UNITED STATES

NUCLEAR REGULATORY COMMISSION

In the Matter of)
Niagara Mohawk Power Corporation) Docket No. 50-410
(Nine Mile Point Nuclear Station Unit 2))

APPLICATION TO UTILIZE
AN
ALTERNATIVE TO THE REQUIREMENTS
OF
10 CFR 50.55a

Pursuant to Section 50.55a(a)(3) of the Commission's Regulations (10 CFR 50.55a(a)(3)) Niagara Mohawk Power Corporation, holder of a facility construction permit authorizing the construction of the Nine Mile Point Nuclear Station Unit 2 (Docket No. 50-410), hereby makes application for authorization to utilize an alternative to the requirements set forth in Section 50.55a(c)(1) of the Commission's Regulations.

Section 50.55a(a)(3) states that:

> alternatives to the requirements of [paragraph c] of this section may be used when authorized by the Director of the Office of Nuclear Reactor Regulation. The applicant must demonstrate that (i) the proposed alternatives would provide an acceptable level of quality and safety, or (ii) compliance with specified requirements of this section would result in hardship or unusual difficulties without a compensating increase in the level of quality and safety. 10 CFR 50.55a(a)(3).

Section 50.55a(c)(1) provides that components which are part of the reactor coolant pressure boundary must meet the requirements for Class I components in ASME Section III.

The Company proposes to utilize a valve for the outermost MSIV in Steam Line A that meets all requirements of ASME Section III for Class I components with the exception of paragraph NB-2211 of ASME Section III. Paragraph NB-2211 requires that material for the tensile and impact test specimens be

heat treated in the same manner as the component including an allowance for any subsequent heat treatment. The material test specimens for said valve were not subjected to simulated postweld heat treatment prior to testing.

Attachment A to this Application demonstrates that the subject valve body is adequate as is and hence that the proposed alternative to Section 50.55a(c)(1) provides an acceptable level of quality and safety. Attachment A also demonstrates that compliance with paragraph NB-2211 of ASME Section III will in this case result in hardship and unusual difficulties without a compensating increase in the level of quality and safety.

WHEREFORE, the Applicant respectfully requests that the proposed alternative to the requirements of 10 CFR 50.55a(c)(1) for said valve be authorized by the Commission.

NIAGARA MOHAWK POWER CORPORATION

By C V Mangan

Subscribed and sworn to before me on this 30 day of November 1984.

Janis M Macro
Notary Public

JANIS M. MACRO
Notary Public in the State of New York
Qualified in Onondaga County No. 4784555
My Commission Expires March 30, 1985

Statement of Problem and Summary of Conclusions

Material test specimens for the body of one main steam isolation valve (MSIV) on the NMP2 plant was not subjected to simulated postweld heat treatment (PWHT) prior to testing as required by the applicable ASME code. Analysis of the heat treatment actually received by the test specimens and the valve body using the Larson-Miller parameter shows that simulated PWHT would have had a negligible effect on the results of the tests. Therefore, the valve body is technically adequate as is and will provide an acceptable level of quality and safety.

Background

The problem was discovered during the review of documentation on the MSIVs conducted by Stone & Webster Engineering Corporation. Initially, all eight MSIVs were identified as being nonconforming, and a Nonconformance and Disposition Report was generated. The problem was reported in accordance with 10CFR50.55(e) via telecon on June 15, 1984. An interim report was submitted on July 13, 1984. A final report requesting NRC concurrence was submitted on October 15, 1984.

Subsequent investigations by the material manufacturer have produced evidence of PWHT simulation on the test material for seven of the eight valves. The certified material test reports for these seven valves have been supplemented by the material manufacturer.

The investigation continued on the one remaining nonconforming valve.

Description of the Valve

The one remaining nonconforming valve is the outermost MSIV in steam line A, bearing Mark No. 2MSS*HYV7A (Valve 7A; see Figure 1). The valve was designed and fabricated by Gulf + Western Manufacturing Company/Fluid Systems Division (currently Crosby Valve Division of Moorco Company) under its ASME III program and certificate. Fabrication was completed in 1981, the valve was code stamped "N" Class 1 and then was shipped to the plant site and welded into main steam line A.

An exploded view of the valve is presented in Figure 2. The valve body, which is the material in question, is a carbon-manganese steel forging meeting SA 350 Grade LF2, manufactured by Cameron Iron Works.

