Why ASTM Standards?

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Abstract.

ASTM Standards for Coated Sheet Products are material and testing standards used worldwide to order, produce, and evaluate the many millions of tons of metallic-coated steel produced annually. The most referenced continuously coated product standards are briefly reviewed, along with a more in-depth review of coating weight designations, and their often-misunderstood limits. On-line coating weight, tolerances, best practice and measuring techniques are reviewed, along with the ASTM specifications that govern the zinc used on continuous coating lines. ASTM standards are consensus documents, which are developed, revised and maintained by volunteers from the producer, user, and general interest segments of the coated sheet community.

Why ASTM Standards?

Introduction

ASTM Standards for Coated Sheet Products are material and testing standards used worldwide to order, produce, and evaluate the many millions of tons of metallic-coated steel produced annually.

Most North American companies and others worldwide who produce or use coated sheet rely on ASTM product and testing standards to assure themselves that consistent quality and product attributes are achieved. Coated steel sheet standards are under the jurisdiction of ASTM Committee A05, and include steel sheet coated with zinc (galvanized), as well as other metallic coatings available on steel sheet, such as 55% aluminum-zinc alloy, zinc-5% aluminum alloy and zinc-aluminum-magnesium alloy.

Standards for zinc, the various zinc alloys used in hot-dip galvanizing, the configuration of zinc jumbo and block ingots, and the color codes used for visual identification of zinc and zinc alloy ingots are under the jurisdiction of ASTM Committee B02.

ASTM's primary mission is to develop and maintain voluntary full consensus standards for materials, products, testing and services, providing a forum for producers, users, ultimate customers, and those having a general interest to meet on common ground and write standards that best meet their needs. Today the ASTM process is being used to develop cutting edge documents addressing the evolving advances and requirements of modern coated steel products.

How Do ASTM Standards Differ from Other Standards?

The primary difference in ASTM's standards is the degree of consensus that is achieved in a standard's development process. During the balloting process, the responsible subcommittee must deal with and resolve every negative vote from any individual. A negative can be found persuasive and the document is sent back to be redrafted or is dropped. If it is found non-persuasive (for technical reasons), or non-related, it is approved as balloted. A general committee on standards reviews all non-persuasive votes that happen at the Main committee to ensure they were properly handled.

Other organizations can develop standards through less than full consensus procedures. Examples of these standards are:

Company Standards – consensus among employees of a given organization.

Industry Standards – consensus among companies within a given industry (typically by a professional society).

Professional Standards – consensus among individual members of a given profession (typically a professional society).

Government Standards – consensus among employees of a government agency or department.

ASTM develops full consensus standards in the belief that with broad input into the standard from the beginning of its development, the result will be technically valid and have the highest credibility when critically examined as the basis for commercial or regulatory actions. "When a standard has a large pool of "owners", i.e., developers, it is more likely to be revised, improved and updated more regularly. A standard in motion has more value than one that is static."[1]

Why Do Members Support ASTM?

They support ASTM because its standards meet their needs. ASTM's management system assures members a voice in the development of standards that will affect their organization and industry. It exempts them from any personal liability in the development of standards. And it ensures their right to due process when they dissent.

Who Uses ASTM Sheet Steel Standards?

ASTM standards are used by thousands of individuals, companies and agencies involved in the entire sheet steel production and consumption industries. Purchasers and sellers write them into contracts. Scientists and engineers use them in their laboratories. Architects and designers use them in their plans. Government agencies reference them in their codes, regulations and laws. All manner of technical people refer to them for guidance.

At the GalvInfo Center, about one-third of the questions received are related to ASTM coated sheet product and testing standards. Most of these questions are about coating weight terminology and thickness tolerances.

ASTM Standards for Coated Sheet

The hot-dip coatings under the jurisdiction of A05 are shown in Table 1. There are seven coating types covered by as many specifications. A653/A653M covers zinc-coated sheet – both galvanize (GI) and galvanneal (GA).

