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May 7, 1987

US Nuclear Regulatory Commission  
Attn: Document Control Desk  
Washington, DC 20555

Dear Sirs:

Three Mile Island Nuclear Station, Unit 2 (TMI-2)  
Operating License No. DPR-73  
Docket No. 50-320  
Plasma Arc Cutting

Attached is the GPU Nuclear response to the NRC request for additional information regarding the formation of nickel carbonyl during plasma arc cutting forwarded by NRC Letter dated March 20, 1987.

Additionally, GPU Nuclear letter 4410-86-L-0143 dated August 27, 1986, stated, "...the gases to be used with the plasma arc torch, either separately or in combination, are nitrogen, carbon dioxide, and argon..." GPU Nuclear is currently planning to use nitrogen for both the primary and secondary torch gas (i.e., carbon dioxide will not be used and use of argon is unlikely). The off-gas releases from the use of nitrogen are currently being evaluated. Any safety concerns that may arise as a result of this evaluation will be discussed under separate cover.

Sincerely,

F. R. Standerfer  
Director, TMI-2

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Attachment

cc: Regional Administrator, Region 1 - W. T. Russell  
Director, TMI-2 Cleanup Project Directorate - Dr. W. D. Travers

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On January 20, 1987, GPU Nuclear responded to NRC concerns regarding the use of a plasma arc torch to cut fuel assembly upper end fittings (Reference 1). In that response, GPU Nuclear attempted to demonstrate that nickel carbonyl would not present a worker safety concern during cutting operations. However, NRC Letter dated March 20, 1987 (Reference 2), requested additional information regarding the generation of nickel carbonyl since the January 20, 1987, GPU Nuclear submittal apparently did not adequately address your concerns. Specifically, your letter states that "...there are literature references which indicate a potential for the formation of nickel carbonyl..." It was requested that GPU Nuclear "...provide the staff with adequate analytical data and literature references describing the chemical processes that affect the formation of nickel carbonyl to further support your position that this compound presents no safety hazard." The following discussion responds to your concerns and supports GPU Nuclear's position that nickel carbonyl will not pose a worker safety problem during plasma arc torch cutting operations.

The response to your concern is organized as follows:

- I. Summary of pertinent chemical/physical properties of nickel carbonyl, and
- II. Discussion of technical data and existing analyses reported for high temperature cutting and welding operations.

I. CHEMICAL/PHYSICAL PROPERTIES FOR NICKEL CARBONYL

The chemical and physical properties of a compound provide a general basis for anticipating the behavior of that compound in a given environment. Consequently, behavior inconsistent with a compound's chemical/physical properties should be regarded as unlikely. The following chemical/physical properties of nickel carbonyl provide a basis for the conclusion that nickel carbonyl is of minimal concern relative to worker safety during plasma arc torch cutting operations.

Particularly noteworthy, given the multicomponent solution chemistry of the TMI-2 reactor vessel coolant, is the fact that the formation of nickel carbonyl is not thermodynamically favored. Nickel compounds such as borates, halides, etc., are more thermodynamically favored than carbonyl formations in a multicomponent system (References 3 and 4). However, if it is assumed that nickel carbonyl is formed during underwater plasma arc cutting, the chemical and physical properties listed below argue against the presence of nickel carbonyl as a concern to worker safety.

1. Boiling point = 43°C (109°F); Melting point = -19.3°C (-2.7°F), (Reference 5)
2. Specific Gravity of Liquid = 1.318 at 17°C (63°F) (Reference 5)
3. Specific Gravity of Vapor = 5.9 (Reference 6)
4. Solubility in Water = 180 ppm at 25°C (77°F) (Reference 5)

5. Chemical Stability:

- a. Compound oxidizes in air and is increasingly unstable thermodynamically with increasing temperature in air with very rapid decomposition at 100°C (212°F) (Reference 5). The decomposition rate (i.e., life-time) in air at 23°C (73°F) is 60  $\pm$  5 seconds (Reference 7).
- b. Autoignition temperature reported to be approximately 60°C (140°F) with reports that vapor forms explosive mixtures with air or oxygen (Reference 5).

Assuming that nickel carbonyl is formed under water (reactor coolant temperature approximately 70°F): the boiling point (#1) and specific gravity (#2) would dictate that it remain a liquid and sink. Assuming further that vapor was transported to the coolant surface: the vapor specific gravity (#3) and compound reactivity (#5a and 5b) would dictate that it remain near the coolant surface and chemically react (i.e., oxidize) or react with the oxides of nitrogen present as a result of primary/secondary torch gas reactions. Therefore, on the basis of the chemical/physical properties of nickel carbonyl, it can be reasonably concluded that the potential for creating a safety hazard for workers during plasma cutting is small.