Description of the Problem

10CFR50.55a(c)(1) requires that components of the reactor coolant pressure boundary meet the requirements for Class 1 components of ASME Section III. In 10CFR50.2(v), the outermost MSIV is defined as being included in the reactor coolant pressure boundary, and therefore it must meet the requirements of ASME Section III, Class 1 (Subsection NB).

The valve in question, valve 7A, was designed, fabricated, tested and installed in accordance with the above and meets all requirements except for paragraph NB-2211 of ASME III.

NB-2211 requires that material for the tensile and impact test specimens be heat treated in the same manner as the component. In the case of PWHT, the total time at temperature for the test material must be at least 80 percent of the total time at temperature during actual PWHT of the component.

The material for the tests for valve body 7A was normalized, austenitized and water quenched and then tempered for six hours at 1200°F, while the valve body itself was normalized, austenitized and water quenched, tempered for six hours at 1200°F and then subjected to approximately 13 hours of PWHT at 1125°F. Therefore, the requirements of NB-2211 have not been met, and the body of valve 7A is not in conformance with ASME III, Class 1, in this respect.

10CFR50.55a(a)(3) provides for the consideration of proposed alternatives to compliance with ASME III, Class 1, if it is demonstrated that (1) the proposed alternative would provide an acceptable level of quality and safety, or (2) compliance with ASME III, Class 1, would result in hardship without a compensating increase in the level of quality and safety.

The following presents an engineering evaluation of the problem and a proposed alternative.

Engineering Evaluation

Since the heat treatments on the test material are identical to those on the valve body itself except for the PWHT, an independent metallurgical evaluation was conducted by Dr. R. D. Stout of Lehigh University to determine the effects of the time at temperature during PWHT. Although the valve received approximately 13 hours of PWHT, the evaluation was performed using 20 hours, providing the capability of PWHT in the future if needed during plant life.

The Larson-Miller parameter was used to study the combined effects of all subcritical heat treatments, including the temper at 1200°F and the PWHT at 1125°F. Because temperature is the dominant factor, the study shows that the tempering has the major effect on the material properties and that the PWHT has negligible additional effect. Therefore, there would not have been a significant difference in the test results if the test material had been subjected to simulated PWHT. Since the reported test values are considerably above the minimum values required by the material specification, this difference would not have caused the reported values to fall below specification minima.

A preliminary report of Dr. Stout's metallurgical evaluation is included in this report as Appendix A, Metallurgical Aspects of Subcritical Heat treatments.

Resolution and Conclusion

The reactor coolant pressure boundary, and thus the jurisdiction of ASME III, Class 1, in the current Nine Mile Point Nuclear Station - Unit 2 extends to the outboard weld on the outermost MSIV. Any possible actions which could be taken to bring valve 7A into compliance with ASME III Class 1 would result in hardship and unusual difficulty. These possible actions are (1) cutting and testing specimens from the valve itself, or (2) complete replacement of the valve body. Cutting specimens from the valve would require weld repair and PWHT of the valve, which would be expected to cause distortion. This distortion would cause the need for additional welding to build up distorted surfaces, followed by remachining of the valve interior. Extensive welding and PWHT such as this has the potential to do more harm than good to the valve. Complete replacement of the valve body would require cutting out and removing the existing body and reducer, fitting and welding in a new body, and modifying the downstream piping to accept a standard reducer. The piping

modifications and standard reducer are necessary to avoid the need for PWHT of the valve field weld. Neither action would result in a compensating increase in the level of quality and safety of the valve or the plant.

Since it has been shown that the valve body material would have met ASME III, Class 1 requirements had it been tested, the alternative of using the existing valve 7A as the outside isolation valve of the reactor coolant pressure boundary will provide an acceptable level of quality and safety.

