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FASTENERS FOR USE IN LOW

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GENERAL DYNAMICS

Convair Division

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SUBJECT: Fasteners for Use in Low Temperature Applications

ABSTRACT: According to the Astronautics Design Manual NAS 1291 nuts are supplied as alloy steel 160,000 psi or A-286 CRES 125,000 psi. Actually, as found from the results of this investigation, the material used in the nuts can be any corrosion resisting steel (CRES) of Mil-N-25027 that meets the magnetic requirements of NAS 1291. These CRES steels may or may not have adequate toughness for low temperature applications. The designer should, therefore, when calling out NAS nuts, specify a specific alloy ordered to an AMS (Aeronautical Materials Specification) known to have adequate toughness, such as A-286.

Prepared by: Charles J. Kropp
C. J. Kropp

Approved by: A. Hurlich
A. Hurlich
Research Group Engineer
Materials Research Group

AH:CJK:vev

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19 June 1961

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SUBJECT: Fasteners for Use in Low Temperature Applications

In a recent Centaur test conducted at Point Loma by the Systems Test Laboratory, the bolts used to fasten the component parts of the SF-1 Valve Assembly, Fill and Drain (P/N 57-23209) failed and a hydrogen fire resulted from this failure. These failed bolts were submitted to this Group for a metallurgical analysis.

A wet chemical analysis of these bolts was obtained. The alloy used in the fabrication of these bolts was identified as AISI 431, a heat treatable martensitic stainless steel which becomes brittle at low temperatures.

This Group then informed the Systems Test Lab that only bolts fabricated from heat treated A-286 alloy[1] can be used in low temperature (-423°F) applications. Reference is made to some previous reports issued by this Group (AA-M-26 dated 8 April 1957; AA-M-37 dated 26 June 1957 and MRG-157 dated 8 June 1960) which present the properties of heat treated A-286 alloy at room temperature, -320°F, and -423°F.

The Systems Test Lab then took steps to correct the situation by obtaining bolts and nuts fabricated from heat treated A-286 alloy from Material Stores. The bolts were obtained per the NAS 1003 to NAS 1020 specification while the nuts were obtained per NAS 1291.

It was then observed that some of the NAS 1291 nuts were either mildly magnetic, very slightly magnetic, or non-magnetic. Heat treated A-286 alloy cannot be made magnetic because it contains a high percentage of nickel which stabilizes the austenite. These nuts were silver plated and stamped with a "C" thus indicating, for visual identification, that the material used in the fabrication of these nuts is a stainless (CRES) steel.

The nickel/iron ratio of all three types of nuts (non-magnetic, very slightly magnetic, mildly magnetic) were determined by x-ray fluorescence to be approximately 0.14. These results indicated that the nuts were not fabricated from A-286 alloy which had a nickel/iron ratio of approximately 0.49. As can be seen in Figures 1, 2, and 3, the microstructure of these nuts is a fine-grained, equiaxed austenite with little evidence of cold work. These photomicrographs were obtained from longitudinal sections through the nuts. This type of microstructure usually has good toughness at sub-zero temperatures.

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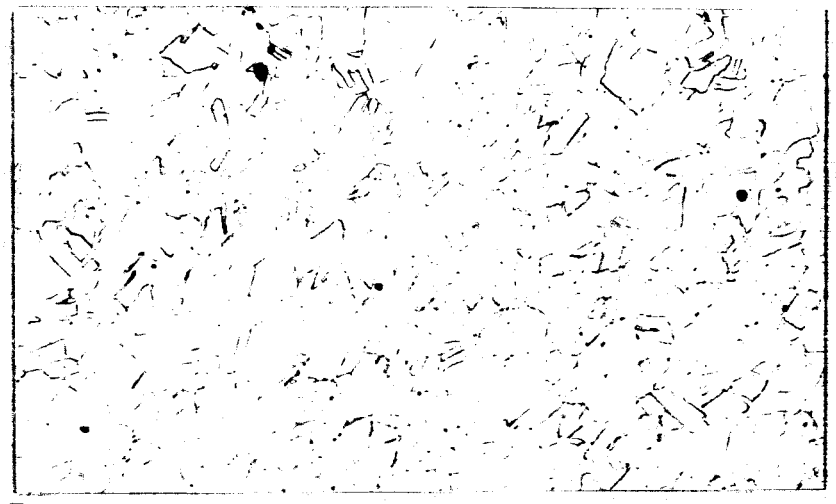
1. A-286, an Allegheny Ludlum alloy, is a heat treatable stainless steel which should not be confused with K-Monel usually identified with the QQ-N-286 specification.

