ILLINOIS POLLUTION CONTROL BOARD
September 20, 1979

IN THE MATTER OF:	)	
	)	
EMISSIONS OF CARBON MONOXIDE	)	R78-1
FROM STEEL MILLS	)	

PROPOSED OPINION OF THE BOARD (by Mr. Dumelle):

This proceeding was initiated on January 18, 1978 when Interlake, Inc.; United States Steel Corporation; WSC Corporation; and Granite City Steel, Division of National Steel Corporation (Petitioners) filed a Petition for amendment of Rule 206(d) of the Air Pollution Control Regulations. The Petition was published in Environmental Register #165 on February 15, 1978. Hearings were held on May 16, 1978 in Chicago; June 1, 1978 in Edwardsville; and September 8, 1978, October 24, 1978, and March 7, 1979 in Chicago. On April 12, 1979 the Board denied a request by Granite City Steel that the proposed amendment be submitted as a tentative revision to the Illinois State Implementation Plan. On June 18, 1979 the Institute of Natural Resources submitted a study to the Board entitled Economic Impact of Changing the Carbon Monoxide Emission Limitations for Steel Mills, R78-1 (INR Document No. 79/14). Hearings on the study were held on July 23, 1979 in Chicago and August 1, 1979 in Granite City. On August 23, 1979 the Board proposed that Rule 206(d) be deleted. This Proposed Opinion supports the Board's Proposed Order.

Rule 206(d) governs emissions of carbon monoxide from sintering plants, blast furnaces, and basic oxygen furnaces. Petitioners operate steel mills in Illinois which are affected by Rule 206(d). Republic Steel Company, although not a petitioner, operates a blast furnace and a basic oxygen furnace in Chicago which are also affected.

None of the operating sintering plants, blast furnaces, or basic oxygen furnaces at Petitioners' facilities comply with the 200 ppm corrected to 50% excess air standard of Rule 206(d). Throughout this proceeding various technologies were evaluated which could possibly result in compliance.

Absorption in copper ammonium salts solution was discounted because of the high oxygen content in the exhaust gas streams from Petitioners' facilities. This oxygen would have to be absorbed along with the carbon monoxide which would result in an operation of enormous size. (Ex.W.,p.25)

Emissions from basic oxygen furnaces can be captured

through installation of a "closed hood" or "off gas" system. These waste gases can then be flared or reused elsewhere. Interlake investigated this alternative and reported its findings in Exhibit H. Interlake dismissed this technology because the cost to capture, store and reuse the gas was prohibitive. If the gas is simply burned instead of stored for reuse, the resulting concentration of carbon monoxide would still be 4,000 ppm, far in excess of the 200 ppm limit in Rule 206(d).

Republic Steel employs an "off gas" collection system on its basic oxygen furnace in Chicago. Since no one from Republic testified in this proceeding, the performance of this system was difficult to gauge. Petitioners felt that since the gases were being flared, their estimate of 4,000 ppm of CO should be applied to Republic. In a comment, the Agency concluded that Republic might be complying with Rule 206(d), but that these emissions could not be measured.

The Board is not convinced that "off gas" systems on basic oxygen furnaces constitute a feasible method of complying with Rule 206(d) unless the gases are captured and stored for reuse. The combustion which occurs directly above the furnaces employing an open hood system (such as Petitioners') may already be destroying more carbon monoxide than closed hood flaring. If capturing these exhaust gases for reuse becomes economically attractive in the future, Petitioners will not need encouragement from the Board to do so.

Catalytic oxidation was studied as an alternative control technique for all affected sources. The authors of the economic impact study concluded that poisoning of catalysts from metal oxide particulates might make catalytic oxidation unworkable in the context of these sources. (Ex.W.,pp.xii, 24 R.513) The only known application of this technology to steel making failed to comply with the present Rule 206(d). (Ex.W.,p.5) The Board was advised that this application has recently been abandoned. (R.118) The Agency also stated that catalytic oxidation was not feasible. (R.658) Consequently the Board concludes that catalytic oxidation is not an available alternative for compliance with Rule 206(d).

Direct flame incineration was the only technology which, at least in theory, might comply with Rule 206(d). The study authors were unable to find any equipment vendor who ". . . could cite an installation where carbon monoxide destruction of the magnitude required by Rule 206(d) actually occurred." (Ex.W.,p.4, R.512)

Each of the Petitioners prepared an estimate of costs to install and operate afterburners which might comply with Rule 206(d). (Ex.B,C,D,I,P) The economic study authors compared these estimates with their own calculations and

included calculations based on maximum use of heat recovery. (Ex.W.,pp.xii,36-37) Assuming that heat recovery would be used because of significant savings and excluding the costs calculated from Republic because of the uncertainty associated with Republic's emissions, application of direct flame incineration would cost Petitioners approximately $25 million per year.