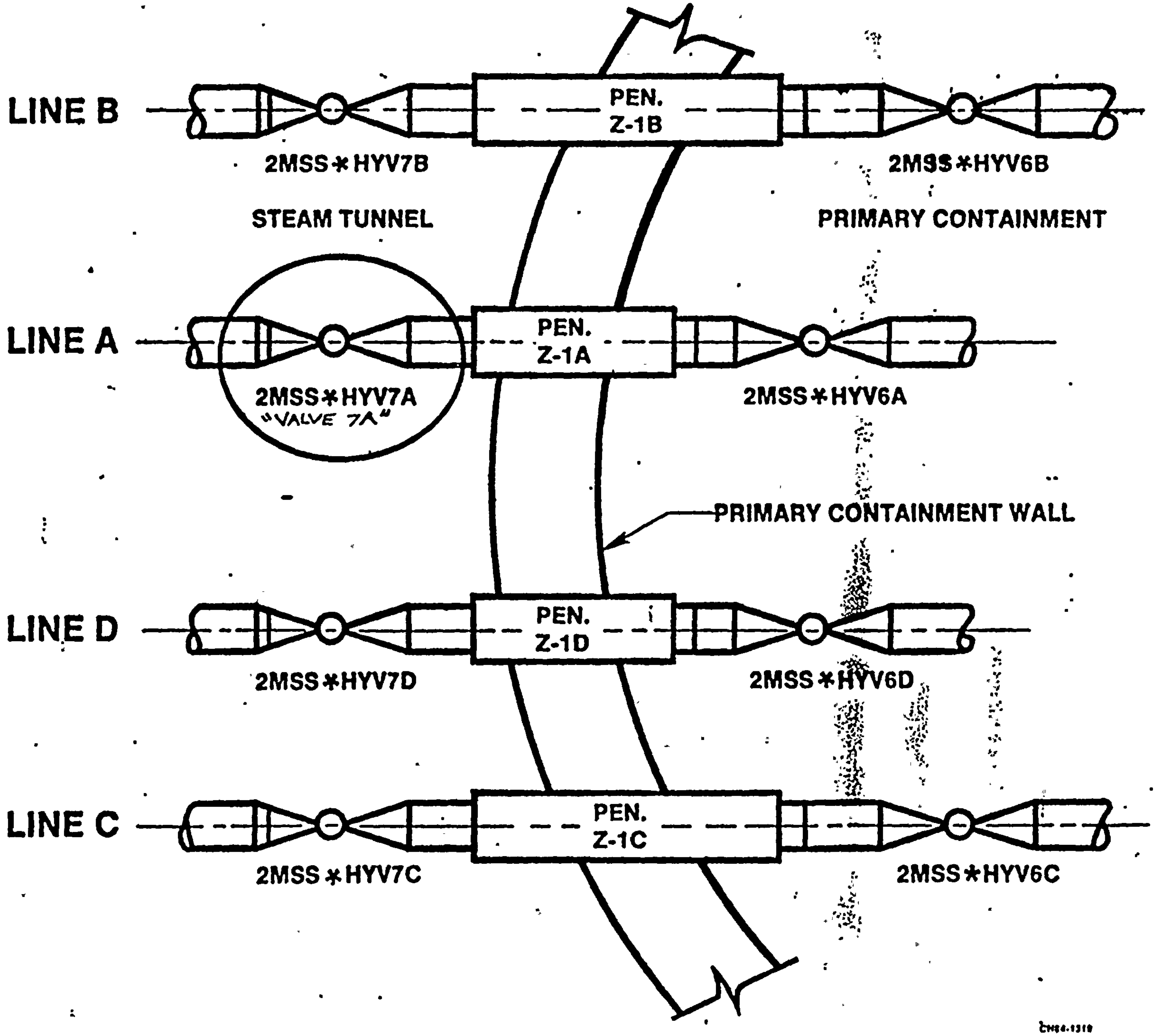
LINE B
PEN.
Z-1B
2MSS*HYV7B
2MSS*HYV6B
STEAM TUNNEL
PRIMARY CONTAINMENT
LINE A
PEN.
Z-1A
2MSS*HYV7A
"VALVE 7A"
2MSS*HYV6A
PRIMARY CONTAINMENT WALL
LINE D
PEN.
Z-1D
2MSS*HYV7D
2MSS*HYV6D
LINE C
PEN.
Z-1C
2MSS*HYV7C
2MSS*HYV6C