Figure 1 ASTM Hot-Dip Coatings

Coating Name	Coating Composition	ASTM Specification
Galvanize	Zinc	A653/A653M A1063/A1063M
Galvanneal	Zinc-10% Iron	A653/A653M
Aluminum-Zinc	55% Aluminum-Zinc	A792/A792M
Zinc-Aluminum	Zinc-5% Aluminum	A875/A875M
Zinc-Aluminum-Magnesium	Zn-5/13% Al-2/4% Mg	A1046/A1046M
Aluminized	Al-5/11% Si, or pure Al	A463/A463M
Terne	Lead-8% Tin	A308/A308M
General requirements for all hot-dip coatings – ASTM A 924/A 924M		

Each product standard in Table 1 covers the attributes specific to that product such as coating composition and coating weight designations. Attributes common to all coated sheet products, such as dimensional and flatness tolerances, are included in A924/A924M General Requirements.

ASTM Coating Designations – What Do They Specify?

ASTM coating designations for hot-dip coated sheet specify:

- A minimum triple-spot-test (TST) value - an average of three edge-center-edge readings, and is a **total-both-sides (TBS) requirement only,**
- A minimum single-spot-test (SST) value - a single spot reading which is a **TBS requirement only**, and
- A minimum single-side requirement - based on **a TST only!**
- The TST test **only applies to the original, full-width (as-coated) sheet**
- Narrow sheet cut from full-width sheet is subject only to a minimum SST, TBS requirement
- With the exception of supplementary Table S2.1 in A653/A653M, ASTM specifications are silent on the minimum weight on one side of a single-spot

Examples of full-width pass/fail test results for A653 are given in Figure 2.

Figure 2 Example G90 Coating Weight Results - Illustrating Passing and Failing the Requirements of A653/A653M (Table 1) – oz/ft^2

Requirements of A653 (Table 1):
Minimum Triple-Spot-Test average (TST), Total-Both-Sides (TBS) – 0.90 oz/ft^2
Minimum Single-Spot -Test (SST), Total-Both-Sides (TBS) – 0.80 oz/ft^2
Minimum One-Side (OS), Triple-Spot-Test average (TST) – 0.32 oz/ft^2 (40% of Minimum SST per Footnote A of A653 Table 1)

Example	Test	E1	C	E2	TST	Comments
1	TBS	0.92	0.93	0.96	**0.94**	**Passes min TST**
2	TBS	0.85	0.93	0.96	**0.91**	**Passes min TST**
3	TBS	0.85	0.87	0.96	**0.89**	**Fails on min TST**
4	TBS	**0.78**	0.95	0.96	0.90	**Fails on min SST**
5	OS-Top	0.30	0.31	0.40	**0.34**	**Passes on min TST-OS & TBS**
	OS-Bot	0.55	0.62	0.47	0.54	
	TBS	0.85	0.93	0.96	**0.91**	
6	OS-Top	0.30	0.31	0.31	**0.31**	**Fails on min TST-OS**
	OS-Bot	0.55	0.62	0.65	0.60	
	TBS	0.85	0.93	0.96	0.91	

It is evident from Figure 2 that to meet the coating weight requirements of ASTM hot-dip sheet standards, there are multiple constraints to monitor and react to: triple spot averages, including total-both-sides and single-side; and single-spot total-both-sides results. When producing coated sheet to automotive coating requirements, only one constraint has to be measured and controlled, and that is the single-side, single-spot results, which is a much simpler task.

Almost all, if not all, hot-dip coating lines use on-line gauges to measure coating weight. ASTM A754/A754M Standard Test Method for Coating Weight (Mass) of Metallic Coatings on Steel by X-Ray Fluorescence covers the method of operating and using the information from these gauges. They measure the top and bottom coating thickness in a zigzag fashion at the edge, center, edge positions and can accumulate thousands of results per coil. As they measure each surface, they can display single-side, single-spot results, or ASTM total-both-sides results. When measuring to ASTM limits, ASTM A924/A924M specifies that the software select at least five random edge-center-edge scans, then average them to determine the coating weight result to be assigned to the coil.

That ASTM hot-dip coating specifications are largely silent on single-side, single-spot minimum coating weights is the principal reason that automotive companies developed their own coated sheet specifications containing these limits because they would not accept triple-spot averages. In his 2006 paper[2] at this conference, Robert Wilhelm argues that the single-side, single-spot minimum is the most pertinent limit of all, and that controlling to both triple-spot and the liberal single-side triple-spot minimum is wasteful of zinc, and perhaps detrimental to product quality.

