Attachment 4

ARGONNE NATIONAL LABORATORY

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August 6, 1982

Roger Lanksbury
USNRC
799 Roosevelt Rd.
Glen Ellyn, IL 60137

<u>SUBJECT</u>: Hardness Tests on A36 Specimens

Dear Roger:

Hardness tests were performed to determine whether the material samples which meet the chemical requirement for A36 material also meet the tensile requirements for this material. The requirements include a minimum and maximum tensile strength, a minimum yield strength, and minimum elongation requirements. These should be determined by uniaxial tensile tests. However, because of limitations on the amount of material available hardness tests offered the only means to estimate these properties. The relationship between hardness and flow stress is well known (see, e.g., F. McClintock and A. Argon, <u>Mechanical Behavior of Materials</u>). Because this material strain hardens substantially and because these specimens were probably subjected to significant deformation when they were removed, the flow stress is best interpreted as a lower bound on the tensile strength.

Five specimens of the nominal A36 were judged suitable for testing. These specimens were mounted and polished to removed ~40 mils of the most severely deformed material from the surface. Vickers hardness tests were than performed using a 163° pyramid indenter with a loading force of 30 kg. Some exploratory tests showed that the particular choice of the loading force had little effect on the measured hardness values. The mean diagonal of the impression d_1 was measured and the Vickers hardness V computed from

$$V = \frac{P}{A_C} = \frac{1.854P}{d_1^2} \quad (P \text{ kg}, d_1 \text{ mm})$$

where P is the loading force and A_C the contact area. The Meyer-Vickers hardness M_V which is based on the projected area A_P instead of the contact area A_C was computed from

$$M_V = \frac{2P}{d_1^2} = \frac{V}{0.927} \quad \text{kg/mm}^2$$

Since the Meyer-Vickers hardness generally is a better representation of the average pressure on the area of contact it was used to compute the flow stress S_F from

$M_V = 3.2\ S_F$

The results from the five specimens are tabulated below, with S_F expressed in the usual American engineering units of psi (1 kg/mm^2 = 1422 psi).

Specimen	V (kg/mm^2)	M_V (kg/mm^2)	S_F (psi)
A36-3	136	137	65,000
A36-9	145	156	69,000
A36-14	136	147	65,000
A36-16	136	147	65,000
A36-23	134	145	64,000

Since the minimum tensile strength for A36 material is 58,000 psi, these results indicate that all these specimens do meet this specification.

The measurements and calculations presented here were actually performed by J. Y. Park and D. Perkins. Since I will be away for the next two weeks, if you have additional questions please call Jang Yul Park at 972-5030.

Sincerely,

William J. Shack

William J. Shack
Materials Science Division

WJS:dkm

cc: J. Y. Park
D. Perkins
R. W. Weeks