FIGURE I

MSIV EXPLODED VIEW

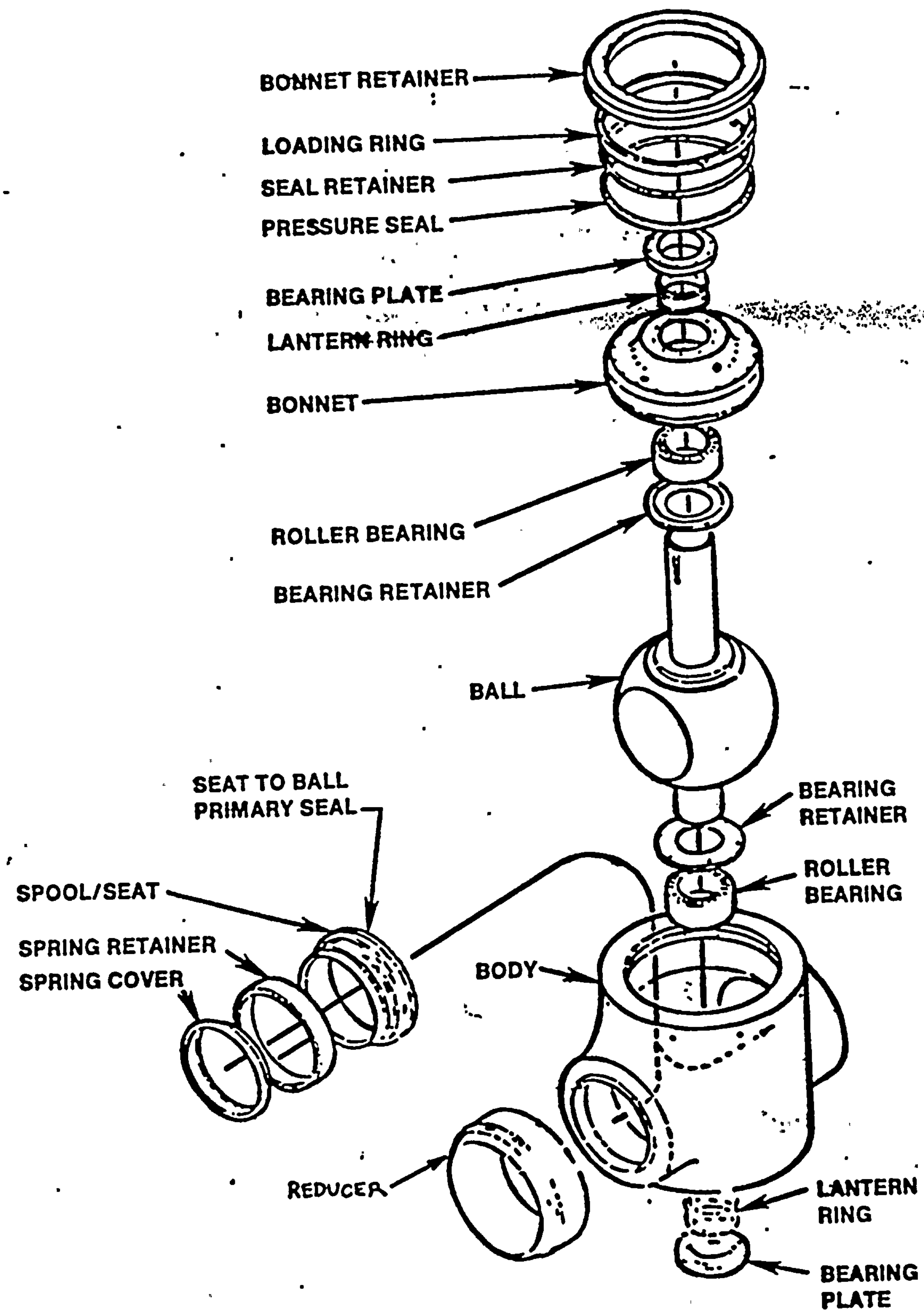

FIGURE 2

APPENDIX A

METALLURGICAL ASPECTS OF SUBCRITICAL HEAT TREATMENTS

Background Information

The 24-inch valve under consideration was manufactured from ASME SA350 Grade LF2 forged steel containing 0.22% C, 1.17% Mn and 0.27% Si. It was normalized at 1650°F, water-quenched from 1600°F and tempered for six hours at 1200°F. Its mechanical properties were determined at that stage to be the following:

	Measured	Required by Specification
Tensile strength	74.9 ksi	70-95 ksi
Yield strength	51.9 ksi	36 ksi
Elongation	32.5%	22%
Reduction of area	71.8%	30%
Charpy tests at 40°F	68-73-76 mils lat exp 90-115-120 ft lb	25 mils lat exp, min

Subsequently, during fabrication it received successive postweld heat treatments of two hours, seven hours and three and one-half hours, all at 1125°F. Since no simulated PWHT was performed for this valve to demonstrate acceptable mechanical properties after PWHT, the technical question to be resolved is whether any of these properties could have been altered sufficiently by PWHT to bring them below specifications.

General Principles

Heat treatments below the transformation temperature range of steels are used for several purposes. They can be used to improve the notch toughness and ductility of steels that have been hardened by quenching, welding or cold work. Also, they serve to relieve residual stresses and to eliminate size instability during machining operations. In addition, the possibility of hydrogen embrittlement can be lessened.

