The material specifications for Fleming Commercial Steel Door and Frame product is:

*Door and frame product shall be manufactured from tension leveled steel to ASTM A924-97(M97), galvanized to ASTM A653-97(M97), Commercial Steel (CS), Type B, coating designation A40 (ZF120), known commercially as paintable galvanneal.*

PROPERTIES

<table>
<thead>
<tr>
<th>Gage</th>
<th>Nominal Thickness</th>
<th>Nominal Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Imperial (inches)</td>
<td>Metric (mm)</td>
</tr>
<tr>
<td>22</td>
<td>0.030&quot;</td>
<td>0.8mm</td>
</tr>
<tr>
<td>20</td>
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<td>.09mm</td>
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<tr>
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<td>2.7mm</td>
</tr>
<tr>
<td>10</td>
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<td>3.5mm</td>
</tr>
</tbody>
</table>

Chemical Analysis: Carbon = 0.15% max, Manganese = 0.60% max, Phosphorus = 0.035% max and Sulphur = 0.040% max

Mechanical Properties: Yield Strength = 43ksi, Ultimate Tensile Strength = 53ksi, Percentage Elongation in 2" = 36%
GALVANNEAL ADVANTAGES

When specifying materials for hollow metal doors and frames what are the characteristics you are looking for?

- A smooth, consistent paint surface
- A minimum of surface preparation in the field
- Maximum paint adhesion
- Complete corrosion protection, inside and out
- Maximum compatibility with and flexibility in the selection of finish paints
- Resilience to job site exposure from humidity and water
- Maximum product performance and warranty

Galvanneal has been developed to specifically address these characteristics. In addition, galvanneal will not fracture when formed and provides maximum arc, spot and projection weld performance when compared to cold rolled or electro-galvanized steels.

Galvanneal is passivated with a chromate and phosphate wash as part of the steel manufacturing process. It presents a dull gray matte surface which is almost mirror smooth the touch. The surface however, provides microscopic keying for finish paint at the zinc-iron alloy surface.

Primed painted cold rolled steel on the other hand yields one of two extremes. Cementisious type factory applied proprietary primers are inherently uneven and rough. Baked-on electrostatically or conventional spray applied, flow-coat or dip types provide a glazed egg shell affect which must be fully sanded before finish painting. Flow-coat or dip process systems can result in uneven coverage, runs and drips.

Galvanneal’s zinc-iron alloy is an integral part of the steel surface. It is on the front, the back and the edges of the material. Fleming manufactures all door and frame components and reinforcements from galvanneal steel. There are no unprotected surfaces.

With cold rolled product, the factory primers are added after the product is completely assembled. The consistency and coverage will vary. The inside of frame profiles generally do not receive the same coverage as the surfaces which will be exposed after installation. There will be areas on the mortised hardware reinforcements which will receive limited, if any primer protection. The inside faces of a cold rolled steel door or mullion and the cold rolled steel internal components and reinforcements receive no primer.

All steel doors and frames need to be cleaned prior to finish painting to remove the dirt, dust, tar and other foreign matter which end up on the products during shipping, handling and installation. Scratches in the surface need to be remedied before painting as well.

For galvanneal doors and frames, cleaning is a simple matter of wiping down the surface to be painted with a cleaner compatible with the finish paint. If latex paint is specified, then soap and water will do the job. When alkyd paints are required, then turpentine or paint thinners will suffice. For some of the more exotic finishes such a epoxies and the like, the paint manufacturer will recommend appropriate materials. The zinc-iron coating will not wash off.

With cold rolled and primed steel there can problems with cleaners removing the primer or the primer absorbing and trapping foreign materials.
Scratches inflicted on galvanneal doors and frames are repaired with the application of any off the shelf, zinc-rich galvanized primer, either brush or spray applied after the surface has been cleaned. You are applying the same material as is already part of the steel surface. There is never a compatibility problem. The steel surface will not appear different in the primed areas after finish painting.

