Note: This is a reference cited in *AP 42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

| | |
|---|---|
| AP32 Section: | 12.5.1 |
| Background Chapter | 3 |
| Reference: | 11 |
| Title: | Compliance Emission Testing for Particulate, Nitrogen Oxide, Carbon Monoxide, Sulfur Dioxide, Volatile Organic Carbon, and Hydrogen Chloride on the Melt Shop Baghouse, Roller Hearth Furnace, Acid Regeneration, HCL Pickle Line, and Cold Reversing Mill at Nucor Steel, Crawfordsville, IN. Test Date: July 17-20, 1990. ATI Job Number: 90T02010. |

# Compliance Emission Testing

for

Particulate, Nitrogen Oxide, Carbon Monoxide Sulfur Dioxide
Volatile Organic Carbon and Hydrogen Chloride

on the

Melt Shop Baghouse, Roller Hearth Furnace, Acid Regeneration,
HCL Pickle Line, and Cold Reversing Mill

at

Nucor Steel

Crawfordsville, Indiana

Test Date: July 17-20, 1990
ATI Job Number: 90T02010

Submitted by:

Air Techniques, Inc.
1724 Nekoma Street
Marietta, GA 30067

Russell Barton,
Testing Manager

Andy Barefoot,
Asst. Testing Manager

## I. Introduction

Compliance emission testing was performed on several sources at the Nucor Steel facility located in Crawfordsville, Indiana. The sources tested and their applicable analytes are: 1) Melt Shop Baghouse; particulate, volatile organic carbon, nitrogen dioxide, sulfur dioxide and carbon monoxide 2) Roller Hearth Furnace; nitrogen dioxide 3) Cold Reversing Mill; particulate 4) HCL Pickle Line; particulate 5) Acid Regeneration; particulate, and hydrogen chloride. The purpose of the testing was to determine if the emissions comply with the limits set forth by the Federal EPA New Source Performance Standards and the Indiana Department of Environmental Management. Visual determination of opacity was also perfomed on the Melt Shop Baghouse.

The testing was conducted on July 17-20, 1990 by Russell Barton, David Ingram, Andy Barefoot, J.B. Hawkins, and Evio deOliveira of Air Techniques, Inc. of Marietta, Georgia. Visual Determination of Opacity from a Stationary Source was performed by Russell Barton.

Air Techniques would like to extend its appreciation to Mr. Dave Sulc and the Nucor Steel plant personnel for their assistance throughout the test program. Air Techniques would also like to thank Mr. Ray Schick and Mr. Dick Sekula with the Indiana Department of Environmental Management for their review of the testing procedures and process operations.

Nucor

## II. Summary of Results

The complete summary of results is shown in tabular form in the Appendix. Below are given the emission rates, concentrations, and allowable emissions.

Melt Shop Baghouse
July 17, 1990

| Analyte | Test 1 | Test 2 | Test 3 | Avg. | Allowable |
|---|---|---|---|---|---|
| Particulate, #/hr: | 10.88 | 11.19 | 8.72 | 10.26 | 12.0 |
| Particulate, gr/dscf: | 0.0012 | 0.0012 | 0.0010 | 0.0011 | .0018 |
| SO2, #/hr: | 5.32 | 3.89 | 5.47 | 4.89 | 7.6 |
| SO2, #/ton steel: | 0.050 | 0.036 | 0.051 | 0.046 | 0.094 |
| VOC, #/hr: | 2273 | 1668 | 3628 | 2523 | 20.8 |
| VOC, #/ton steel: | 21.3 | 15.1 | 34.1 | 23.5 | 0.26 |
| CO, #/hr: | 351 | 338 | 110 | 266 | 58.0 |
| NOx, #/hr: | 30.8 | 38.0 | 52.6 | 40.5 | 56.0 |
| NOx, #/ton steel: | 0.29 | 0.36 | 0.49 | 0.38 | 0.70 |

Cold Reversing Mill
July 18, 1990

| Analyte | Test 1 | Test 2 | Test 3 | Avg. | Allowable |
|---|---|---|---|---|---|
| Particulate, #/hr: | 5.91 | 3.83 | 2.26 | 4.0 | 7.2 |
| Particulate, gr/dscf: | 0.0141 | 0.0091 | 0.0055 | .0096 | 0.01 |

