CONTINUED FROM THE FRONT

| 1. POLLUTANT AND CAS NUMBER (if available) | 2. MARK 'X' a. TESTING REQUIRED | b. BELIEVED PRESENT | c. BELIEVED ABSENT | 3. EFFLUENT a. MAXIMUM DAILY VALUE (1) CONCENTRATION | (2) MASS | b. MAXIMUM 30 DAY VALUE (if available) (1) CONCENTRATION | (2) MASS | c. LONG TERM AVRG. VALUE (if available) (1) CONCENTRATION | (2) MASS | d. NO. OF ANALYSES | 4. UNITS a. CONCENTRATION | b. MASS | 5. INTAKE (optional) a. LONG TERM AVERAGE VALUE (1) CONCENTRATION | (2) MASS | b. NO. OF ANALYSES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GC/MS FRACTION – VOLATILE COMPOUNDS | | | | | | | | | | | | | | | |
| 1V. Acrolein (107-02-8) | | | X | | | | | | | | | | | | |
| 2V. Acrylonitrile (107-13-1) | | | X | | | | | | | | | | | | |
| 3V. Benzene (71-43-2) | | | X | | | | | | | | | | | | |
| 4V. Bis (Chloromethyl) Ether (542-88-1) | | | X | As per 46 Federal Register 2264, this analyte was removed from the Priority Pollutant List. | | | | | | | | | | | |
| Bromoform 5-2) | | | X | | | | | | | | | | | | |
| 6V. Carbon Tetrachloride (56-23-5) | | | X | | | | | | | | | | | | |
| 7V. Chlorobenzene (108-90-7) | | | X | | | | | | | | | | | | |
| 8V. Chlorodibromomethane (124-48-1) | | | X | | | | | | | | | | | | |
| 9V. Chloroethane (75-00-3) | | | X | | | | | | | | | | | | |
| 10V. 2-Chloroethylvinyl Ether (110-75-8) | | | X | | | | | | | | | | | | |
| 11V. Chloroform (67-66-3) | | | X | | | | | | | | | | | | |
| 12V. Dichlorobromomethane (75-27-4) | | | X | | | | | | | | | | | | |
| 13V. Dichlorodifluoromethane (-71-8) | | | X | | | | | | | | | | | | |
| 1,1-Dichloroethane (75-34-3) | | | X | | | | | | | | | | | | |
| 15V. 1,2-Dichloroethane (107-06-2) | | | X | | | | | | | | | | | | |
| 16V. 1,1-Dichloroethylene (75-35-4) | | | X | | | | | | | | | | | | |
| 17V. 1,2-Dichloropropane (78-87-5) | | | X | | | | | | | | | | | | |
| 18V. 1,3-Dichloropropylene (542-75-6) | | | X | | | | | | | | | | | | |
| 19V. Ethylbenzene (100-41-4) | | | X | | | | | | | | | | | | |
| 20V. Methyl Bromide (74-83-9) | | | X | | | | | | | | | | | | |
| 21V. Methyl Chloride (74-87-3) | | | X | | | | | | | | | | | | |

CONTINUE ON PAGE V

| EPA I.D. NUMBER (copy from Item 1 of Form 1) | OUTFALL NUMBER |
|---|---|
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PART C - If you are a primary industry and this outfall contains process wastewater, refer to Table 2c-2 in the instructions to determine which of the GC/MS fractions you must test for. Mark "X" in column 2-a for all such GC/MS fractions that apply to your industry and for ALL toxic metals, cyanides, and total phenols. If you are not required to mark column 2-a *(secondary industries, non-process wastewater outfalls, and non-required GC/MS fractions)*, mark "X" in column 2-b for each pollutant you know or have reason to believe is present. Mark "X" in column 2-c for each pollutant you believe to be absent. If you mark either columns 2-a or 2-b for any pollutant, you must provide the results of at least one analysis for that pollutant. Note that there are seven pages to this part; please review each carefully. Complete one table *(all seven pages)* for each outfall. See instructions for additional details and requirements.

| 1. POLLUTANT AND CAS NUMBER (if available) | 2. MARK "X" | | | 3. EFFLUENT | | | | | | | 4. UNITS | | 5. INTAKE (optional) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a. TEST INC. REQUIRED | b. BELIEVED PRESENT | c. BELIEVED ABSENT | a. MAXIMUM DAILY VALUE (1) CONCENTRATION | (2) MASS | b. MAXIMUM 30 DAY VALUE (if available) (1) CONCENTRATION | (2) MASS | c. LONG TERM AVRG. VALUE (if available) (1) CONCENTRATION | (2) MASS | d. NO. OF ANALYSES | a. CONCENTRATION | b. MASS | a. LONG TERM AVERAGE VALUE (1) CONCENTRATION | (2) MASS | b. NO. OF ANALYSES |
| METALS, CYANIDE, AND TOTAL PHENOLS | | | | | | | | | | | | | | | |
| 1M. Antimony, Total (7440-36-0) | | | X | | | | | | | | | | | | |
| Arsenic, Total (0-38-2) | | | X | | | | | | | | | | | | |
| 3M. Beryllium, Total, 7440-41-7) | | | X | | | | | | | | | | | | |
| 4M. Cadmium, Total (7440-43-9) | | | X | | | | | | | | | | | | |
| 5M. Chromium, Total (7440-47-3) | | | X | | | | | | | | | | | | |
| 6M. Copper, Total (7550-50-8) | | | X | | | | | | | | | | | | |
| 7M. Lead, Total (7439-92-1) | | | X | | | | | | | | | | | | |
| 8M. Mercury, Total (7439-97-6) | | | X | | | | | | | | | | | | |
| 9M. Nickel, Total (7440-02-0) | | | X | | | | | | | | | | | | |
| 10M. Selenium, Total (7782-49-2) | | | X | | | | | | | | | | | | |
| 11M. Silver, Total (7440-22-4) | | | X | | | | | | | | | | | | |
| 12M. Thallium, Total (7440-28-0) | | | X | | | | | | | | | | | | |
| 13M. Zinc, Total (7440-66-6) | | | X | | | | | | | | | | | | |
| 14M. Cyanide, Total (57-12-5) | | | X | | | | | | | | | | | | |
| 15M. Phenols, Total | | X | | 40 | N/A | | | | | 1 | µg/L | N/A | | | |
| DIOXIN | | | | | | | | | | | | | | | |
| 2,3,7,8-Tetrachlorodibenzo-P-Dioxin (1764-01-6) | | | X | DESCRIBE RESULTS | | | | | | | | | | | |

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EPA Form 3510-2C (Rev. 12-80)
Previous edition may be used.