Many hot-dip lines are capable of producing compliant material to automotive single-spot, single-side requirements and do so on a regular basis, yet efforts to change A653/A653M to the single-spot system have met with producer resistance over the last 20 years. In 2008 though, a supplementary Table S2.1 was approved for A653/A653M. It allows coated sheet to be ordered to single-spot, single-side minimum values upon the agreement of the producer.

It is again time to revisit the ASTM total-both-sides coating weight standards for galvanized sheet to determine if the single-side, single-spot limit should replace the triple-spot, total-both-sides system as the default control method. The triple-spot system was devised many years ago before continuous on-line coating weight measurement was widely deployed, and before modern coating rig equipment systems. We have the capability today to apply zinc more evenly without risk to single-spot minimums and we should be taking advantage of this by defaulting to single-side, single-spot limits.

Other ASTM Coated Sheet Specification Developments

Table 1 refers to A924/A924M General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process. One recent major revision to this standard dealt with thickness tolerances. A task group examined thickness tolerances in sheet steel standards from other parts of the world, principally ISO standards and EN standards. ASTM thickness tolerances were considered to be very wide, so much so that for years producers were compelled to sell to one-half ASTM tolerances.

One important aspect of sheet steel thickness is the “feathering” of thickness that occurs near the edges due to the bending of the work rolls during rolling. Starting from about 1.5 inches in from each edge, out to the edges, there is an increasingly severe thinning of the strip.

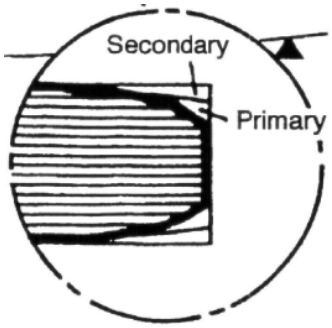

Figure 3 Secondary and primary edge drop off on as-rolled steel sheet

The default ASTM tolerances excluded only the outer 3/8” of the width from being measured. On most products this point is in the primary drop zone shown in Figure 3. When supplying to one-half ASTM tolerances, mills were allowed to exclude the outer 1-inch, which made it very much easier to comply with the tolerance restriction as that point is well into the secondary region. ISO and EN sheet standards only use the 1-inch (25 mm) edge distance exclusion. The task group quickly realized that if ASTM defaulted to the 1-inch edge distance, then the published thickness tolerances would be equal or better than any in the world, since mills in

North America are just as capable of holding tight thickness as elsewhere. In 2009 the balloting was completed to make the tighter, 1" edge distance tolerance tables the default standard. The 3/8" edge distance tables are still available as a supplement for those users who require them. This activity illustrates how ASTM was able to elevate the worth and world perception of its coated sheet standards, not as the result of an overt technology change, but by studying similar documents from around the world.

Committee A05 has just completed work on a new standard that covers the Advanced High Strength Steels that have been under development by the steel and automobile companies over the last decade or so. It will be published as "A1079 Steel Sheet, Complex Phase (CP), Dual Phase (DP) and Transformation Induced Plasticity (TRIP), Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process". This is the first standard in ASTM that covers these new high strength and very formable steels, and is written in a similar fashion to those of automotive companies. While it is too much to expect that this standard will be adopted and used by the automotive industry in the near future, it will serve as an industry "educational" standard, with the hope that it will forestall the proliferation of perhaps an unmanageable number of different steel chemistries. If this standard, or what it evolves into, can serve as a framework to capture the pooled advances and developments that are to come in this area, then it can become a valued document used throughout the industry to order steel.

ASTM Standards for Zinc

"Using the correctly specified grade of zinc, continuous galvanizing grade (CGG) alloy, or master alloy is key to producing a galvanized product that meets the requirements of the marketplace"[3]. For example, close control of the amount of aluminum in the zinc is critical to achieving good adhesion to the steel substrate. To accomplish this, the galvanizer must be able to depend on a supply of raw zinc ingots that meet specific composition limits. This is accomplished through a series of ASTM standards that cover zinc products.