EFFECT ON AIR QUALITY

In order to determine if the emission levels of CO which would be allowed under the rule change would lead to violations of the ambient air quality standard for CO, two air quality simulation modeling studies were performed. One study, (Ex.BB) "Modeling of Carbon Monoxide Dispersion from Four Illinois Steel Production Facilities," was done by Environmental Quality Research, Inc. (EQR) for the steel mills in the Chicago area. The other study, (Ex.L) "A Program of Ambient Air Quality Analysis for Granite City Steel, Granite City, Illinois," was done by Air Resources, Inc. (ARI). Both studies determined what meteorological conditions would lead to worst-case (highest) ground level concentrations of CO and then calculated those concentrations. In both studies, the maximum concentration occurred when the wind direction was such that the plumes from individual point sources (stacks) of CO were aligned. The maximum concentrations were due to a combination of all sources.

The emission inventory data for the Chicago area study was supplied to EQR by Technical Center, Interlake, Inc. Much of this data was based on actual stack measurements during typical operating conditions. (R.162) However, since WSC Corp. is not presently operating its sinter plant, emission levels used in the study for it were extrapolated to the levels that would be expected if the sinter plant were operating. (R.13)

Early versions of the modeling study (Ex.J,Q,R) found that the U.S. Steel blast furnace contributed significantly more to the maximum ground level concentration than any other source. Upon further investigation, it was found that the CO emission rate for USS's blast furnace was the highest reported CO concentration for that source. The concentration that should have been used in the study was the average of several readings which were taken at three minute intervals. (R.549) Such an average would more closely approximate a one hour average than the highest instantaneous sample. Since the air quality simulation model calculates one hour averages, it would be more appropriate to use an emission rate that approximates a one hour average than it would be to use the highest instantaneous value. The final EQR report (Ex.BB) used the average CO reading for U.S. Steel's blast furnace.

EQR used U.S. EPA's UNAMAP model PTMAX to determine the location of regions where maximum ground-level concentrations would occur from each source. These areas were then superpositioned to "[produce] a pattern of candidate regions for the maximum ground-level concentration due to the combined sources." This information was used to plan the locations of the receptors for which concentrations would be calculated using U.S. EPA's UNAMAP model PTMTP. Since the report authors found that their version of PTMAX occasionally produced erroneous concentrations, they recalculated all of these concentrations using "Workbook of Atmospheric Dispersion Estimates" (Turner, D.B. 1969).

Next EQR calculated one-hour ground level concentrations using PTMTP. The calculations were performed for 36 combinations of wind speed and stability classes which correspond to the STAR meteorological data classes for Chicago during the last five years. A 300 meter mixing depth was used for all calculations (R.392). The expected 8-hour average calculations were derived from 1-hour averages by using the method described in Turner's Workbook ("Workbook of Atmospheric Dispersion Estimates," Turner, p.37, 1970.) This information was used to determine the location and magnitude of the maximum 1-hour and 8-hour ground-level concentrations for each class of meteorological conditions (Ex.BB,pp.4-5). The maximum calculated one-hour average was about 4000 to 5000 ug/m^3 (the standard is 40,000 ug/m^3). The maximum eight-hour average was 2700 to 3360 ug/m^3 (the corresponding standard is 10,000 ug/m^3). If the lake breeze effect is taken into account, the calculated concentrations would be approximately double (Ex.BB, p.29).

This method of calculation was questioned at hearing since it used dispersion coefficients which are more appropriate for dispersion simulations in rural areas than it is for urban areas. In general, heat sources, structures, etc. found in urban areas tend to decrease atmospheric stability. Some dispersion modelers feel that the UNAMAP model RAM would be more appropriate since it uses dispersion coefficients developed from studies of urban areas (R.649). This may be true. However, a certain amount of conservatism was built into the study that EQR did. According to their calculations, class A stability (the most unstable) caused the highest ground-level CO concentrations from the point sources. EQR used these concentrations for determining the ground-level impact, even though there is some debate in the literature that class A stability may not exist (R.398,421). (The next more stable condition is class B for which the maximum calculated concentration was 3634 ug/m^3 as compared to 4795 ug/m^3 for class A.)

D. Bruce Turner in "Atmospheric Dispersion Modeling: A Critical Review" (official notice taken of Journal of the Air Pollution Control Association, Vol. 29, No. 5, pp.