The Standard Parts Manual indicates that these nuts may be fabricated per the procurement specification, Mil-N-25027. This specification does not, however, specify what type of corrosion resistant stainless steel should be used. The Design Manual, Volume 2, may then be considered in error since it indicates that these NAS 1291 nuts may be fabricated from only two materials-alloy steel for a 160 ksi strength level or from A-286 (CRES) for a 125 ksi strength level.

The alloy used to fabricate the nuts in question has not been identified as yet because a complete wet chemical analysis would be required and a large number of nuts would be necessary to make up the required approximate weight of one gram per element. An investigation of some of the properties of these nuts at low temperature (-423°F) was conducted by the Materials Test Lab and the results are discussed in Report No. 7E2368, dated 24 August 1960.

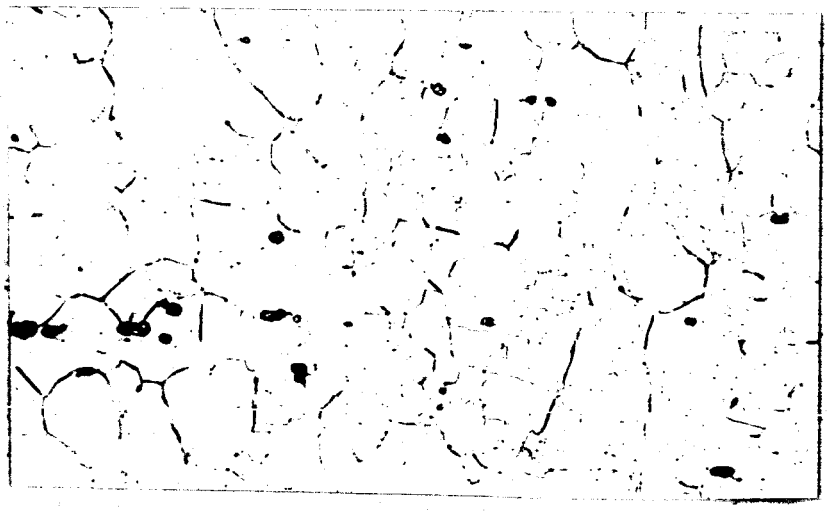
To avoid recurrence of the above situation, these NAS 1291 nuts should be purchased according to the specification, AMS 5735, which is used for the A-286 bolts (NAS 1003 thru NAS 1020) and the A-286 washers (88-50001-001 thru -026).



Mag. 500X

Etchant: Electrolytic 10% Sulfuric Acid

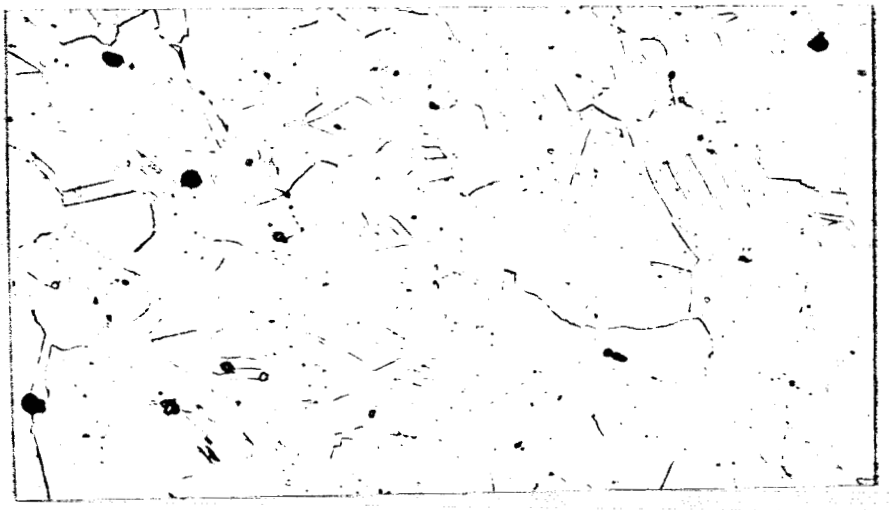
Figure 1. Photomicrograph of the longitudinal section of a non-magnetic NAS 1291 nut. Knoop microhardness measurements were obtained and converted to Rockwell C hardness values of 36, 37 and 37.



Mag. 500X

Etchant: Same as in Figure 1.

Figure 2. Photomicrograph of the longitudinal section of a very slightly magnetic NAS 1291 nut. Knoop microhardness measurements were obtained and converted to Rockwell C hardness values of 34, 30, and 31.5.



Mag. 500X

Etchant: Same as in Figure 1.

Figure 3. Photomicrograph of the longitudinal section of a mildly magnetic NAS 1291 nut. Knoop microhardness measurements were obtained and converted to Rockwell C hardness values of 32, 33, and 36.

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