HCl Pickle Line
July 19, 1990

| Analyte | Test 1 | Test 2 | Test 3 | Avg. | Allowable |
|---|---|---|---|---|---|
| Particulate,#/hr: | 1.44 | 2.55 | 1.88 | 1.96 | 0.3 |
| Particulate, gr/dscf: | 0.0175 | 0.0336 | 0.0233 | 0.0248 | 0.003 |

## Acid Regeneration
July 19, 1990

| Analyte | Test 1 | Test 2 | Test 3 | Avg. | Allowable |
|---|---|---|---|---|---|
| Particulate, #/hr: | 1.01 | 1.09 | 1.18 | 1.09 | .02 |
| Particulate, #/MM ft3 natural gas: | 155.5 | 167.4 | 193.8 | 172.2 | 3.0 |
| HCl, #/hr: | .09 | .08 | .09 | 0.09 | n/a |
| HCl, #/MM ft3 natural gas: | 13.2 | 12.6 | 15.5 | 13.8 | n/a |

## Roller Hearth Normalizing Furnace
July 19, 1990

### Stack 1

| Analyte | Test 1 | Test 2 | Test 3 | Avg. |
|---|---|---|---|---|
| NOx, #/hr: | 0.08 | 0.12 | 0.27 | 0.16 |
| NOx, #/MM ft3 nat. gas: | 1.472 | 3.323 | 5.067 | 3.287 |

### Stack 2

| Analyte | Test 1 | Test 2 | Test 3 | Avg. |
|---|---|---|---|---|
| NOx, #/hr: | 0.44 | 0.30 | 0.36 | 0.37 |
| NOx, #/MM ft3 nat. gas: | 9.260 | 6.195 | 7.470 | 7.642 |

### Stack 3

| Analyte | Test 1 | Test 2 | Test 3 | Avg. |
|---|---|---|---|---|
| NOx, #/hr: | 0.83 | 0.74 | 1.00 | 0.89 |
| NOx, #/MM ft3 nat. gas: | 17.693 | 15.806 | 21.218 | 18.239 |

### Total

| Analyte | 1 | 2 | 3 | Avg. | Allow. |
|---|---|---|---|---|---|
| NOx, #/hr: | 1.35 | 1.16 | 1.63 | 1.42 | 24.8 |
| NOx, #/MM ft3 Natural Gas: | 28.425 | 25.234 | 33.755 | 29.168 | 364 |

Total 4.14

## IV. Process Description

Nucor Steel in Crawfordsville, Indiana operates two electric arc furnaces (EAF) which are controlled by a direct shell evacuation system. The emissions from each source are routed into a common positive pressure fabric filter baghouse. Carbon Monoxide emissions are reduced by thermal destruction in the direct shell evacuation elbow leading to the baghouse. The ladle metallurgical station and the continuous caster vent to the common EAF baghouse also.

Steel poured through the continuous caster is processed in the roller hearth normalizing furnace. Only natural gas is burned in the furnace and emissions are vented through three separate natural draft stacks. Nitrogen oxide emissions are controlled by NOx suppresser control technology consisting of Stein-Heurtey BSI 1 + 2 burners with recuporator.

The steel is further processed by the cold reversing mill. Emissions are drawn from the process and through two filter condensers by two axial fans in parallel. The gas streams are combined into a common stack before being emitted into the atmosphere.

SUMMARY OF TEST RESULTS
Nucor Steel
Baghouse Melt Shop
July 17, 1990
(particulate)