II. TECHNICAL DATA DISCUSSION OF HIGH TEMPERATURE CUTTING AND WELDING OPERATIONS

Nickel carbonyl,  $\text{Ni}(\text{CO})_4$ , is given a TLV/TWA = 0.35 mg/m<sup>3</sup> (as Ni) by the American Conference of Governmental Industrial Hygienists, Inc. (ACGIH) (Reference 8), and the National Institute of Occupational Safety and Health (NIOSH) recommends its regulation as a carcinogen (Reference 5). Consequently, the potential for nickel carbonyl to constitute a health hazard to workers during high temperature metal cutting/welding operations of stainless steels has led to conservative speculation and data interpretation in the past (References 9 through 12). However, recently published work, summarizing extensive studies by the International Nickel Company (INCO) on this issue, provides a clear and definitive demonstration that nickel carbonyl is not an issue of concern during high temperature cutting/welding operations.

The INCO work summarized several years of testing, analysis, and evaluation of data from high temperature metal operation (Reference 13). The study was primarily undertaken to ascertain if nickel carbonyl was formed during typical high temperature welding and cutting\* operations. Secondly, it was designed to measure CO gas concentrations (CO is required for carbonyl formation). During the study, a wide range of welding processes, as well as plasma cutting, were examined. The majority of the base metals used during the study were of high nickel content (e.g., Nickel 200, Inconel 600, Incoloy 800, Monel 400) although 304 and 316 stainless steels also were utilized. The injection of a CO cover gas was employed to increase the potential for carbonyl formation. The study involved use of continuous monitors for: 1)  $\text{Ni}(\text{CO})_4$  by a chemiluminescence analyzer with a detection limit of 0.1 ppb of  $\text{Ni}(\text{CO})_4$  in air and 2) a CO analyzer with detection scales of 0-100 and

\*Reference 13 presents the test results for MIG and TIG welding only. Test results for plasma arc cutting have not been formally presented. However, they do not differ from those for MIG and TIG welding.



0-500 ppm with an accuracy of  $\pm 5\%$  of scale. The cutting/welding was performed in a welding chamber and the generated fumes/gases were exhausted by fan through a filter with the continuous monitors for  $\text{Ni(CO)}_4$  and CO located just downstream of the filter. The results indicated that nickel carbonyl was nondetectable in the majority of cases. In those few cases where detection occurred, it was at the detection limit (0.1 to 0.2 ppb). The test results support the conclusion that nickel carbonyl (TLV/TWA = 133 ppb  $\text{Ni(CO)}_4$ ) does not present a concern for worker health and safety.

Thus, considering the basic nickel carbonyl chemistry and the data collected and evaluated on high temperature metal operations by INCO, it may be concluded that nickel carbonyl is not an issue of concern regarding the health and safety of workers during plasma arc cutting operations.

REFERENCES

1. GPU Nuclear letter 4410-87-L-0012 dated January 20, 1987, "Plasma Arc Cutting," F. R. Standerfer (GPU Nuclear) to W. D. Travers (NRC).
2. NRC Letter NRC/TMI-87-022 dated March 20, 1987, "Plasma Arc Cutting," W. D. Travers (NRC) to F. R. Standerfer (GPU Nuclear).
3. I. Barin and O. Knacke, Thermochemical Properties of Inorganic Substances, Springer-Verlag (1973).
4. J. A. Dean, Langes Handbook of Chemistry, McGraw-Hill Book Company, 13th Edition, 1985.
5. N. Irving Sax, Editor, Hazardous Chemicals Information Annual No. 1, van Nostrand Reinhold Information Services (1986).
6. U.S. Department of Transportation, United States Coast Guard, CHRIS Hazardous Chemical Data, June 1985.
7. D. H. Stedman et. al., "Nickel Carbonyl: Decomposition in Air and Related Kinetic Studies," Science, Vol. 208 (30 May 1980).
8. American Conference of Governmental Industrial Hygienists, Inc., Document of the Threshold Limit Values, Fourth Edition (1980), with Supplemental Documentation for 1984.
9. G. J. Newton, M. D. Hoover, E. B. Barr, B. A. Wong, and P. D. Ritter, "Aerosols from Metal Cutting Techniques Typical of Decommissioning Nuclear Facilities - Experimental System for Collection and Characterization," 1982 International Decommissioning Symposium Proceedings, Seattle, Washington (CONF-821005).
10. M. D. Hoover, G. J. Newton, E. B. Barr, and B. A. Wong, "Aerosols from Metal Cutting Techniques Typical of Decommissioning Nuclear Facilities - Inhalation Hazard and Worker Protection," 1982 International Decommissioning Symposium Proceedings, Seattle, Washington, (CONF-821005).
11. K. M. Croft, TMI Lower Support Disassembly Project Underwater -- Cutting Using the Plasma Arc Cutting Method, Preliminary Test Report, DOE Contract No. DE-AC07 - 76 IDO 1570 (May 1986).
12. D. L. Smith, Final Report SPERT - IV Decontamination and Decommissioning, TREE-1373 (August 1979).
13. L. G. Wiseman and E. T. Chapman, "Test Program to Determine Whether Nickel Carbonyl Forms During the Welding of Nickel Containing Alloys," Proceedings of the International Conference on Health Hazards and Biological Effects of Welding Fumes and Gases, Copenhagen, February 1986, Elsevir Science Publishers (1986).