With cold-rolled and primed product, the scratches must be sanded out, feathered and a touch-up primer, compatible with the factory proprietary primer, is applied.

There can be compatibility problems between the proprietary factory primers and standard commercial primers used by the finish painters. Adhesion of standard commercial primers, used by the finish painter, may be compromised between his primer and the factory’s.

Paint adhesion and corrosion resistance can be measured using several methods. The most widely specified test standard for steel door and frame products is ANSI A224.1. This standard requires that separate sets of prepared samples are subjected to salt spray and water fog exposures together with a series of unexposed sample tests.

This standard, although useful, does not provide a thorough evaluation. The salt spray exposed samples are only evaluated for corrosion resistance (rust). The water fog exposed samples only for paint blistering. The unexposed samples are evaluated only for tape test paint adhesion after impacting and lattice style scribing of the painted surface. The exposures do not address severe acid rain, industrial environments.

Through a nationally recognized independent lab, extensive testing and evaluations comparing Fleming galvanneal and cold rolled steels, each with or without primers and finish paints, were done. These tests went well beyond the requirements of the ANSI A224.1 standard, all the way to simulating the demands of an acid rain, industrial environment. For each type of exposure the samples were evaluated to ASTM standards for corrosion resistance (rust), film adhesion, paint blistering and paint creepage.

The following provides an overview of this test program, materials, evaluations and graphic comparisons of the results.

**TEST PROGRAM**

**PURPOSE:** To conduct a comparative analysis and evaluation of base steel substrates, Paintable Galvanneal and Cold Rolled Steel, utilized in the manufacture of commercial hollow metal doors and frames with their regularly specified paints and/or primers.

**Tests:** Four (4) separate tests, as noted below, were conducted on representative panels by an independent laboratory.

**Salt Spray Testing - ASTM B117**
In this test, specimens are placed in a chamber with one (1) side exposed continuously for 120 hours to an airborne 5% sodium chloride in water solution. The temperature within the chamber is maintained at 95°F throughout the test. The face of each specimen was scribed in accordance with ASTM D1654.

**Water Fog Testing - ASTM D1735**
In this test the specimens are placed in a chamber with one (1) side exposed continuously to atomized (sprayed) water. The temperature within the chamber is maintained at 100°F. Two (2) Water Fog Tests were run. The first had a duration of 120 hours and the face of each panel was scribed in accordance with ASTM D1645. The second was 240 hours in duration and the panels were not scribed.

**Film Adhesion - ASTM D3359, Method ‘B’**
Commonly known as the Adhesion by Tape test, samples are scribed in a lattice pattern (cross-hatch) with six (6) cuts in each direction. A length of specialized 1” wide pressure sensitive tape is place over the scribed area and then rapidly pulled off.
Acid Rain - Industrial Environment Testing - ASTM G87
For this test, also known as the Kesternich Test, cross-scribed samples are placed in a chamber with one (1) side exposed to atomized SO₂ and distilled water solution (600ppm SO₂) at 100°F for an 8 hour period. The samples are then subjected to a 16 hour cycle of drying at ambient. This cycle is repeated four (4) times for a total of 96 hours.

**Materials:**

Steel
Three non-lighted production doors utilizing Cold Rolled Steel complete with the manufacturers’ proprietary factory applied primer and an un-primed Paintable Galvanneal door were utilized. Specimens were taken from both the fronts and backs of window cutouts.

Primer and Paint
The primer utilized for the Paintable Galvanneal panels, as recommended by the American Hot Dip Galvanizers Association was a Cementitious Primer for Galvanized Metal. This primer also meets the requirements of CGSB 1-GP-198, and was brush applied to 1.5 mil thickness.

Additional primers were not required for the three (3) CRS doors as each is supplied complete with a proprietary primer from the factory.

The finish paint, a high quality commercial latex, meeting US Federal Government Standard # TT-P-1511B and CGSB 1-GP-195, and was brush applied to a 2 mil thickness.

The primer and finish paint were supplied and applied by the quality control laboratory of an internationally recognized paint manufacturer.