Because many combinations of temperature and time at temperature may be chosen for subcritical heat treatment, extensive efforts were made to reduce the separate effects of temperature and time to a comprehensive parameter which would allow prediction of the integrated influence of these variables on steel properties. Hollomon and Jaffe, and later Larson and Miller, developed such a parameter, which was found to be applicable to hardness, tensile properties, residual stress, notch toughness and creep strength. The parameter, L-M, takes the following form:

$$\text{L-M} = K^{\circ}\,(20 + \log H) \times 10^{-3}$$

Where:
K = the treatment temperature in degrees Kelvin
H = the time at temperature in hours

The specific relation displayed between a particular property and the L-M parameter is dependent on the composition and initial microstructure of the steel involved, but for a given steel the property values follow faithfully the parameter values regardless of the individual vagaries of temperature and time combined in the parameter. Illustrations of this obedience are attached, Figures A-1 through A-3.

Several significant consequences of the parameter form should be noted. First, the influence of the temperature level far outweighs that of time. For example, a change in the postheating temperature from 1200°F to 1125°F (922°K to 880°K), which amounts to 4.5 percent, requires an increase in time from one hour at 1200°F to 9.1 hours at 1125°F in order to keep L-M constant and, therefore, keep the metallurgical response the same. Secondly, the effect of time increments at constant temperature decreases logarithmically. Thus, a steel given repeated one-hour treatments changes in properties progressively less with each cycle.

In contrast to alloy steels, C-Mn steels undergo uncomplicated changes in microstructure and properties during subcritical heat treatment. In the case of the heavy-section valve steel, the initial quench and temper does not produce a martensitic structure, except perhaps for a shallow skin on the forging surface. The cooling rates in the interior sections of the quenched forging are comparable to those in a 1/2-inch thick plate that is normalized. Consequently, a pearlite and ferrite structure forms which is relatively insensitive to postheating. The principal effect is gradually to spheroidize and agglomerate the carbides and therefore to soften the steel and raise tensile ductility moderately. At higher temperatures and longer times, the agglomeration of carbides at ferrite grain boundaries will lower the notch toughness. The complications of temper embrittlement which cause serious problems in some alloy steels are absent in carbon steels.

Some Data on Postweld Heat-Treated Carbon Steels

Information on the response of A350-LF2 forging steels to subcritical heat treatment is limited; however, data on other similar C-Mn steels normalized in thin sections, and so cooled at about the same rate, are listed in Table A-1. Note that five hours at 1200°F produces a more marked effect on properties than any of the cycles at 1100°F, and also that the time effects taper off as time is extended.

There are two heats of A350-LF2 for which property data are available after quench and temper and after subsequent stress-relief treatments. They are entered into Figure A-4, where the data of Table A-1 are plotted against the L-M factors.

Discussion

At this point, the problem of valve 7A can be addressed directly. It is quite safe to say that the yield strength, elongation and notch toughness values for valve 7A are so far above the required minima that no risk is involved in their falling below specifications because of PWHT treatments at 1125°F. Both the tests on the other valves and the data of Table 1 support this view firmly. The only proper question is whether the tensile strength could have been lowered below 70 ksi by the stress relief cycles.

The L-M parameter can be used to show that steel already subjected to a six hour hold at 1200°F would be little affected by PWHT. If it is assumed that the 13 hours total exposure to 1125°F is extended to 20 hours to allow for future stress-relief treatments, the L-M parameter shows that 20 hours at 1125°F are equivalent to adding 2.1 hours of exposure at 1200°F for a total of 8.1 hours. The increase in the L-M parameter is found to be from 19.16 to 19.28, which is demonstrated by Figure A-4 to alter tensile strengths to a negligible degree.

Conclusion

On the basis of well-established engineering principles, it is my opinion that valve 7A, in its present condition, is entirely suitable for its intended service without the PWHT qualification and that its acceptance does not entail any risk of failure.