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| 1. POLLUTANT AND CAS NUMBER (If available) | 2. MARK 'X' a. TEST ING REQUIRED | b. BELIEVED PRESENT | c. BELIEVED ABSENT | 3. EFFLUENT a. MAXIMUM DAILY VALUE (1) CONCENTRATION | (2) MASS | b. MAXIMUM 30 DAY VALUE (If available) (1) CONCENTRATION | (2) MASS | c. LONG TERM AVRG. VALUE (If available) (1) CONCENTRATION | (2) MASS | d. NO. OF ANALYSES | 4. UNITS a. CONCENTRATION | b. MASS | 5. INTAKE (optional) a. LONG TERM AVERAGE VALUE (1) CONCENTRATION | (2) MASS | b. NO. OF ANALYSES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **GC/MS FRACTION – VOLATILE COMPOUNDS** *(continued)* | | | | | | | | | | | | | | | |
| 22V. Methylene Chloride (75-09-2) | | | X | | | | | | | | | | | | |
| 23V. 1,1,2,2-Tetrachloroethane (79-34-5) | | | X | | | | | | | | | | | | |
| 24V. Tetrachloroethylene (127-18-4) | | | X | | | | | | | | | | | | |
| 25V. Toluene (108-88-3) | | | X | | | | | | | | | | | | |
| 26V. 1,2-Trans-Dichloroethylene (156-60-5) | | | X | | | | | | | | | | | | |
| 27V. 1,1,1-Trichloroethane (71-55-6) | | | X | | | | | | | | | | | | |
| 28V. 1,1,2-Trichloroethane (79-00-5) | | | X | | | | | | | | | | | | |
| 29V. Trichloroethylene (79-01-6) | | | X | | | | | | | | | | | | |
| 30V. Trichlorofluoromethane (75-69-4) | | | X | As per 46 Federal Register 2264, this analyte was removed from the Priority Pollutant List. | | | | | | | | | | | |
| 31V. Vinyl Chloride (75-01-4) | | | X | | | | | | | | | | | | |
| **GC/MS FRACTION – ACID COMPOUNDS** | | | | | | | | | | | | | | | |
| 1A. 2-Chlorophenol (95-57-8) | | | X | | | | | | | | | | | | |
| 2A. 2,4-Dichlorophenol (120-83-2) | | | X | | | | | | | | | | | | |
| 3A. 2,4-Dimethylphenol (105-67-9) | | | X | | | | | | | | | | | | |
| 4A. 4,6-Dinitro-O-Cresol (534-52-1) | | | X | | | | | | | | | | | | |
| 5A. 2,4-Dinitrophenol (51-28-5) | | | X | | | | | | | | | | | | |
| 6A. 2-Nitrophenol (88-75-5) | | | X | | | | | | | | | | | | |
| 7A. 4-Nitrophenol (100-02-7) | | | X | | | | | | | | | | | | |
| 8A. P-Chloro-M-Cresol (59-50-7) | | | X | | | | | | | | | | | | |
| 9A. Pentachlorophenol (87-86-5) | | | X | | | | | | | | | | | | |
| 10A. Phenol (108-95-2) | | | X | | | | | | | | | | | | |
| 11A. 2,4,6-Trichlorophenol (88-06-2) | | | X | | | | | | | | | | | | |

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| 1. POLLUTANT AND CAS NUMBER (if available) | 2. MARK 'X' | | | 3. EFFLUENT | | | | | | | 4. UNITS | | 5. INTAKE (optional) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a. TESTING REQUIRED | b. BELIEVED PRESENT | c. BELIEVED ABSENT | a. MAXIMUM DAILY VALUE | | b. MAXIMUM 30 DAY VALUE (if available) | | c. LONG TERM AVRG. VALUE (if available) | | d. NO. OF ANALYSES | a. CONCENTRATION | b. MASS | a. LONG TERM AVERAGE VALUE | | b. NO. OF ANALYSES |
| | | | | (1) CONCENTRATION | (2) MASS | (1) CONCENTRATION | (2) MASS | (1) CONCENTRATION | (2) MASS | | | | (1) CONCENTRATION | (2) MASS | |
| GC/MS FRACTION – BASE/NEUTRAL COMPOUNDS | | | | | | | | | | | | | | | |
| 1B. Acenaphthene (83-32-9) | | | X | | | | | | | | | | | | |
| 2B. Acenaphtylene (208-96-8) | | | X | | | | | | | | | | | | |
| 3B. Anthracene (120-12-7) | | | X | | | | | | | | | | | | |
| 4B. Benzidine (92-87-5) | | | X | | | | | | | | | | | | |
| 5B. Benzo (a) Anthracene -55-3) | | | X | | | | | | | | | | | | |
| 6B. Benzo (a) Pyrene (50-32-8) | | | X | | | | | | | | | | | | |
| 7B. 3,4-Benzo-fluoranthene (205-99-2) | | | X | | | | | | | | | | | | |
| 8B. Benzo (ghi) Perylene (191-24-2) | | | X | | | | | | | | | | | | |
| 9B. Benzo (k) Fluoranthene (207-08-9) | | | X | | | | | | | | | | | | |
| 10B. Bis (2-Chloro-ethoxy) Methane (111-91-1) | | | X | | | | | | | | | | | | |
| 11B. Bis (2-Chloro-ethyl) Ether (111-44-4) | | | X | | | | | | | | | | | | |
| 12B. Bis (2-Chloro-isopropyl) Ether (39638-32-9) | | | X | | | | | | | | | | | | |
| 13B. Bis (2-Ethyl-hexyl) Phthalate (117-81-7) | | | X | | | | | | | | | | | | |
| 14B. 4-Bromo-nyl Phenyl ner (101-55-3) | | | X | | | | | | | | | | | | |
| 15B. Butyl Benzyl Phthalate (85-68-7) | | | X | | | | | | | | | | | | |
| 16B. 2-Chloro-naphthalene (91-58-7) | | | X | | | | | | | | | | | | |
| 17B. 4-Chloro-phenyl Phenyl Ether (7005-72-3) | | | X | | | | | | | | | | | | |
| 18B. Chrysene (218-01-9) | | | X | | | | | | | | | | | | |
| 19B. Dibenzo (a,h) Anthracene (53-70-3) | | | X | | | | | | | | | | | | |
| 20B. 1,2-Dichloro-benzene (95-50-1) | | | X | | | | | | | | | | | | |
| 21B. 1,3-Dichloro-benzene (541-73-1) | | | X | | | | | | | | | | | | |



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| 1. POLLUTANT AND CAS NUMBER (If available) | 2. MARK 'X' a. TESTING REQUIRED | b. BELIEVED PRESENT | c. BELIEVED ABSENT | 3. EFFLUENT a. MAXIMUM DAILY VALUE (1) CONCENTRATION | (2) MASS | b. MAXIMUM 30 DAY VALUE (if available) (1) CONCENTRATION | (2) MASS | c. LONG TERM AVRG. VALUE (if available) (1) CONCENTRATION | (2) MASS | d. NO. OF ANALYSES | 4. UNITS a. CONCENTRATION | b. MASS | 5. INTAKE (optional) a. LONG TERM AVERAGE VALUE (1) CONCENTRATION | (2) MASS | b. NO. OF ANALYSES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GC/MS FRACTION — BASE/NEUTRAL COMPOUNDS (continued) | | | | | | | | | | | | | | | |
| 22B. 1,4-Dichlorobenzene (106-46-7) | | | X | | | | | | | | | | | | |
| 23B. 3,3'-Dichlorobenzidine (91-94-1) | | | X | | | | | | | | | | | | |
| 24B. Diethyl Phthalate (84-66-2) | | | X | | | | | | | | | | | | |
| 25B. Dimethyl Phthalate (131-11-3) | | | X | | | | | | | | | | | | |
| 26B. Di-N-Butyl Phthalate (84-74-2) | | | X | | | | | | | | | | | | |
| 27B. 2,4-Dinitrotoluene (121-14-2) | | | X | | | | | | | | | | | | |
| 28B. 2,6-Dinitrotoluene (606-20-2) | | | X | | | | | | | | | | | | |
| 29B. Di-N-Octyl Phthalate (117-84-0) | | | X | | | | | | | | | | | | |
| 30B. 1,2-Diphenylhydrazine (as Azobenzene) (122-66-7) | | | X | | | | | | | | | | | | |
| 31B. Fluoranthene (206-44-0) | | | X | | | | | | | | | | | | |
| 32B. Fluorene (86-73-7) | | | X | | | | | | | | | | | | |
| 33B. Hexachlorobenzene (118-71-1) | | | X | | | | | | | | | | | | |
| 34B. Hexachlorobutadiene (87-68-3) | | | X | | | | | | | | | | | | |
| 35B. Hexachlorocyclopentadiene (77-47-4) | | | X | | | | | | | | | | | | |
| 36B. Hexachloroethane (67-72-1) | | | X | | | | | | | | | | | | |
| 37B. Indeno (1,2,3-cd) Pyrene (193-39-5) | | | X | | | | | | | | | | | | |
| 38B. Isophorone (78-59-1) | | | X | | | | | | | | | | | | |
| 39B. Naphthalene (91-20-3) | | | X | | | | | | | | | | | | |
| 40B. Nitrobenzene (98-95-3) | | | X | | | | | | | | | | | | |
| 41B. N-Nitrosodimethylamine (62-75-9) | | | X | | | | | | | | | | | | |
| 42B. N-Nitrosodi-N-Propylamine (621-64-7) | | | X | | | | | | | | | | | | |