502-519, May 1979) states that there are several sources of error in dispersion modeling. Some of these are due to oversimplifications such as the use of "a single stability condition with its related dispersion rate", and "the assumptions of complete eddy reflection at the ground and the top of the mixing height." (Turner, p.512) These oversimplifications which were used in this study would lead to an overcalculation of ground-level concentrations. The Board finds that although EQR could have used the more sophisticated and possibly more accurate version of the urban RAM model, the model that was used probably overestimates ground-level CO concentrations and for purposes of this proceeding is adequate.

The ground-level CO concentrations from the point sources were overlaid on the CO concentrations due to mobile sources in the area. EQR used Illinois Department of Transportation Environmental Policy Processes-Air Quality Manual (IDOT Manual) to estimate the mobile source contribution. The composite emission factor used was a 1978 emission factor. The percentiles of vehicle type and speed used in the modeling study were extracted from data in the IDOT manual. Cook County's 1975 traffic map was used to obtain information on average daily traffic (ADT) (Ex.BB,p.5). However, since the modeling study over estimated the average traffic speed during the worst 8-hours, the emission factors used are probably less than they should be. Consequently, the calculated CO concentrations from mobile sources may be under estimates.

The roadway maximums were determined by calculating CO concentrations at receptors located 50 feet from the roadways with the highest ADT volumes in the area. A wind-roadway angle of 22.5 degrees and class F stability were used since the constitute the most adverse meteorology for dispersal of roadway pollution.

In reality, there is a very small percentage of occurrence of class F stability which coincides with maximum traffic conditions. One or two percent of the total class F stability occurring in any period of time could reasonably coincide with high traffic volumes (i.e. the eight-hour maximum volume). Therefore, the assumption of class F stability for a 'worst probable' condition for computational purposes presents an ultra-conservative approach to prediction of pollution concentrations due to motor vehicles. (Official notice taken of the Illinois Department of Transportation Air Quality Manual, Sept, 1978, prepared by Leonard F. Vik and Miles E. Byers, pp.2-9 to 2-10).

The general ambient background was assumed to be 625 ug/m^3 (0.5 ppm). This value does not include any significant point, area, or roadway sources that might be in the area (R.648).

The worst-case maximum concentrations were obtained by adding the contributions from the stationary sources, roadways

and background. The maximum along the roadway was the sum of the concentration due to the stationary sources at that location with class A stability (worst-case meteorology), roadway contributions at 50 feet from the roadway, and background.

The modeling study did predict that violations of the 8-hour standard would occur along some of the roadways. The report states that "[t]he highest expected 8-hour CO concentration within the 'significant area', which is defined by the area having 625 ug/m^3 or more stationary source contributions, is about 21525 ug/m^3. It consists of 1156 ug/m^3 (5%) from stationary sources, 19744 ug/m^3 (92%) from mobile sources, and 625 ug/m^3 (3%) of background" (Ex.BB,p.29). The meteorological conditions that would lead to this situation are expected to occur less than once per year. The highest possible CO concentration in the area with the highest ADT is 54503 ug/m^3 for the next 8-hour average. "The contributions from the stationary sources on this area is negligible" (Ex.BB,p.30). Thus it appears that exceedences of the eight-hour standard (10,000 ug/m^3) would occur even if the steel mills ceased emitting CO altogether and that the amount of CO which the steel mills contribute to the violation is very small in comparison to the amount contributed by mobile sources.

The study does not predict that either the 1-hour or the more stringent 8-hour standard will be exceeded in the areas where the steel mills would have their maximum impact even when the lake shore effect is considered. These areas are located far enough from the large mobile sources that the CO attributable to these mobile sources at these locations is negligible.

In summary, although the EQR modeling study has some shortcomings, it has been a useful tool to illustrate that in the areas of the steel mills, mobile sources contribute the most CO to ground-level concentrations.

The air quality simulation study for the Granite City Steel facility (Ex.L) was done using the ARI Air Quality Analysis Model (AQAM). This model is based on Turner's Workbook and uses Pasquill-Gifford Gaussian dispersion equations, modified Holland or Briggs plume rise equations and dispersion parameters generalized by Slade. In this particular study, the Briggs plume rise formula, incorporating stack aerodynamic downwash effects was used. The CO emission data for the Granite City Steel facility was supplied by that facility.

Since the meteorological condition that could produce the maximum short-term ground-level concentration was not observed in that area during the five years between January 1970 and December 1974, ARI also calculated the maximum

one-hour ground-level concentration for the most adverse observed meteorological condition. The theoretical short-term maximum concentration due to the point sources alone was found to be 5.7 ppm, while the maximum value calculated for observed meteorology was 2.4 ppm. Both these values are well below the one-hour standard of 35 ppm. The other concentrations calculated for longer averaging times were also well below the respective standards.