TABLE A-1

DATA ON SUBCRITICAL HEAT-TREATED CARBON STEELS

Grade	Treatment	Y.S. (ksi)	T.S. (ksi)	Elong.%	Charpy, 15-Mil Temp. (°F)	L-M Parameter
A537 Cl 1	Norm.	55.0	79.5	31	-90	--
	N+1 hr, 1100°F	53.5	77.6	31.5	-80	17.6
	N+5 hr, 1100°F	52.5	76.2	31.8	-70	18.2
	N+25 hr, 1100°F	51.5	75.2	31.8	-65	18.8
	N+1 hr, 1200°F	52.7	77.2	31.7	-70	18.5
	N+5 hr, 1200°F	51.4	73.6	32.2	-50	19.1
A633, Grade C	Norm.	58.0	81.4	30.0	-70	--
	N+1 hr, 1100°F	56.4	80.3	30.5	-80	17.6
	N+5 hr, 1100°F	55.2	79.4	30.2	-75	18.2
	N+25 hr, 1100°F	55.4	78.5	31.3	-70	18.8
	N+1 hr, 1200°F	55.4	79.6	30.6	-75	18.5
	N+5 hr, 1200°F	55.4	78.1	30.8	-60	19.1
Carbon Steel	Norm.	53.4	78.5	30.5	-75	--
(1.8C, 1.13Mn)	N+1 hr, 1100°F	52.0	77.1	31.2	-85	17.6
	N+5 hr, 1100°F	51.5	76.5	31.4	-80	18.2
	N+25 hr, 1100°F	50.5	75.0	31.8	-60	18.8
	N+1 hr, 1200°F	51.6	76.3	32.0	-70	18.5
	N+5 hr, 1200°F	51.0	74.0	32.3	-65	19.1
A212, Grade B	Oil quenched	69.0	92.8	28.5	-10	--
	Q+1 hr, 1100°F	60.7	87.8	28.0	-18	17.6
	Q+10 hr, 1100°F	54.0	81.2	31.5	-30	18.5
	Q+100 hr, 1100°F	49.7	76.6	34.0	-8	19.4
	(No data at 1200°F)					

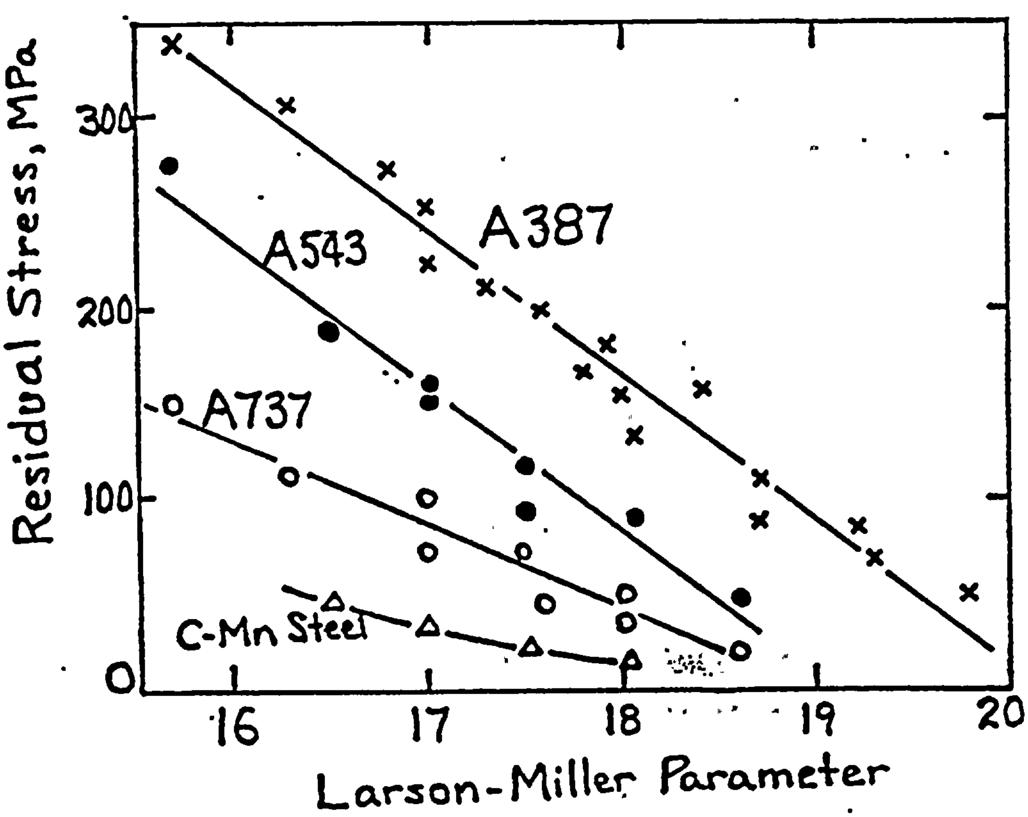

Fig. A-1. Influence of alloy content on thermal stress relief [31]