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| POLLUTANT AND CAS NUMBER (if available) | 2. MARK 'X' | | | 3. EFFLUENT | | | | | | | 4. UNITS | | 5. INTAKE (optional) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a. TESTING REQUIRED | b. BELIEVED PRESENT | c. BELIEVED ABSENT | a. MAXIMUM DAILY VALUE | | b. MAXIMUM 30 DAY VALUE (if available) | | c. LONG TERM AVRG. VALUE (if available) | | d. NO. OF ANALYSES | a. CONCENTRATION | b. MASS | a. LONG TERM AVERAGE VALUE | | b. NO. OF ANALYSES |
| | | | | (1) CONCENTRATION | (2) MASS | (1) CONCENTRATION | (2) MASS | (1) CONCENTRATION | (2) MASS | | | | (1) CONCENTRATION | (2) MASS | |
| C/MS FRACTION — BASE/NEUTRAL COMPOUNDS (continued) | | | | | | | | | | | | | | | |
| B. N-Nitro-diphenylamine 6-30-6) | | | X | | | | | | | | | | | | |
| B. Phenanthrene 5-01-8) | | | X | | | | | | | | | | | | |
| B. Pyrene 29-00-0) | | | X | | | | | | | | | | | | |
| B. 1,2,4 - Tri-lorobenzene 20-82-1) | | | X | | | | | | | | | | | | |
| C/MS FRACTION — PESTICIDES | | | | | | | | | | | | | | | |
| P. Alc 09-00-4) | | | X | | | | | | | | | | | | |
| P. α-BHC 19-84-6) | | | X | | | | | | | | | | | | |
| P. β-BHC 19-85-7) | | | X | | | | | | | | | | | | |
| P. γ-BHC 58-89-9) | | | X | | | | | | | | | | | | |
| P. δ-BHC 319-86-8) | | | X | | | | | | | | | | | | |
| P. Chlordane 57-74-9) | | | X | | | | | | | | | | | | |
| P. 4,4'-DDT 50-29-3) | | | X | | | | | | | | | | | | |
| P. 4,4'-DDE 72-55-9) | | | X | | | | | | | | | | | | |
| P. 4,4'-DDD 72-5 | | | X | | | | | | | | | | | | |
| 10P. Dieldrin 60-57-1) | | | X | | | | | | | | | | | | |
| 11P. α-Endosulfan (115-29-7) | | | X | | | | | | | | | | | | |
| 12P. β-Endosulfan (115-29-7) | | | X | | | | | | | | | | | | |
| 13P. Endosulfan Sulfate (1031-07-8) | | | X | | | | | | | | | | | | |
| 14P. Endrin (72-20-8) | | | X | | | | | | | | | | | | |
| 15P. Endrin Aldehyde (7421-93-4) | | | X | | | | | | | | | | | | |
| 16P. Heptachlor (76-44-8) | | | X | | | | | | | | | | | | |



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| EPA I.D. NUMBER (copy from Item 1 of Form 1) | OUTFALL NUMBER |
|---|---|
| IND000810861 | 004 |

Form Approved OMB No. 158-R0173

| 1. POLLUTANT AND CAS NUMBER (if available) | 2. MARK 'X' | | | 3. EFFLUENT | | | | | | | 4. UNITS | | 5. INTAKE (optional) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a. TESTING REQUIRED | b. BELIEVED PRESENT | c. BELIEVED ABSENT | a. MAXIMUM DAILY VALUE | | b. MAXIMUM 30 DAY VALUE (if available) | | c. LONG TERM AVRG. VALUE (if available) | | d. NO. OF ANALYSES | a. CONCENTRATION | b. MASS | a. LONG TERM AVERAGE VALUE | | b. NO. OF ANALYSES |
| | | | | (1) CONCENTRATION | (2) MASS | (1) CONCENTRATION | (2) MASS | (1) CONCENTRATION | (2) MASS | | | | (1) CONCENTRATION | (2) MASS | |
| GC/MS FRACTION – PESTICIDES (continued) | | | | | | | | | | | | | | | |
| 17P. Heptachlor epoxide (1024-57-3) | | | X | | | | | | | | | | | | |
| 18P. PCB-1242 (53469-21-9) | | | X | | | | | | | | | | | | |
| 19P. PCB-1254 (11097-69-1) | | | X | | | | | | | | | | | | |
| 20P. PCB-1221 (11104-28-2) | | | X | | | | | | | | | | | | |
| 21P. PCB-1232 (11141-16-5) | | | X | | | | | | | | | | | | |
| 22P. PCB-1248 (12672-29-6) | | | X | | | | | | | | | | | | |
| 23P. PCB-1260 (11096-82-5) | | | X | | | | | | | | | | | | |
| 24P. PCB-1016 (12674-11-2) | | | X | | | | | | | | | | | | |
| 25P. Toxaphene (8001-35-2) | | | X | | | | | | | | | | | | |



N/A: Not applicable. Flow is intermittent.

FOOTNOTE (h): As per IDEM 1993 WLA, summer = July 1 – September 30 and winter = October 1 – June 30.

(i): Estimated values are presented. Actual grab samples are: summer (8/5/94) = 20°C and winter (5/3/94) = 12.8°C.

