AcmeCast®

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Heat, Wear, Abrasion, Pressure & Corrosion Resistant
Castings, Spares, Replacement Parts, Custom-Made Components
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Conversion to Castings from Fabrications, Forgings & Welded Assemblies
Engineering, Materials & Metallurgical Consulting

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Annexure A:
Technical Note on Castings & Cast Components

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There is a slight difference between Wrought (rolled type) alloys and Cast alloys in terms of composition, characteristics, behaviour, performance and service life. **Cast alloy chemical composition ranges are not the same as the wrought alloy composition ranges.** For convenience, buyers often use wrought alloy designations for castings and frequently use them while specifying materials for castings. Most of the wrought alloy compositions have equivalent and corresponding cast alloy composition, designations; used in alloy standards of different countries. Therefore, one must specify the desired alloy composition by casting type designation. Use of Alloy Casting Institute (ACI) or American Society for Testing Materials (ASTM) standards & specifications; have been developed, as a consensus of consumers, producers and disinterested experts is often the most effective way to ensure understanding of the requirements. Ask the manufacturer cast alloy equivalent of your wrought alloy grade to benefit from casting the part close to final geometry.

Most **steel casting specifications** take into consideration the chemical analysis of the casting either directly by specifying the analysis, or indirectly by specifying properties that are related to the analysis, such as hardness or tensile strength, and leave the choice of composition to the foundry. Nevertheless, how one might consider, the composition is important.

Variations occur in dimensions and weights of parts made by any metal-shaping process. Tolerances are the expression of the expected or acceptable variation. **Dimensional tolerances** should be included on any casting drawing. Quotation and acknowledgements from the foundry will often refer to a variation in weight or weight tolerance.

Hardness and **harden-ability** should not be confused. Hardness is a property usually specified, and is a measure of the resistance to indentation during the hardness test. Harden-ability is a property that determines the depth and distribution of hardness induced by quenching. The importance of mechanical properties at the depth below the surface of the casting of a given design determines the significance, which the engineer must place on hardenability. Carbon steels are less harden-able than low alloy steels and should not be used in applications requiring high hardenability.

For many years, most casting specifications, including those issued by ASTM, contained very ambiguous wording in regard to surface inspection and integrity. For instance, castings were to be clean and "**free from injurious defects**." There was no definition for defect: no basis for judgment as to what was "injurious". If the purchaser's inspector said a discontinuity was injurious no matter how small, it had to be removed and repaired. Furthermore, the "injurious defect" had to be "completely removed to sound metal". Again, there was no definition for "sound metal" and no basis for judgment for "completely ". Requirement of this type can easily be misunderstood, and misapplied; they can cause no end grief for both foundry and the purchaser.

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Welding methods, likewise, should be left to the foundry and not dictated by a process specification. Upgrade welding is just as much an operation in the manufacture of steel castings as in the molding operation or any other operation involved in casting manufacturing, and all freedom possible should be granted to foundry. However, since the weld will become a part of the casting and go onto service with the casting, it is perfectly justifiable, for metallurgical reasons, to specify that the welding procedures be qualified. ASTM A 488/ A 488 M is an example of Standard Specification for Welding Procedures.

Many non-standard specifications or proprietary specifications, such as those prepared by individual company organizations, may have conflicting requirements. A common example is a Brinell Hardness requirement, which is not always compatible with the specified tensile strength. Since there is no absolute conversion from hardness to tensile strength and a maximum hardness. Even then, care should be taken to be sure there is a workable range between the two. Another example is specification of chemical analysis when mechanical properties might be the only requirement really needed. Unfortunately, in some cases, changes are made to the existing ASTM requirements, and then incorporated into customer specifications even though they may not apply to the customer's casting needs. These changes frequently contain provisions that have been previously rejected by ASTM and other international standards as impractical or unnecessary. The net result is partial duplication of specifications and some unnecessary restrictions. Thus, castings for similar end use may have requirements for two or three different quality levels. Such multiplicity of specifications results in confusion and misunderstanding, and unnecessarily increases the cost of a casting without affecting its serviceability.