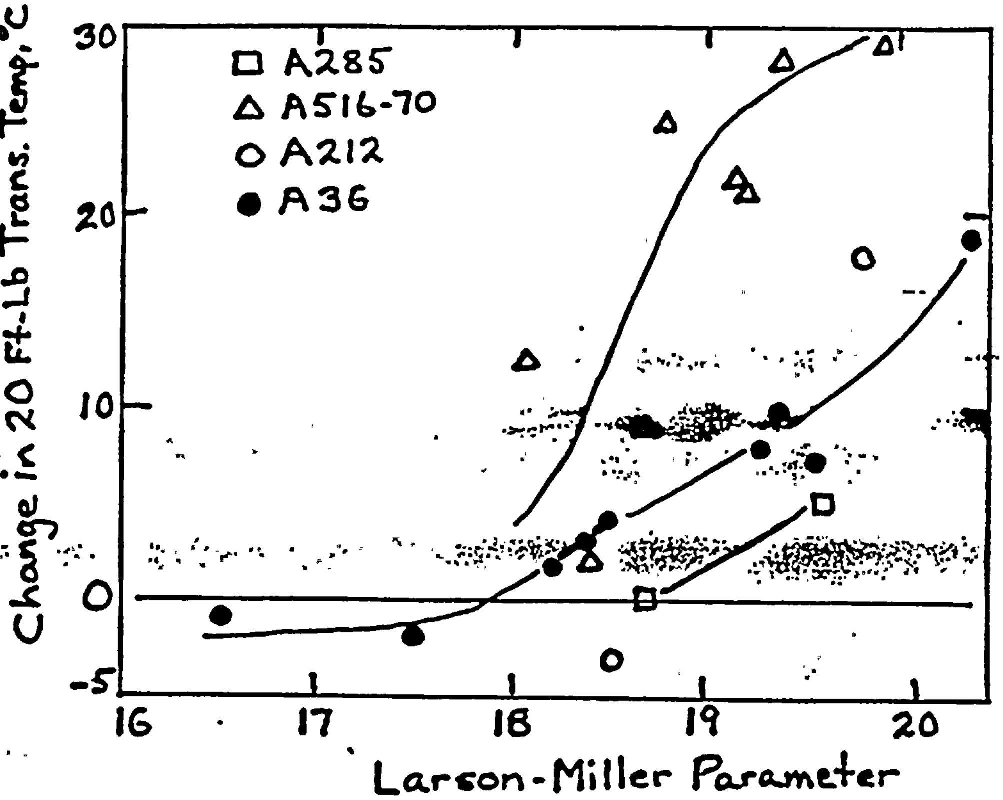

Fig. A2. Loss of notch toughness in carbon steels after PWHT

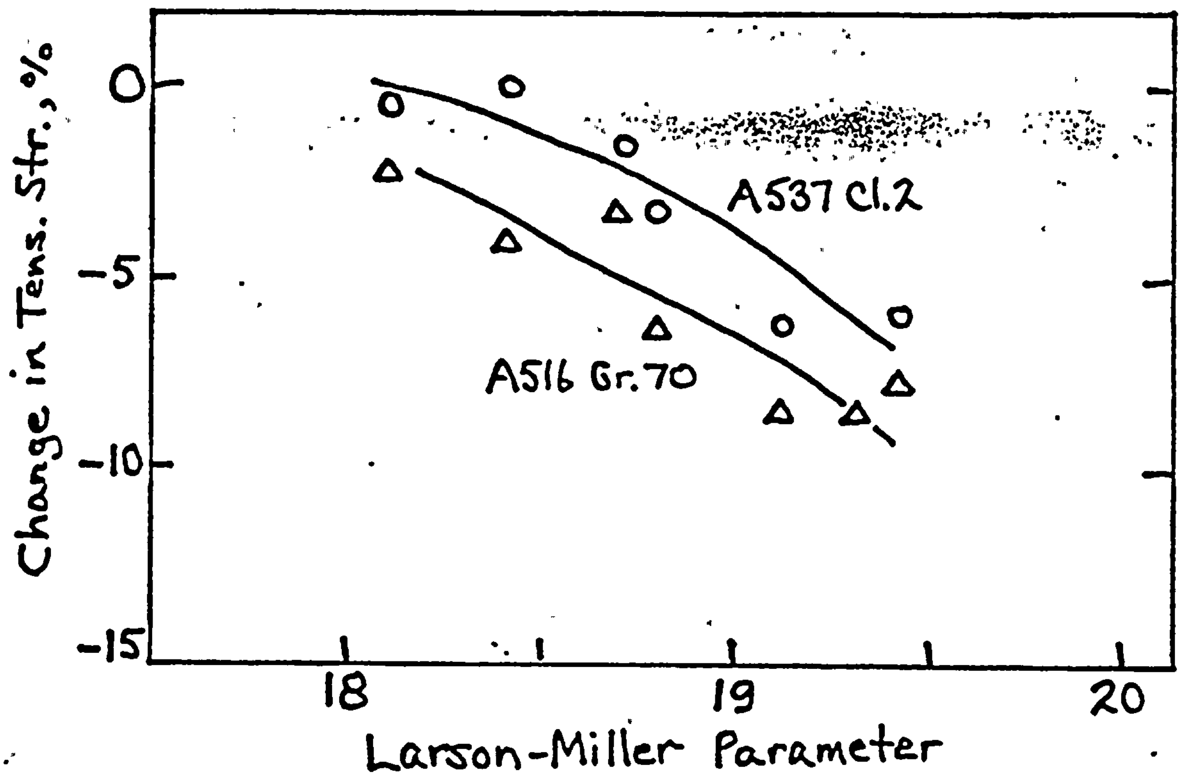