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# FOOTNOTE A

# AMOCO OIL COMPANY - WHITING REFINERY

# SUMMARY OF "NON DETECTS" (ND) FROM OUTFALL DATABASES

FORM 2C – V
FOOTNOTE A – TABLE 1

SUMMARY OF "NON DETECTS" (ND) FROM OUTFALL DATABASES

| OUTFALL 001 | # OF SAMPLES | # OF NON-DETECTS | % NON-DETECTS | ANALYTICAL METHOD | MDL mg/L |
|---|---|---|---|---|---|
| PHENOLS | 482 | 408 | 84.6% | EPA 420.1 | 0.001 |
| TOTAL CHROMIUM | 165 | 145 | 87.9% | EPA 218.1, 16th Ed. 303A | 0.010 |
| COBALT | 4 | 4 | 100% | EPA 200.7 | 0.003 |
| COPPER | 8 | 5 | 62.5% | EPA 200.7 | 0.005 |
| TIN | 4 | 4 | 100% | EPA 282.2 | 0.007 |
| TITANIUM | 4 | 4 | 100% | EPA 283.2 | 0.007 |
| ANTIMONY | 4 | 4 | 100% | EPA 200.7 | 0.020 |
| BERYLLIUM | 4 | 3 | 75% | EPA 200.7 | 0.001 |
| CADMIUM | 7 | 7 | 100% | EPA 200.7 | 0.002 |
| MERCURY | 5 | 5 | 100% | EPA 245.1 | 0.0005 |
| NICKEL | 7 | 6 | 86% | EPA 200.7 | 0.007 |
| SILVER | 4 | 4 | 100% | EPA 200.7 | 0.005 |
| THALLIUM | 4 | 4 | 100% | EPA 279.2 | 0.002 |

| OUTFALL 002 | # OF SAMPLES | # OF NON-DETECTS | % NON-DETECTS | ANALYTICAL METHOD | MDL mg/L |
|---|---|---|---|---|---|
| IN-OIL | 482 | 311 | 64.5% | EPA 413.2, 16th Ed. 503B | 0.1 |
| OIL | 483 | 204 | 42.2% | EPA 413.2, 16th Ed. 503B | 0.1 |
| TOTAL RESIDUAL CHLORINE | 161 | 160 | 99% | EPA 4500-CL-I, 17th Ed. | 0.04 |

**To be conservative, all statistical summaries and load calculations were performed substituting the MDL for analytical results reported as "<" or "ND".**

# FOOTNOTE B

# AMOCO OIL COMPANY - WHITING REFINERY

# WHITING STORET DATABASE

FORM 2C – V
FOOTNOTE B – TABLE 1

WHITING STORET DATABASE JAN 23, 1990 TO NOV 17, 1993

| PARAMETER | UNIT | METHOD DETECTION LIMIT | NUMBER OF SAMPLES | NUMBER OF DETECTIONS | PERCENT DETECTIONS |
|---|---|---|---|---|---|
| Arsenic | µg/L | | 33 | 33 | 100% |
| Barium | µg/L | | 34 | 34 | 100% |
| COD | mg/L | 5 | 32 | 27 | 84% |
| Fecal Coliform * | #/100ml | 10 | 45 | 13 | 29% |
| Copper | µg/L | 4 | 34 | 29 | 85% |
| Fluoride | mg/L | 0.1 | 32 | 25 | 78% |
| Hardness | mg/L | | 32 | 32 | 100% |
| Iron(tot) | µg/L | | 33 | 33 | 100% |
| Magnesium * | mg/L | | 37 | 37 | 100% |
| Manganese | µg/L | 10 | 34 | 17 | 50% |
| Nitrate/Nitrite | mg/L | | 32 | 32 | 100% |
| Oil & Grease * | mg/L | 1 | 18 | 17 | 94% |
| pH(lab) | s.u. | | 32 | 32 | 100% |
| TSS | mg/L | 4 | 4 | 3 | 75% |
| Sulfate | mg/L | | 31 | 31 | 100% |
| Temperature | oC | | 5 | 5 | 100% |
| Zinc | µg/L | 10 | 34 | 14 | 41% |

**Notes:**
* = no recent monitoring conducted, results presented for Jul 19, 1984 to Dec 12, 1989
Metals, unless otherwise denoted , are as "total"
MDL presented is most prevalent in database
Parameter considered "believed present" in intake if greater than 25% of sample results are detections.

# FOOTNOTE C

# AMOCO OIL COMPANY - WHITING REFINERY

# TOTAL VERSUS DISSOLVED METAL RATIO STUDY

# FORM 2C-V
# FOOTNOTE C
# TOTAL VERSUS DISSOLVED RATIO STUDY

## INTRODUCTION

Amoco is presenting data that could be used, as per 327 IAC 5-2-11.1(d)(2) and IDEM and EPA guidance, to adjust the aquatic life criteria for metals based on total or total recoverable measurements. Currently, based on the Mixing Zone Demonstration provided as Volume II of this application, Amoco will not need to use this total versus dissolved metals data to meet the aquatic life criteria. Even though this data is not needed to adjust the aquatic life criteria, it does clarify the bioavailability of metals in Outfall 001.

The procedure for calculating the total versus dissolved metals ratio suggested by 327 IAC 5-2-11.1(d)(2) and IDEM and EPA guidance employs the ratio of total versus dissolved metals in the receiving water after mixing with the discharge to adjust the effluent limit.

The Water Quality Criteria for metals presented in Table 1 of 327 IAC 2-1-6 are expressed in terms of the acid-soluble fraction to reflect the form of the metals used to derive the published USEPA ambient water quality criteria. Aquatic metals criteria were derived from laboratory toxicity (bioassay) tests using the acid-soluble or bioavailable form of the metals, e.g. water-soluble metal salts.

A reliable acid-soluble method has not been developed by the USEPA. In the absence of an analytical method to determine the acid-soluble fraction of a metal, the IWQS criteria in 327 IAC 2-1-6 Table 1 are to be enforced as total recoverable metals in NPDES permits. Total recoverable analyses, however, do not reflect the acid-soluble or bioavailable form of a metal.

To establish effluent limitations based on Table 1 metals criteria, 327 IAC 5-2-11.1(d)(2) allows the ratio of the soluble fraction of the metal to the total recoverable fraction of the metal in the effluent. This ratio is used to adjust numeric water quality-based effluent limitations to the permit-required total recoverable limit.

The draft "General Guidance to Supplement 327 IAC 2-1-8.8: Variances from a State Water Quality Standard", February 11, 1993, OWM, IDEM, presents a procedure to determine the ratio of the soluble fraction to total recoverable fraction of the metal in the discharge. In drafting the procedure, IDEM cites the May 1992 "Interim Guidance on Interpretation and Implementation of Aquatic Life Criteria for Metals", OST, USEPA which focuses on the correlation among the soluble and total recoverable metals in determining the bioavailability of the metals.

Data on the toxicity of metals indicate that the toxic portion of the total metal is that portion which is dissolved in water and bioavailable to aquatic organisms. Recent guidance issued by the USEPA ("Interim Guidance on Interpretation and Implementation of Aquatic Life Criteria for Metals", May 1992 and the "Office of Water Policy and Technical Guidance on Interpretation and Implementation of Aquatic Life Metals Criteria", October 1, 1993) also supports this conclusion and offers information on the modification of aquatic life criteria for metals which are based on total or total recoverable measurements.

Dissolved or soluble metals are defined as those which pass through a 0.45 $\mu m$ filter.

## BASIS FOR USING METALS RATIO

On October 1, 1993, the Acting Assistant Administrator for Water issued the memo titled "Office of Water Policy and Technical Guidance on Interpretation and Implementation of Aquatic Life Metals Criteria". This memorandum transmits Office of Water (OW) policy and guidance on the interpretation and implementation of aquatic life criteria for the management of metals.

Addressed in this document are the policy and guidance concerning the dissolved versus total recoverable metals expression of aquatic life criteria. As stated in this memorandum, it is now the policy of the Office of Water that the use of dissolved metal to set and measure compliance with water quality standards is the recommended approach, as dissolved metal measurements more closely approximate the bioavailable fraction of metal in the water column than does total recoverable metal measurements. The document states that this conclusion regarding metals bioavailability is supported by a majority of the scientific community within and outside the Agency. As presented in this memorandum, one reason the dissolved metal measurements more closely approximate the bioavailable fraction of metal in the water column is that a primary mechanism for water column toxicity is adsorption at the gill surface and requires metals to be in the dissolved form.