**Evaluations:** All evaluations were performed by experienced personnel on the professional staff of the testing laboratory, independent of the Applicant/Sponsor. Results are based on the average of three (3) identically prepared, exposed and evaluated samples.

The panels subjected to the Salt Spray and Water Fog exposures were evaluated for Blistering (ASTM D714), Film Creep and Corrosion (ASTM D1654), Rust (ASTM D610), Film Adhesion (ASTM D3359, Method ‘A’) and Flaking or Scaling (ASTM D772).

The ‘grading scales’ for Blistering (ASTM D714) and Rust (ASTM D610) are based on photographic reference standards developed by the Steel Structures Painting Council (SSPC) and adopted by ASTM. All other scales are quantitatively measured.

Panels tested for Film Adhesion at cross-hatch (ASTM D3359, Method ‘B’) not subjected to either the Salt Spray or Water Fog exposures were evaluated as described in ASTM D3359, Method ‘B’.

The panels subjected to the Acid Rain-Industrial Environment exposures were evaluated for Rusting (D610) and Film Creepage (ASTM D1654) at the cross-scribe lines.

**Results:** Comparisons were made for the following:

- Paintable Galvanneal versus CRS primed versus Paintable Galvanneal primed
- Paintable Galvanneal finish painted versus CRS primed and finish painted versus Paintable Galvanneal primed and finish painted

The results as illustrated on Sheets 7 through 9 clearly indicate the application of primer on Paintable Galvanneal at best does not improve product performance and in many instances acts to its detriment.
WATER FOG EXPOSURE TO ASTM D1735
Rust Grade at Unscribed Area Evaluated to ASTM D610

Simulates Door as Finished Product on Job Site
Paintable Galvanneal Out-Performs CRS + Primers
Inside and Outside of Paintable Galvanneal Equally Protected vs Interior of CRS Door Rusts
Primer on Paintable Galvanneal Shows No Performance Enhancement

120 HOURS OF SALT SPRAY EXPOSURE TO ASTM B117

Simulates Door as Finish Painted on Job Site
(Outside of Panel Exposed)
No Rust, Film Creep or Adhesion Loss with Paintable Galvanneal + Paint
Paintable Galvanneal + Paint Out-Performs Galvanneal + Primer + Paint
Paintable Galvanneal + Finish Paint is Excellent vs Erratic Performance of CRS + Primers + Paints
120 HOURS OF SALT SPRAY EXPOSURE TO ASTM B117

Simulates Door as Supplied to Job Site
No Blistering or Film Adhesion Loss on Paintable Galvanneal
Rust on Inside Face of Unprotected CRS Ranges from 33% to 75% of Surface vs Less than 1% for Galvanneal
Rust on Outside Face of CRS + Primer Covers up to 16% of Surface vs Paintable Galvanneal with Less than 3%, up to 5 Times Better Field Performance

FILM ADHESION
Evaluated to ASTM D3359

Simulates Door as Finish Painted on Job Site
Paintable Galvanneal + Paint Out-Performs CRS + Primer + Paint in All 3 Situations
Paintable Galvanneal is Excellent vs CRS Performance Which is Erratic
96 HOURS OF SO₂ EXPOSURE TO ASTM G87
Simulating Acid Rain - Industrial Environment
Kesternich Test

Simulates Door as Finish Painted on Job Site
(Outside of Panel Exposed)
No Rust or Film Creep on Galvanneal + Paint vs Up to 10% of Surface Area Rusted on CRS + Primer + Paint
Galvanneal with Primer Does Not Enhance Galvanneal Performance
CRS + Primer + Paint Samples Exhibit Film Creep Problems

The results consistently confirm galvanneal's superior performance prior to and after the application of finish paint under all tested conditions.

In the last section of this manual you will find our publication “Effective Rust Protection”. It provides more answers to many of the myths and realities on paintable galvanneal steel.

These are the reasons that Fleming paintable galvanneal comes with a 10 year rust perforation and paint adhesion warranty.