Often, if the designer or the customer design and development department, is unfamiliar with the foundry process or the alloy; may specify a quality higher than the design really requires, which serves no purpose except to increase the cost of the casting. A more favourable price and delivery can be obtained by first selecting the material specification which meets the mechanical test requirement, and whose scope encompasses the service for which the part is intended. Before ordering castings and proceeding for makes moulds, does, core boxes etc, we strongly suggest our customers to discuss with us, their application and requirement from the part in terms life, service environment, duty, performance or the expected life of the desired part/component.

Steel and alloy steel castings are specially designed, and custom manufactured parts, and, therefore, the cost of castings will depend upon the complexity of the design of the part and upon the purchaser's genuine requirements. The cost of one cannot necessarily be compared to the cost of another similar casting in weight, shape, alloy and design, because differences in quality requirements may exist. Two castings, which may look alike, may have different costs because the service requirements of the two are entirely different; dictating that the quality and tolerance requirements of one are of a different order than those of the other.

Steel and alloy steel casting costs reflect variations in material specification, tolerance limits, inspection requirements, acceptance standards, affidavits, and certification requirements. The purchaser should always rely on value analysis in the specification and buying steel and alloy steel castings.

A wide range in estimating casting costs from several foundry bidders often reflects that the purchaser was not specific as to the properties and requirements desired at the first instance itself. Specifying minimum quality requirements is

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necessary if castings of minimum costs are desired. The principal costs in the area of quality control and quality assurance are incurred when the castings are processed though the shop. Coincident with any extra testing and inspection is the cost of upgrading/sophistication of the foundry and the skill of the workmen. Narrow ranges of acceptability are usually congruent with high quality levels, and a higher percentage of rejected and reworked casting is probable. Naturally, these costs must be reflected in the price of the casting.

Levels of quality those are higher than demanded by the end use are excessively costly, and add nothing to the serviceability of the casting. If the requirements of the same casting are overstated, the cost of the casting will be higher than it should be. Necessary quality requirements should not be compromised in order to obtain a lower price, but it must be recognized that the more requirements specified to attain higher levels of quality, the more costly the product will be.

Specified range versus process capability. Like any other manufacturing process, even keeping abreast with the prevailing technology, casting process has its own process capability. The determination of an economical specification range, whether it is for chemical analysis, mechanical properties, hardness, dimensional tolerances, or any other range requires careful study, much statistical information, and common sense.

Acceptance Quality Level (AQL) to be mutually agreed between the buyer and the manufacturers

The preparation of a specification is an exacting undertaking in which buyers and producers should collaborate. Control over specification can be achieved, when the normal expected value and the standard deviation are known. The proper creation of a specification is much more difficult and time consuming than often thought. Averaging the results of a few tensile tests, or thumbing through the pages of technical handbooks and selecting average values and adopting them, as specification limits is never satisfactory, even detrimental at times. When the distribution curve is normal, half the test results are higher than the average and half the results are lower. If the average value is considered the specification limit, half the results will be immediately rejected. Specification limits shall never be based on averages. A specification range should be as narrow as necessary and practicable. However, if it is too small, rejections become excessive. Therefore, a balance needs to be maintained between the value of establishing a narrow specification range and the cost increase resulting from the more exacting quality control required in holding the process to narrow limits. On the other hand, if the range is too wide, additional processing costs in other areas may be incurred. For instance, if the chemical ranges for a low alloy heat treatable steel are too wide, the hardenability of the castings from different heats of that grade of steel might have a wide variation which will result in excessive heat-treating costs when heat treating to a narrow range. It is probably much more economical and advantageous in the long run for purchasers, producers, and engineering groups to discard private specifications and replace them with specifications created by internationally known specification writing bodies.

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Disclaimer:

This document envisages to inform our customers about specifying steel castings and cast components. It will facilitate our existing as well as prospective customers in assessing its application needs better and enable them to arrive at specifications which are mutually agreeable "Acceptance Quality Level (AQL)" with reference to material, alloy, manufacturing, inspecting and testing standards. The document is not a comprehensive specifying guide. For more information, please not hesitate to contact us to discuss developing and manufacturing custom made parts.

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