Additionally, this document claims that any error incurred from excluding the contribution of particulate metal will generally be compensated by other factors which make criteria conservative. For example, metals in toxicity tests are added as simple salts to relatively clean water. Due to the likely presence of a significant concentration of metals binding agents in many discharges and ambient waters, metals in toxicity tests would generally be expected to be more bioavailable than metals in discharges or in ambient waters.

## STUDY OBJECTIVE

Amoco Oil Company, Whiting Refinery, developed a sampling and analysis program to determine the ratio of total versus dissolved metals in the treated process effluent discharged through Outfall 001. The data was to be used to determine the potential applicability of 327 IAC 5-2-11.1(d). In developing the program, Amoco considered the EPA guidance documents and memos and IDEM draft guidance.

Based on the Mixing Zone Demonstration provided as Volume II of this application, Amoco will not need to use this total versus dissolved metals data to meet the aquatic life criteria. Even though this data is not needed to adjust the aquatic life criteria, it does clarify the bioavailability of metals in Outfall 001.

Amoco, if needed, would be adjusting the aquatic life criteria for the following metals based on the total versus dissolved ratio:

- Arsenic
- Lead
- Zinc
- Copper
- Selenium

## SAMPLING PROCEDURES

As discussed in the "Office of Water Policy and Technical Guidance on Interpretation and Implementation of Aquatic Life Metals Criteria", the quality of trace level metal data may be compromised due to contamination of samples during collection, preparation, storage, and analysis. The document further states that depending on the level of metal present, the use of "clean" techniques for sampling and analysis may be critical to gather accurate data collection for the implementation of aquatic life criteria for metals.

In response to these concerns, where possible, the metal samples collected and analyzed for the development of the ratio of the dissolved versus total metals have been handled according to these "clean" sampling and analysis techniques.

Effluent (Outfall 001) samples were collected by Amoco personnel between January 13, 1994 and July 26, 1994 as 24-hour composites. Immediately after sampling was completed, the collection jugs were swirled, samples were collected and shipped to the contracted laboratory for analysis. For each of the sampling events, one of the two ISCO autosamplers was programmed to collect a 24-hour composite sample to be analyzed for total metals, while the other was fitted with an in-line 0.45 $\mu m$ filter and programmed to collect a 24-hour composite sample for dissolved metals analyses. The ISCO composite sampling receiving jug was cleaned with a complete Alconox and nitric acid decontamination regime prior to collecting each 24-hour composite sample. Samples were preserved and containerized indoors to minimize the opportunity for airborne contaminants to be introduced into the samples. Samples were preserved with ultra-pure nitric acid and were transported on ice to the laboratories.

Sampling events occurred when the refinery and wastewater treatment plant were operating within normal conditions.

## ANALYSIS PROCEDURES

Samples were analyzed by two different laboratories, the Amoco Research and Development Laboratory in Naperville, IL, and HydroLogic Laboratory in Asheville, NC. The Amoco Lab performed all of the metals analysis except for the copper analysis. HydroLogic was contracted to perform the copper and some additional metals analyses.

As discussed above, where possible, the samples were sampled and analyzed as per EPA draft "clean" metals sampling and analysis procedures. EPA is in the process of developing recommendations for "clean" sampling and analysis for use in the implementation of metals criteria. A copy of the draft "Guidance on Metals Clean Methods and Data Assessments" has been included as Appendix C-1. Wherever possible, Amoco personnel, the Amoco Laboratory, and the Hydrologic Laboratory followed the guidance presented in this document. Some of the issues in assessing and developing metals analytical data are:

- general - use of better than reagent quality grade acids in all steps, use of non-talc gloves, hot acid soaking/wash for all labware and sample bottles;
- sample handling - nonmetallic sampling devices, isolation from the atmosphere;
- sample preparation - filtration and digestion in an area free of atmospheric sources of particulates, filtration with membrane filters, digestion not to be performed in metallic hoods (not possible for this study);
- sample analysis - control of salt interferences, use of nitric versus hydrochloric acid, use of standard additions calibration; and
- quality control for each sample batch - procedure blank, procedure MDL, matrix spike, certified standard reference, sampling replicates, and lab duplicates.

The methods used by the two laboratories and the corresponding method detection limits for the metals analysis are presented as Table C-1.

## QA/QC PROCEDURES

All appropriate chain-of-custody protocols were followed during this study and blanks (field, equipment, and trip) were collected throughout the study. Trip blanks were submitted for every sampling event, fieldblanks were collected and analyzed twice, and an equipment blank was collected and analyzed once during the study. Both the Amoco and HydroLogic laboratories participate in the EPA Water Supply & Water Pollution Studies program. Hydrologic is certified by both North Carolina Public Drinking Water Division and the North Carolina Wastewater and Groundwater division to perform analyses.

Each data point was validated by either Amoco or Hydrologic personnel. This internal data validation indicated that the copper results from January through April 1994 were invalid and should not be to used to calculate the total versus dissolved ratio. To replace these data points, samples were subsequently collected and analyzed for copper. The lead data collected on January 13-14, 1994 were determined by this internal data validation to be suspect, and will

also not be used in the total versus dissolved metals ratio calculation. As with copper, additional lead samples were collected and analyzed to replace the suspect result. The QA/QC results are presented in Appendix C-2.

## RESULTS

The results of analyses for these metals along with the results of a QA/QC evaluation of the data are presented in Table C-2. Results of copper analyses are presented in Table C-3. As previously discussed, the copper results from January through April failed a QC evaluation and will not be used to calculate the total versus dissolved ratio. Also presented on Tables C-2 and C-3 are the results of conventionals analyses performed concurrently with the metals samples. This information augments the assessment of bioavailability as TSS, TOC, pH, TDS, and hardness are known to alter the form, and hence the toxicity, of metals.

Presented in Tables C-4 and C-5 are the total versus dissolved metals ratio calculations. Table C-4 presents the ratio calculation for metals other than copper, and Table C-5 presents the ratio calculation for copper. Arsenic and selenium are mostly present in the water soluble form, zinc is only partially soluble, and most of the lead in the Amoco effluent is insoluble.

Table C-6 provides additional information concerning the difference between total and dissolved metals in Amoco's effluent. Presented in this table are metals analyses results, QA/QC evaluations, and the total versus dissolved metals ratios for some additional metals. While Amoco would not request that these ratios be applied to adjust permit effluent limits, they confirm that effluent characteristics influence the solubility of metals. For example, barium and boron would be expected to be very soluble in the effluent and iron and aluminum would be expected to exist more in the particulate state. The evaluation of these metals confirm these predictions.

## TABLE C-1. METHODS AND DETECTION LIMITS

| PARAMETER | AMOCO - NAPERVILLE | | HYDROLOGIC - ASHEVILLE | |
|---|---|---|---|---|
| | METHOD | MDL (ug/L) | METHOD | MDL (ug/L) |
| Arsenic | 206.2 | 1 | | |
| Copper | 200.7 | 3 | 200.7 | 5.00 |
| Lead | 239.2 | 1 | 6010/200.7 | 3.00 |
| Selenium | 270.2 | 2 | 200.7 | 10.0 |
| Zinc | 200.7 | 1 | 200.7 | 10.0 |
| Aluminum | 200.7 | 4 | | |
| Barium | 200.7 | 1 | | |
| Boron | 200.7 | 10 | | |
| Iron | 200.7 | 10 | | |
| Mangnesium | 200.7 | 1 | | |
| Molybdenum | 200.7 | 5 | | |
| Manganese | 200.7 | 1 | | |

NOTES:

All detection limits presented in ppb.
Hydrologic performed the copper, lead, selenium, and zinc analysis after April 25-26.