| | Test # 1 | Test # 2 | Test # 3 |
|---|---|---|---|
| Sample Volume (Vm): | 198.389 | 188.720 | 197.790 |
| Sqrt Delta P: | N/A | N/A | N/A |
| Sampling Time (min): | 240 | 240 | 240 |
| Barometric Pressure (Pb): | 29.34 | 29.36 | 29.31 |
| Delta H (H): | 2.04 | 1.92 | 2.04 |
| Volume in Impingers (mls): | 50.0 | 43.0 | 54.0 |
| Static Pressure (in. wc.): | 6.4 ok | 6.4 | 6.5 |
| Stack Pressure (Ps): | 29.81 | 29.83 | 29.78 |
| Stack Temperature (Ts): | 133 | 132 | 136 |
| Meter Coefficient (Y): | 0.992 | 0.992 | 0.992 |
| Pitot Coefficient (Cp): | n/a | n/a | n/a |
| Meter Temperature (Tm): | 96 | 91 | 97 |
| Area Stack (As): | n/a | n/a | n/a |
| Area Nozzle (An): | 0.003068 | 0.003068 | 0.003068 |
| Percent CO2 (%): | 0.0 | 0.0 | 0.0 |
| Percent O2 (%): | 20.0 | 20.0 | 20.0 |
| Percent N2 (%): | 80.0 | 80.0 | 80.0 |
| Milligrams: | 14.1 | 14.1 | 11.5 |

| | | | |
|---|---|---|---|
| Molecular Weight Dry (Md): | 28.80 | 28.80 | 28.80 |
| Volume Water (Vwstd): | n/a | n/a | n/a |
| Volume Gas Sampled (Vmstd): | 184.131 | 176.814 | 183.059 |
| Wet Fraction (Bws): | 0.012 ok | 0.014 | 0.015 |
| Molecular Weight Wet (Ms): | 28.67 | 28.65 | 28.64 |
| Volume Gas Sampled (Vma): | 210.079 | 201.688 | 210.738 |
| Stack Gas Velocity, (Vs): | 4.60 ? | 4.52 | 4.68 |
| Volumetric Flowrate (Qs): | 1,074,133 ok | 1,061,454 ok | 1,049,159 |
| Volumetric Flowrate (Qa): | 1,221,330 ok | 1,215,530 ok | 1,190,384 |
| Grainloading, gr/dscf (cs): | 0.0012 | 0.0012 | 0.0010 |
| Grainloading, gr/ACF (csi): | 0.0010 | 0.0011 | 0.0008 |
| Emission Rate, #/Hour: | 10.88 ok | 11.19 ok | 8.72 |
| Percent Isokinetic Sampling: | 103.50 | 100.79 | 101.85 |

~~22.96~~
Vw = 47.2

SUMMARY OF TEST RESULTS
Nucor Steel
Baghouse Melt Shop
July 17, 1990
Sulfur Dioxide

| | Test # 1 | Test # 2 | Test # 3 |
|---|---|---|---|
| Sample Volume (Vm): | 198.389 | 188.720 | 197.790 |
| Sqrt Delta P: | N/A | N/A | N/A |
| Sampling Time (min): | 240 | 240 | 240 |
| Barometric Pressure (Pb): | 29.34 | 29.36 | 29.31 |
| Delta H (H): | 2.04 | 1.92 | 2.04 |
| Volume in Impingers (mls): | 50.0 | 43.0 | 54.0 |
| Static Pressure (in. wc.): | 6.4 | 6.4 | 6.5 |
| Stack Pressure (Ps): | 29.81 | 29.83 | 29.78 |
| Stack Temperature (Ts): | 133 | 132 | 136 |
| Meter Coefficient (Y): | 0.992 | 0.992 | 0.992 |
| Pitot Coefficient (Cp): | n/a | n/a | n/a |
| Meter Temperature (Tm): | 96 | 91 | 97 |
| Area Stack (As): | n/a | n/a | n/a |
| Area Nozzle (An): | 0.003068 | 0.003068 | 0.003068 |
| Percent CO2 (%): | 0.0 | 0.0 | 0.0 |
| Percent O2 (%): | 20.0 | 20.0 | 20.0 |
| Percent N2 (%): | 80.0 | 80.0 | 80.0 |
| Milligrams SO2: | 6.9 | 4.9 | 7.2 |
| | | | |
| Molecular Weight Dry (Md): | 28.80 | 28.80 | 28.80 |
| Volume Water (Vwstd): | n/a | n/a | n/a |
| Volume Gas Sampled (Vmstd): | 184.131 | 176.814 | 183.059 |
| Wet Fraction (Bws): | 0.012 | 0.014 | 0.015 |
| Molecular Weight Wet (Ms): | 28.67 | 28.65 | 28.64 |
| Volume Gas Sampled (Vma): | 210.079 | 201.688 | 210.738 |
| Stack Gas Velocity, (Vs): | 4.60 | 4.52 | 4.68 |
| Volumetric Flowrate (Qs): | 1,074,133 | 1,061,454 | 1,049,159 |
| Volumetric Flowrate (Qa): | 1,221,330 | 1,215,530 | 1,190,384 |
| Grainloading, gr/dscf (cs): | 0.0006 | 0.0004 | 0.0006 |
| Grainloading, gr/ACF (csi): | 0.0005 | 0.0004 | 0.0005 |
| Emission Rate, #/Hour: | 5.32 | 3.89 | 5.46 |
| Percent Isokinetic Sampling: | 103.50 | 100.79 | 101.85 |
| | | | |
| Steel Produced, tons/hr: | 106.7 | 106.7 | 106.7 |
| # SO2/Ton Steel | 0.050 | 0.036 | 0.051 |