The ARI study also found that "[v]ehicular emissions from major streets and highways in this region are the major sources of CO. The highest ground concentrations from this source usually occur under stable conditions and low wind speeds." These are not the same conditions which would lead to maximum ground-level concentrations due to elevated point sources. The highest CO concentration attributable to point sources was calculated to be 0.307 ppm (Ex.L,p.v-1).

In conclusion, the Board believes that allowing the Granite City Steel Company to continue emitting CO at its current rate will not cause a violation of any CO standards and will not create a human health problem.

In the Illinois State Implementation Plan for CO (Ex.DD), the Illinois EPA has determined that in the two areas of the state with CO air quality violations (the Chicago six county area and the Peoria two county area), 83% of the CO emissions is from on-highway mobile sources. These sources make the most significant contributions to violations because, in addition to producing most of the CO, their emissions occur near ground-level and near heavily populated areas. Carbon monoxide from stationary sources, on the other hand, is generally emitted from stacks elevated above ground level so that the CO concentration is greatly diluted by the time it reaches ground-level. Hence, " . . . the CO SIP is based on control of emissions from mobile sources, with emissions from stationary and area sources considered in the analyses as secondary effects."

ECONOMIC IMPACT

The Illinois Institute of Natural Resources submitted to the Board a document entitled Economic Impact of Changing the Carbon Monoxide Emission Limitations for Steel Mills, R78-1 (IINR Doc. No. 79/14) (Ex.W. hereafter "Study"). Section 2 of the Study described the affected processes (and related emissions) and discussed control technology. Estimated capital costs were compared (Ex.W., Tables 2-5 through 2-8). Section 3 analyzed three control scenarios in terms of prices, output, and employment.

Section 3.1, Economic Characteristics of the Iron and Steel Industry, while not determinative in this proceeding,

does provide a useful description. Section 3.2 and 3.3 make it clear that compliance with the existing Rule would have severe economic consequences for the Illinois steel industry. Section 3.4 summarizes those consequences (Ex.W., Table 3-22).

Section 4.0, Health and Environmental Consequences, examines the differences between compliance with the existing Rule 206(d) and the proposal of R78-1 (Ex.W.,p.90). The effects are analyzed both qualitatively and quantitatively. The qualitative discussion encompassed effects on human health, fauna and flora, and energy demand.

The quantitative analysis attempted to monetize the carbon monoxide damage which is attributable to the proposal of R78-1. Two methods were used: one used a damage factor based on emission rates and the other used a damage factor based on ambient levels. Both approaches yield results which are of limited usefulness. The author of this section of the Study attributed the greatest uncertainty to the estimates of health effects at low ambient concentrations (Ex.W.,p.119).

The Agency raised objections to the methodologies used to assess CO damages and concluded that ". . . the quantitative information . . . must be regarded with a degree of skepticism that would negate its value for decision-making purposes" (Ex.CC,p.5).

The Board determines that the proposed regulation may have a slight adverse economic impact on the people of the State of Illinois due to the slightly higher ambient levels of CO that will be permissible. However, a positive economic impact also accrues to the people of the State of Illinois through the abolition of the existing rule.

DELETION OF RULE 206(d)

At the last hearing in this matter, Petitioners endorsed the Agency's proposed language for Rule 206(d) in Exhibit V. The Agency's proposal was similar to Rule 206(h) which limits emissions based on the fuel value of the waste gas stream. The proposal also would have required a fall back to the present Rule 206(d) in the event that any affected source contributed to a violation of ambient air quality standards by more than specified increments.

The Board has chosen to reject the proposed language in Exhibit V for the following reasons. First, since none of the affected sources has a fuel value which approaches 20% of that required for flame incineration of the waste gas stream at 1460°F (Ex.B,D,P; R.112), the proposal would not have required any controls. Second, the Board can see no

reason to require a fallback to 200 ppm when that standard is either impossible to achieve or unreasonably expensive. Third, the specified increments are borrowed from Federal regulations (Ex.T,U) with no record to support them here. Fourth, the language of Exhibit V does not specify how these violations or contributions to violations are to be calculated. Fifth, and most important, the record in this proceeding demonstrates that controlling carbon monoxide emissions from these sources, to any level, will have no significant effect on ambient air quality.

Mr. Werner concurs.

I, Christan L. Moffett, Clerk of the Illinois Pollution Control Board, hereby certify the above Proposed Opinion was adopted on the 20th day of September, 1979 by a vote of 5-0.

Christan L. Moffett
Christan L. Moffett, Clerk
Illinois Pollution Control Board