EPA Methods for the Analysis of Water and Wastes - Revised March 1993:

200.7 = ICP AES
XXX.2 = AA - Furnace

EPA Test Methods for Evaluating Solid Waste (SW-846)

6010 = ICP

## TABLE C-2. METALS SAMPLING RESULTS AND QA/QC EVALUATION

| CONSTITUENT | UNITS | JANUARY 13-14 | | QA/QC | FEBRUARY 10-11 | | QA/QC | MARCH 01-02 | | QA/QC | MARCH 09-10 | | QA/QC | APRIL 13-14 | | QA/QC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METALS | | Total | Dissolved | | Total | Dissolved | | Total | Dissolved | | Total | Dissolved | | Total | Dissolved | |
| Arsenic | ug/L | 14 | 14 | A | 20 | 21 | A | 12 | 11 | J | 16 | 17 | A | 18 | 11 | A |
| Lead | ug/L | 11 | <1 | R | 10 | <1 | A | 7 | <1 | A | 11 | <1 | J | 8 | 1 | A |
| Selenium | ug/L | 39 | 36 | A | 36 | 30 | A | 30 | 26 | J | 33 | 31 | J | | | |
| Zinc | ug/L | 25 | 23 | J | 33 | 27 | A | 24 | 17 | A | 26 | 18 | A | 20 | 16 | A |
| pH | s.u. | | 7.6 | | | 7.9 | | | 7.7 | | 7.6 | | | 7.8 | | |
| TSS | mg/L | 5 | | | 20 | | | 8 | 9 | | 9 | 5 | | 5 | 6 | |
| TDS | mg/L | | | | | | | | | | | | | | 846 | |
| TOC | mg/L | | | | | | | | 12 | A | | | | | | |
| Recieving Water Hardness | mg/L | 142* | | | | | | | | | | | | | | |

| CONSTITUENT | UNITS | APRIL 28-29 | | QA/QC | JULY 8 | | QA/QC | JULY 14 | | QA/QC | JULY 22 | | QA/QC | JULY 26 | | QA/QC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METALS | | Total | Dissolved | | Total | Dissolved | | Total | Dissolved | | Total | Dissolved | | Total | Dissolved | |
| Arsenic | ug/L | 13 | 16 | A | | | | | | | | | | | | |
| Lead | ug/L | 4 | <1 | A | 13.0 | <3.00 | | | | | 12.0 | <3.00 | | <10.00 | <3.00 | |
| Selenium | ug/L | | | | | | | 26.0 | 17.0 | | | | | | | |
| Zinc | ug/L | 15 | 16 | A | | | | | | | 106 | 21.0 | | 269 | 10.0 | |
| pH | s.u. | 7.8 | | | | | | | | | | | | | | |
| TSS | mg/L | 5 | 5 | | | | | | | | | | | | | |
| TDS | mg/L | | 633 | | | | | | 829 | | | 1,015 | | | 1,239 | |
| TOC | mg/L | | | | | | | | | | | | | | | |

NOTES:
R = Rejected due to QA/QC problems
J = The associated numerical value is an estimated quantity
A = Acceptable Data
QA/QC data is a complete validation (Lab & Field)
* = Average based on data collected from January 1990 to November 1993.

## TABLE C-3. COPPER SAMPLING RESULTS AND QA/QC EVALUATION

| CONSTITUENT | UNITS | JANUARY 13-14 | | QA/QC | FEBRUARY 10-11 | | QA/QC | MARCH 01-02 | | QA/QC | MARCH 09-10 | | QA/QC | APRIL 13-14 | | QA/QC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | Dissolved | | Total | Dissolved | | Total | Dissolved | | Total | Dissolved | | Total | Dissolved | |
| Copper | ug/L | 15 | 6 | R | 16 | 4 | R | 18 | 4 | R | 18 | 6 | R | 10 | 5 | R |
| pH | s.u. | | 7.6 | | | 7.9 | | | 7.7 | | 7.6 | | | 7.8 | | |
| TSS | mg/L | 5 | | | 20 | | | 8 | 9 | | 9 | 5 | | 5 | 6 | |
| TDS | mg/L | | | | | | | | | | | | | | 848 | |
| TOC | mg/L | | | | | | | | 12 | A | | | | | | |
| Recieving Water Hardness | mg/L | 142* | | | | | | | | | | | | | | |

| CONSTITUENT | UNITS | APRIL 25-26 | | QA/QC | JUNE 01 | | QA/QC | JUNE 07 | | QA/QC | JUNE 30 | | QA/QC | JULY 08 | | QA/QC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | Dissolved | | Total | Dissolved | | Total | Dissolved | | Total | Dissolved | | Total | Dissolved | |
| Copper | ug/L | 8 | <3 | R | <5.00 | <5.00 | | <5.00 | <5.00 | | <5.00 | <5.00 | | <5.00 | <5.00 | |
| pH | s.u. | 7.8 | | | | | | | | | | | | | | |
| TSS | mg/L | 5 | 5 | | | | | | | | | | | | | |
| TDS | mg/L | | 633 | | | | | | | | | 696 | | | | |
| TOC | mg/L | | | | | | | | | | | | | | | |

| CONSTITUENT | UNITS | JULY 14 | | QA/QC | JULY 22 | | QA/QC | JULY 29 | | QA/QC |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | Dissolved | | Total | Dissolved | | Total | Dissolved | |
| Copper | ug/L | 29.0 | <5.00 | | <5.00 | <5.00 | | 11.4 | <5.00 | |
| pH | s.u. | | | | | | | | | |
| TSS | mg/L | | | | | | | | | |
| TDS | mg/L | | 629 | | | 1,015 | | | 1,239 | |
| TOC | mg/L | | | | | | | | | |

NOTES:
R = Rejected due to QA/QC problems
J = The associated numerical value is an estimated quantity
A = Acceptable Data
QA/QC data is a complete validation (Lab & Field)
* = Average based on data collected from January 1990 to November 1993.