Nucor Steel
Carbon Monoxide
Melt Shop Baghouse
July 17, 1990

| Test No. | Test 1 | Test 2 | Test 3 |
|---|---|---|---|
| Gas Flowrate (DSCFM): | 1074133 | 1061454 | 1051689 |
| CO Concentration (mg/cu M): | 87.360 | 85.030 | 27.955 |
| CO Concentration (PPM): | 75 | 73 | 24 |
| Carbon Monoxide, (Lb/hr): | 351.21 | 337.81 | 110.04 |
| | 3.3 | 3.1 | 1.03 |

Nucor Steel
Nitrogen Oxides
Melt Shop Baghouse
July 17, 1990

| Test No. | Test 1 | Test 2 | Test 3 |
|---|---|---|---|
| Gas Flowrate (DSCFM): | 1074133 | 1061454 | 1049159 |
| NO2 Concentration (mg/cu M): | 8 | 10 | 13 |
| NO2 Concentration (PPM): | 4 | 5 | 7 |
| NO2, (Lb/hr): | 30.77 32.19 | 38.01 39.7 | 52.60 |
| Steel Produced, Tons/Hr: | 106.7 | 106.7 | 106.7 |
| NO2, (lbs NO2/Ton Steel): | 0.29 | 0.36 | 0.49 |

Nucor Steel
Volatile Organic Carbon
Melt Shop Baghouse
July 17, 1990

| Test No. | Test 1 | Test 2 | Test 3 |
|---|---|---|---|
| Gas Flowrate (DSCFM): | 1074133 | 1061454 | 1049159 |
| VOC Concentration (mg/cu M): | 566 | 420 | 924 |
| VOC Concentration (PPM): | 1133 | 841 | 1851 |
| VOC, (Lb/hr): | 2273.84 2277.44 | 1667.90 1670.19 | 3628.44 3631.85 |
| Steel Produced, tons/hr: | 106.7 | 106.7 | 106.7 |
| VOC, (lbs VOC/Ton Steel): | 21.31 | 15.63 | 34.01 |

Ave = 2526.37 lb/hr VOC

SUMMARY OF TEST RESULTS
Nucor Steel
Crawforsville, IN.
July 18, 1990
Cold Reversing Mill
(particulate)