Fig. A-3. Effect of PWHT on Tensile Strength of C-Mn Steels

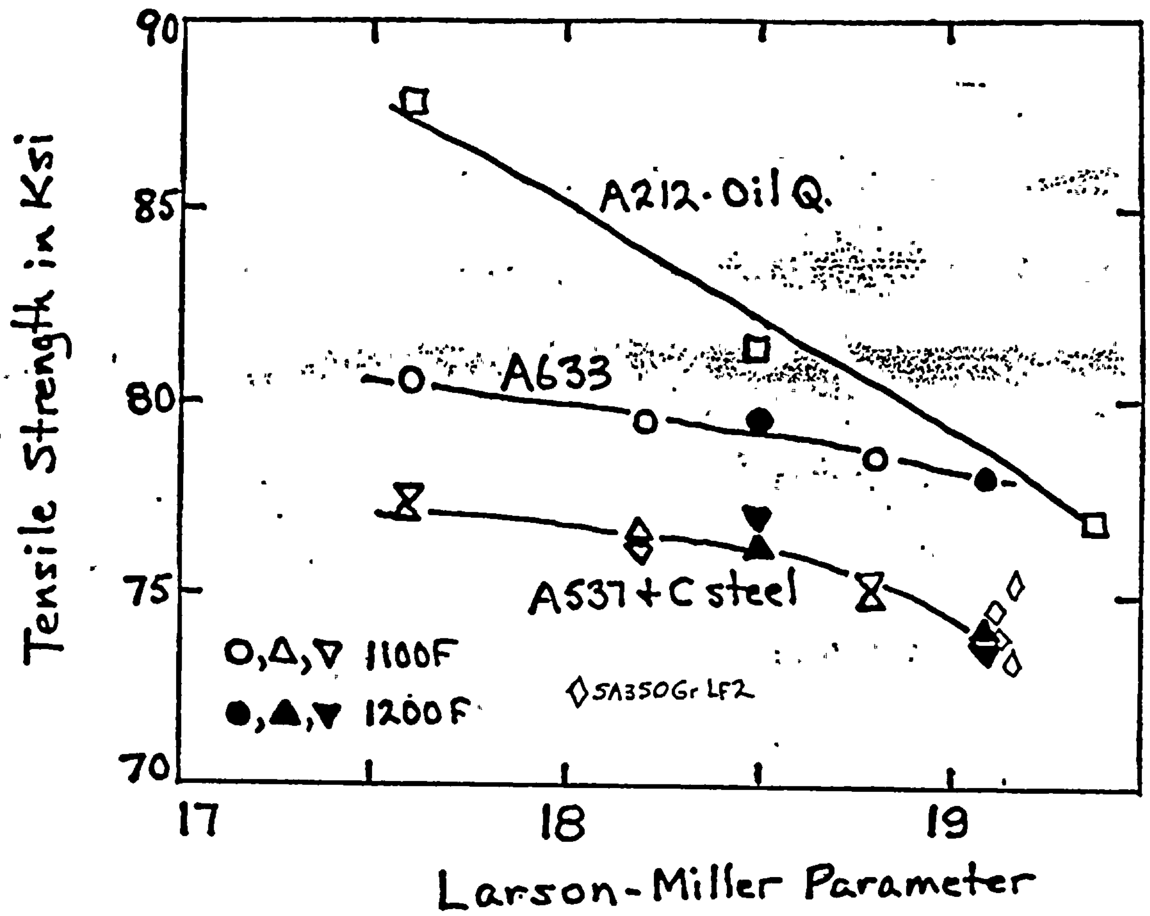

FIG. A-4. Response of C-Mn Steels to Subcritical Heat Treatment