## TABLE C-4. RATIO CALCULATIONS

| CONSTITUENT | UNITS | 01/13-14 | 02/10-11 | 03/01-02 | 03/09-10 | 04/13-14 | 4/25-26 | 07/06 | 07/14 | 07/22 | 07/26 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Arsenic | | | | | | | | | | | | |
| Total | ug/L | 14.0 | 20.0 | 12.0 | 16.0 | 18.0 | 13.0 | | | | | |
| Dissolved | ug/L | 14.0 | 21.0 | 11.0 | 17.0 | 11.0 | 16.0 | | | | | |
| Lead | | | | | | | | | | | | |
| Total | ug/L | | 10.0 | 7.00 | 11.0 | 8.00 | 4.00 | 13.0 | | 12.0 | 10.0 | |
| Dissolved | ug/L | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 3.00 | | 3.00 | 3.00 | |
| Selenium | | | | | | | | | | | | |
| Total | ug/L | 39.0 | 30.0 | 30.0 | 33.0 | | | | 26.0 | | | |
| Dissolved | ug/L | 38.0 | 30.0 | 25.0 | 31.0 | | | | 17.0 | | | |
| Zinc | | | | | | | | | | | | |
| Total | ug/L | 25.0 | 33.0 | 24.0 | 26.0 | 20.0 | 15.0 | | | 105 | 269 | |
| Dissolved | ug/L | 23.0 | 27.0 | 17.0 | 18.0 | 16.0 | 16.0 | | | 21.0 | 10.0 | |
| **TOTAL TO DISSOLVED RATIO** | | | | | | | | | | | | **RATIO MEAN** |
| Arsenic | | 1.00 | 1.0 | 1.1 | 1.0 | 1.6 | 1.0 | | | | | 1.1 |
| Lead | | | 10.0 | 7.0 | 11.0 | 8.0 | 4.0 | 4.3 | | 4.0 | 3.3 | 6.[illegible] |
| Selenium | | 1.03 | 1.2 | 1.2 | 1.1 | | | | 1.5 | | | 1.[illegible] |
| Zinc | | 1.09 | 1.2 | 1.4 | 1.4 | 1.3 | 1.0 | | | 5.0 | 26.9 | 4.[illegible] |

= < Values

If ratio < or + 1.0; metal present is entirely in the soluble form

## TABLE C-5. RATIO CALCULATIONS – COPPER

| CONSTITUENT | UNITS | June 01 | June 07 | June 30 | July 08 | July 14 | July 22 | July 24 | |
|---|---|---|---|---|---|---|---|---|---|
| Copper | | | | | | | | | |
| Total | ug/L | 5.00 | 5.00 | 5.00 | 5.00 | 29.0 | 5.00 | 11.4 | |
| Dissolved | ug/L | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | |
| **TOTAL TO DISSOLVED RATIO** | | | | | | | | | **RATIO MEAN** |
| Copper | | * | * | * | * | 5.8 | * | 2.3 | 4.0 |

= < Values
* = Since both values were < MDL, calculation of a ratio is not possible
If ratio ≤ or + 1.0; metal present is entirely in the soluble form

## TABLE C-6. METALS ANALYSIS RESULTS, QA/QC EVALUATION, AND RATIO CALCULATION – ADDITIONAL METALS

| CONSTITUENT | UNITS | JANUARY 13-14 | | QA/QC | FEBRUARY 10-11 | | QA/QC | MARCH 01-02 | | QA/QC | MARCH 09-10 | | QA/QC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METALS | | Total | Dissolved | | Total | Dissolved | | Total | Dissolved | | Total | Dissolved | |
| Aluminum | ug/L | 49 | 17 | J | 62 | 23 | J | 51 | 26 | J | 62 | 32 | J |
| Barium | ug/L | 90 | 88 | A | 68 | 69 | A | 76 | 79 | A | 58 | 58 | A |
| Boron | ug/L | 260 | 260 | A | 210 | 200 | A | 230 | 240 | A | 240 | 240 | A |
| Iron | ug/L | 80 | 20 | J | 120 | 10 | J | 100 | 20 | J | 100 | 20 | A |
| Magnesium | ug/L | 17,600 | 20,000 | A | 14,600 | 19,100 | A | 18,500 | 19,900 | A | 18,300 | 20,200 | A |
| Molybdenum | ug/L | 20 | 16 | A | 20 | 20 | A | 19 | 21 | A | 81 | 73 | A |
| Manganese | ug/L | 80 | 94 | A | 34 | 32 | A | 31 | 28 | A | 26 | 24 | A |

| TOTAL TO DISSOLVED RATIO | | | | | RATIO MEAN |
|---|---|---|---|---|---|
| Aluminum | 2.9 | 2.7 | 2.0 | 1.9 | 2. |
| Barium | 1.0 | 1.0 | 1.0 | 1.0 | 1. |
| Boron | 1.0 | 1.1 | 1.0 | 1.0 | 1. |
| Iron | 4.0 | 12.0 | 5.0 | 5.0 | 6. |
| Magnesium | 0.9 | 0.8 | 0.9 | 0.9 | 0. |
| Molybdenum | 1.3 | 1.0 | 0.9 | 1.1 | 1. |
| Manganese | 0.9 | 1.1 | 1.1 | 1.1 | 1. |

NOTES:
J = The associated numerical value is an estimated quantity
A = Acceptable Data
QA/QC data is a complete validation (Lab & Field)
If ratio < or = 1.0; metal present is entirely in the soluble form

# APPENDIX C-1

USEPA, OFFICE OF WATER MANAGEMENT, WASHINGTON D.C.
DRAFT "GUIDANCE ON METALS CLEAN METHODS AND DATA ASSESSMENTS"
MAY 20, 1993

# Amoco Oil Company

# Whiting Refinery

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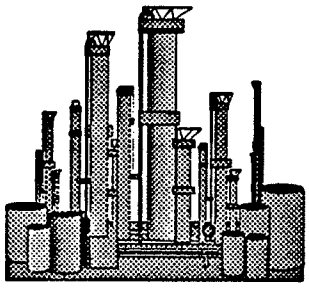
# Pollution Prevention Progress



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August 25, 1994

# Pollution Prevention at the Whiting Refinery

The Whiting Refinery supports Amoco Corporation's Environment, Health and Safety Policy of protecting the environment and the health and safety of employees, the users of our products and the communities in which we operate. Minimizing the environmental impact of our operations through pollution prevention and environmental conservation is a cornerstone of this policy.

In 1989, Amoco participated in an unprecedented joint two-year project with EPA to study ways to reduce pollution at Amoco's Yorktown, Virginia Refinery. The study identified the types, amounts and sources of emissions that the Refinery released to the air, land and water; developed options to reduce these emissions; determined which options were the most cost-effective and environmentally beneficial; and identified factors which promote/impede pollution prevention initiatives. The study resulted in a better knowledge of the sources of emissions from refineries. The key finding was that regulatory flexibility, which allows alternate compliance options to reduce these emissions, can achieve more effective environmental improvements than traditional command-and-control approaches. A brochure describing the Yorktown study is attached.

We are proud of pollution prevention achievements such as the Yorktown Pollution Prevention Project, our innovative management practices to promote waste minimization and our activities which support environmental conservation and sustain good community relations. The following pages highlight additional achievements, innovative projects and practices in each of these areas at the Whiting Refinery. However, before discussing these projects, we believe it is important to first define the term "pollution prevention."

## What is Pollution Prevention

The Whiting Refinery supports the "pollution prevention hierarchy" defined by Congress in the Pollution Prevention Act of 1990 (Attachment). The "pollution prevention hierarchy" states that pollution prevention alternatives should be evaluated in the following hierarchical order: source reduction, followed by recycle/reuse, treatment and as a last resort, disposal or other release into the environment. The hierarchy recognizes that while source reduction is of the highest importance, other environmentally safe alternatives exist to carry out pollution prevention goals.

This concept is important to the petroleum refining industry because crude oil, from which all petroleum products are made, contains naturally occurring impurities like nitrogen, sulfur and salts; and trace amounts of metals such as copper, lead, nickel, selenium and zinc. Source reduction and chemical substitution, therefore, may have limited application. Environmentally sound recyle/reuse alternatives thus play a much larger role in the pollution prevention strategy of a refinery, as evidenced by many of the projects on the following list.