There are a number of ASTM standards that specify, not only the chemistry of zinc and various zinc alloys used in hot-dip galvanizing, but the configuration of zinc jumbo and block ingots, and the color codes used for visual identification of zinc and zinc alloy ingots. Examples are:

B6 Standard Specification for Zinc

- Specifies the chemical requirements and other delivery conditions for 5 zinc grades, including Special High Grade (SHG), High Grade (HG), and Prime Western Grade (PW). [LME Grade and Intermediate Grade are also specified.)
- SHG and HG grades, and scores of nonstandard variations of them, were once all that were available for use by the continuous galvanizing industry. Some are still employed in certain instances, e.g., SHG (99.990% Zn) is used to reduce the aluminum content in coating line zinc baths. The grades in this standard are also used in the general galvanizing and zinc die-casting industries. The compositions of SHG and HG are shown in Figure 4 below.

B852 Standard Specification for Continuous Galvanizing Grade (CGG) Zinc for Hot-Dip Galvanizing of Sheet Steel

- This standard specifies eight CGG grades of zinc having aluminum levels from 0.25% to 1.0%. Recognizing that lead is, for the most part, an unwanted impurity in galvanize coatings, it restricts lead content to a maximum of 0.007% in all but one of these grades. The chemistries of each grade are shown in Figure 4. While this specification does allow for other compositions, it has achieved a significant reduction in the number of custom grades of zinc that once were used by galvanizing lines.

Figure 4 Chemical Composition Limits for Zinc & Zinc Alloys Used in Continuous Galvanizing (Wt%, Range or Max)

ASTM	Grade (UNS*)	Al	Pb	Cd	Fe	Cu	Others
B6 - SHG	Z13001	0.002	0.003	0.003	0.003	0.002	0.01 (all)
B6 - HG	Z15001	0.01	0.03	0.01	0.02	-	0.10 (all)
B852 CGG	Z80310	0.22 - 0.28	0.007	0.01	0.0075	0.01	0.01
	Z80411	0.31 - 0.39	0.007	0.01	0.0075	0.01	0.01
	Z80511	0.40 - 0.50	0.007	0.01	0.0075	0.01	0.01
	Z80531	0.40 - 0.50	0.01-0.03	0.01	0.0075	0.01	0.01
	Z80610	0.49 - 0.61	0.007	0.01	0.0075	0.01	0.01
	Z80710	0.58 - 0.72	0.007	0.01	0.0075	0.01	0.01
	Z80810	0.67 - 0.83	0.007	0.01	0.0075	0.01	0.01
	Z80910	0.90 - 1.10	0.007	0.01	0.0075	0.01	0.01

Note the different levels of aluminum that are available in CGG grades. The reason for these different ranges of aluminum is to enable more effective management of zinc bath chemistry. Sudden changes in bath aluminum levels and/or temperature should be avoided as much as possible in order to protect against poor zinc adhesion and dross generation. With a well-designed bath management program, two or three well-chosen aluminum levels in the supply zinc can be employed to both lower bath aluminum when needed, and to raise it without the general use of brightener bar. This avoids “shocking” the bath with too much aluminum that can cause the generation of large amounts of dross.

B860 Standard Specification for Zinc Master Alloys Used in Hot Dip Galvanizing

- This standard specifies zinc master alloys of zinc-aluminum (brightener bar) and zinc-antimony which are used to adjust the alloy content of the galvanizing bath.

B897 Standard Specification for the Configuration of Zinc and Zinc Alloy Jumbo and Block Ingot

- Specifies the dimensions of 2400 lb (1089 kg) jumbo and block ingots designed for use with automatic handling systems that add zinc to the baths on continuous galvanizing lines. The introduction of this specification standardized the dimensions of these products, allowing a reduction in the multiple ingot designs that were specific to individual coating lines. A revision is in process to add dimensions for the traditional slab ingot configuration to this standard.

Summary

ASTM standards are developed to do the most good for the most people. "A standard developed in a spirit of cooperative antagonism by a full, balanced contingent of interests, has credibility and integrity. It is less likely to be biased or unduly influenced by a single driving force, or beneficial to only a small segment of society"[4]. ASTM standards for the continuous galvanizing industry have and continue to be developed and improved in this manner. The control "philosophy" of hot-dip sheet coating weight measurement needs to be reviewed and possibly revised to bring it in line with current production capabilities. The active participation of members of the coated sheet industry in the management of ASTM standards is encouraged.

References

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