SECTION II

ALNICO MAGNETS

1.0 CHEMICAL COMPOSITION

Alnico alloys basically consist of aluminum, nickel, cobalt, copper, iron and titanium. In some grades cobalt and/or titanium are omitted. Also these alloys may contain additions of silicon, columbium, zirconium or other elements which enhance heat treatment response of one of the magnetic characteristics.

2.0 MANUFACTURING METHODS

The Alnico alloys are formed by casting or powder metallurgical processes. The magnetic performance of most grades can be increased in a preferred direction by applying a magnetic field during heat treatment thus producing magnetic anisotropy. These alloy systems are hard and brittle and do not lend themselves to conventional machining. The best properties of cast Alnico magnets are achieved with columnar or single crystal structure with the direction of magnetization parallel to the columnar grain axis.

3.0 MAGNETIC PROPERTIES

Typical magnetic properties and chemical compositions of the various commercial grades of Alnico are given in Table II-1.

4.0 DIMENSIONS AND TOLERANCES

Allowable tolerances for cast and sintered Alnico are given in Tables II-2 and II-3.

5.0 MECHANICAL CHARACTERISTICS

The following general specifications are for mechanical characteristics and visual imperfections.

5.1 Surface Conditions

51.1 All magnet surfaces shall be free of foreign materials which would tend to hold or collect extraneous particles on the magnet surface in the unmagnetized condition.

5.2 Chips and Burrs

5.2.1 Magnets shall be free of loose chips and burrs. They shall be free of imperfections which will result in loose chips or particles under normal conditions of handling and service.

5.2.2 A chipped edge or surface shall be acceptable if no more than 10 percent of the surface is removed, provided no loose particles remain and further provided the magnet under examination meets the agreed upon magnetic specification.

5.3 Other Physical Imperfections

5.3.1 Imperfections such as cracks, porosity, voids, cold loose chips or particles under normal conditions of handling, shipping, assembly and service. flow, shrinkage, pipe and others, all of the type commonly found in cast or sintered Alnico magnets, shall be judged acceptable if the following conditions are met:

5.3.1.1 The magnet meets the minimum magnetic performance criteria agreed upon.

5.3.1.2 The imperfections do not create loose particles or other conditions which will interfere with proper functioning of the end use device.

5.3.1.3 These visual imperfections do not extend more than 50% through any cross-section. However, this does not apply to the columnar materials (Alnico 5-7 and Alnico 9) which are particularly crack-prone due to their columnar grain. Magnets made of these materials shall be judged acceptable if they maintain their physical integrity satisfactorily for the application.

5.4 Other Conditions

5.4.1 Inspection methods such as the use of penetrants, microscopic inspection, magnetic particle analysis, spin tests, ultrasonics, or x-ray shall not be acceptable methods for judging the quality of cast or sintered Alnico magnets except as provided in 5.4.2 below.

5.4.2 In cases where the magnet is expected to with stand abnormal conditions or stresses, such conditions must be previously specified and a mutually acceptable service test devised to assure that the magnet shall not fail under the specified service conditions. Such tests should duplicate service conditions with appropriate safety factors.

6.0 PHYSICAL PROPERTIES

Typical physical properties for Alnico magnets are given in Table II-4.

7.0 THERMAL PROPERTIES

Typical thermal properties for Alnico magnets are listed in Table II-5.

8.0 INSPECTION SAMPLING PLANS

Unless otherwise agreed upon, magnets will be inspected for all specified characteristics by the use of a statistically valid sampling plan. Such plans may be derived from, Quality Planning and Analysis: From Product Development Through Use, J. M. Juran and F. M. Gryna, 3rd Edition McGraw Hill (1993), Chapter 19. ISBN-0-07-033183-9.