| | Test # 1 | Test # 2 | Test # 3 |
|---|---|---|---|
| Sample Volume (Vm): | 46.316 | 46.583 | 45.656 |
| Sqrt Delta P: | 0.650 | 0.656 | 0.642 |
| Sampling Time (min): | 60 | 60 | 60 |
| Barometric Pressure (Pb): | 29.40 | 29.37 | 29.40 |
| Delta H (H): | 1.66 | 1.69 | 1.61 |
| Volume in Impingers (mls): | 31.0 | 33.5 | 36.5 |
| Static Pressure (in. wc.): | -0.3 | -0.2 | -0.2 |
| Stack Pressure (Ps): | 29.38 | 29.36 | 29.38 |
| Stack Temperature (Ts): | 94 | 98 | 97 |
| Meter Coefficient (Y): | 0.998 | 0.998 | 0.998 |
| Pitot Coefficient (Cp): | 0.840 | 0.840 | 0.840 |
| Meter Temperature (Tm): | 87 | 97 | 96 |
| Stack Diameter, (inches): | 66.0 | 66.0 | 66.0 |
| Area Stack (As): | 23.76 | 23.76 | 23.76 |
| Nozzle Diameter, (inches): | 0.250 | 0.250 | 0.250 |
| Area Nozzle (An): | 0.000341 | 0.000341 | 0.000341 |
| Percent CO2 (%): | 0.0 | 0.0 | 0.0 |
| Percent O2 (%): | 21.0 | 21.0 | 21.0 |
| Percent N2 (%): | 79.0 | 79.0 | 79.0 |
| Milligrams: | 40.1 | 25.6 | 15.2 |
| | | | |
| Molecular Weight Dry (Md): | 28.84 | 28.84 | 28.84 |
| Volume Water (Vwstd): | 1.46 | 1.58 | 1.72 |
| Volume Gas Sampled (Vmstd): | 44.007 | 43.425 | 42.672 |
| Wet Fraction (Bws): | 0.032 | 0.035 | 0.039 |
| Molecular Weight Wet (Ms): | 28.49 | 28.46 | 28.42 |
| Volume Gas Sampled (Vma): | 48.583 | 48.474 | 47.683 |
| Stack Gas Velocity, (Vs): | 37.97 | 38.50 | 37.65 |
| Volumetric Flowrate (Qs): | 49,033 | 49,165 | 48,033 |
| Volumetric Flowrate (Qa): | 54,131 | 54,881 | 53,673 |
| Grainloading, gr/dscf (cs): | 0.0141 | 0.0091 | 0.0055 |
| Grainloading, gr/ACF (csi): | 0.0127 | 0.0081 | 0.0049 |
| Emission Rate, #/Hour: | 5.91 | 3.83 | 2.26 |
| Percent Isokinetic Sampling: | 104.32 | 102.66 | 103.26 |

Nucor Steel
Crawfordsville, IN.
July 19, 1990
Roller Hearth Normalizing Furnace
Stack 1
Nitrogen Oxides

| Test No. | Test 1 | Test 2 | Test 3 |
|---|---|---|---|
| Gas Flowrate (DSCFM): | 3631 | 3438 | 2678 |
| NO2 Concentration (mg/cu M): | 6 | 10 | 27 |
| NO2 Concentration (PPM): | 3 | 5 | 14 |
| NO2 Emission Rate, (Lb/hr): | 0.08 | 0.12 | 0.27 |
| Nat. Gas Used, MM ft3/hr: | 0.053 | 0.053 | 0.053 |
| NO2, (lbs NO2/MM ft3 nat. gas): | 1.472 | 2.323 | 5.067 |

Nucor Steel
Crawfordsville, IN.
July 19, 1990
Roller Hearth Normalizing Furnace
Stack 2
Nitrogen Oxides

| Test No. | Test 1 | Test 2 | Test 3 |
|---|---|---|---|
| Gas Flowrate (DSCFM): | 2387 | 2595 | 2503 |
| NO2 Concentration (mg/cu M): | 50 | 31 | 38 |
| NO2 Concentration (PPM): | 26 | 16 | 20 |
| NO2 Emission Rate, (Lb/hr): | 0.44 | 0.30 | 0.36 |
| Nat. Gas Used, MM ft3/hr: | 0.048 | 0.048 | 0.048 |
| NO2, (lbs NO2/mm ft3 nat. gas): | 9.260 | 6.195 | 7.470 |

Nucor Steel
Crawfordsville, IN.
July 20, 1990
Roller Hearth Normalizing Furnace
Stack 3
Nitrogen Oxides

| Test No. | Test 1 | Test 2 | Test 3 |
|---|---|---|---|
| Gas Flowrate (DSCFM): | 2977 | 2593 | 3238 |
| NO2 Concentration (mg/cu M): | 75 | 77 | 82 |
| NO2 Concentration (PPM): | 39 | 40 | 43 |
| NO2 Emission Rate, (Lb/hr): | 0.83 | 0.74 | 1.00 |
| Nat. Gas Used, MM ft3/hr: | 0.047 | 0.047 | 0.047 |
| NO2, (lbs NO2/MM ft3 nat. gas): | 17.693 | 15.806 | 21.218 |