## Waste Minimization Goal Exceeded

The Whiting Refinery contributed to Amoco Oil Company's goal to reduce the disposal of wastes by 50% by year-end 1994 by undertaking its own five-year 50% waste minimization goal in 1989. To date, the Refinery has exceeded this goal, reducing the volume of waste disposed of by over 50%. This was accomplished through source control, recycle/reuse options, improved operations and the assignment of a waste minimization coordinator to oversee the project and promote increased pollution prevention awareness throughout the Refinery.

## 33/50 Program

Amoco Corporation has made a five-year commitment to EPA's 33/50 Program to reduce emissions of certain toxic release inventory (TRI) chemicals by 50% by 1995. One of the Refinery's significant contributions in helping the Corporation meet this goal is the reduction in the use of a solvent used to remove paraffins at the methyl ethyl ketone (MEK) dewaxing unit. The solvent contains MEK and toluene, both substances on the 33/50 chemical list. In 1993, enhanced maintenance and equipment replacement reduced usage of this solvent 53%, from 738 gallons per day to 389 gallons per day. The Refinery is currently evaluating chemical substitutions and other alternatives to further reduce usage of this solvent.

## Minimizing Oil Loss to the Process Sewer

Over the past 15 years, the amount of oil entering the process sewer has been reduced by over 80%, as evidenced by the corresponding decline in the volume of oil recovered at the WWTP. This has been accomplished through improved unit operations control and greater awareness throughout the Refinery. This reduction minimizes product loss and maximizes the performance of the WWTP.

## Reduction in Solids to the Process Sewer

Through training, better operations, and new waste management practices such as improved tank cleaning techniques, solids to the process sewer have been substantially reduced over the past four years. As a direct result, WWTP sludges have been reduced by over 33%. Solids to the sewer can form emulsions with oil and water, which are difficult to degrade at the WWTP. According to various estimates, one pound of dirt in the sewer can form up to ten pounds of oily emulsions. Reducing the amount of solids to the sewer increases the efficiency of the WWTP and also decreases the volume of waste which must be incinerated.

## Reduction in WWTP Sludges

Oily sludges are produced at the Refinery WWTP as part of the water treating process. In the late 1980's, the Refinery installed filter presses at the WWTP to further extract water and hydrocarbons from the sludge. This process results in over a 60% reduction in the volume of sludges produced at the WWTP, reducing the amount of hazardous waste which must be incinerated.

**Miniminizing Amine Losses to the Process Sewer**
In 1993, the Refinery set a record for the lowest amine losses to the process sewer. Monoethanolamine (MEA) is used to control air pollution by removing hydrogen sulfide from refinery fuel gas streams. Although MEA is biologically degraded at the WWTP, high concentrations can stress the biological system. Reducing amine losses to the sewer minimizes potential WWTP upsets and reduces MEA waste treatment.

**Reductions in Process Water Usage**
Over the last ten years, even though the crude oil processing rate has increased, the volume of treated wastewater has remained constant. This is because process water usage has declined from 85 gallons per barrel of crude processed to 60 gallons per barrel of crude processed. This reduction demonstrates efficiency of operations in maximizing unnecessary process water usage.

**Benzene NESHAP Improvements**
The Refinery is completing several projects to improve its wastewater handling system to comply with the benzene National Emission Standards for Hazardous Air Pollutants (NESHAP) regulation. One such project is an improved closed tank water draw system. This will result in minimizing oil loss to the sewer because oil is recovered in decant tanks before the water draws are drained to the sewer. Another project involves sealing sewer vents to minimize air emissions. This has the added benefit of preventing solids from entering the sewer, thus reducing the formation of emulsions and improving WWTP performance.

**Environmental Inspectors**
For approximately 20 years, the Refinery has maintained a staff of environmental inspectors as part of our increased focus on environmental performance. The environmental inspection team provides a close 24-hour surveillance of all on-site refinery environmental matters, including monitoring water quality of the influent to the WWTP and controlling special draining to the process sewer. Whenever the water quality of the influent indicates a potential WWTP upset could occur, the inspectors act quickly to sample sewer trunks to locate and stop the source of the problem. They act as first-responders to environmental incidents such as leaks and spills and respond to community concerns by investigating and promptly evaluating any complaints reported to the Refinery. The inspectors have played a vital role in raising environmental awareness throughout the Refinery and have helped the Refinery make the transition from a reactive to preventive mode on many environmental issues.

## Improved Tank Cleaning Techniques and Maintenance Practices

Over the past year, tank cleaning techniques and maintenance practices have been improved resulting in increased recovery of hydrocarbons and reduced volume of solids requiring disposal. This has been accomplished by coordinating multiple tank cleaning projects. It then becomes cost effective to hire specialty tank cleaning contractors who use the latest techniques to centrifuge and/or filterpress tank sludges to recover the hydrocarbons and to reduce the amount of solids requiring disposal in a landfill. At a recent cleaning of a crude oil tank, oily sludge was reduced by over 98%, from 3,000 cubic yards to 60 cubic yards and over 10,000 barrels of valuable hydrocarbons were recovered and reprocessed.

## Reusable Sewer Covers

For the past four years, the Refinery has been using reusable sewer covers instead of sand and tarpaulins to cover sewer openings during maintenance activities. This eliminates the possibility of sand entering the sewer, reducing solids that create sludges which must be disposed of as hazardous waste and allowing the WWTP to operate more efficiently. The sewer covers look like miniature wading pools, which are filled with water and placed over sewer openings to create an effective seal. The covers are easily emptied and reused.

## Lime Slurry Reuse

The lime which is produced when softening raw boiler feed water is very pure and free from contamination. Rather than disposing of it in a landfill as was past practice, the Refinery has established a sales contract with agricultural companies who distribute the lime to farmers as a soil conditioner and sweetener.

## Zeolite Recycle/Reuse

Zeolite, a resin that is found in home, commercial and industrial water softeners, is used to soften raw boiler feed water by removing hardness. Rather than dispose of the zeolite resin during maintenance on the water softeners, the resin is stored in drums and recycled back into the softeners for further use.

## Used Battery Regeneration/Recycle

As an alternative to disposal, the Refinery sends used batteries to an outside firm for regeneration and/or recycling.

## Chemical Substitution for Degreaser Solvents

The Refinery has replaced chlorinated solvents with high flashpoint hydrocarbon solvents in degreasers used to clean parts and equipment. Spent hydrocarbon solvents can be recycled back into the refinery process; spent chlorinated solvents had to be disposed of off-site.

## Used Motor Oil Recycling

Amoco Oil Company was one of the first companies to establish service stations as used motor oil drop-off and recycling facilities for the "do-it-yourselfer" who may otherwise dispose of used motor oil in environmentally harmful ways. The used motor oil is sent to off-site recyclers for reprocessing.

**Used Industrial Oil Recycling**
Several industrial facilities send the Whiting Refinery used industrial oil. Used industrial oil that meets EPA used oil specifications is recycled as fuel at the Refinery's Power Station.

**Used Antifreeze and Freon Recycling**
The Refinery's vehicle maintenance garage recycles used antifreeze, thus eliminating its disposal and eliminating the cost of purchasing new antifreeze for the refinery fleet. Freon is also recovered and recycled during maintenance on the refinery fleet's air conditioners.

**TGU Sulfur Reuse**
Tail Gas Unit (TGU) sulfur, which is of lower quality than the traditional sulfur recovered at the Sulfur Recovery Unit, is sold to a sulfuric acid manufacturing facility for use as a raw material. Previously, the TGU sulfur had been disposed of in a landfill.

**Chemical Wash Water Minimization**
When the SRU is shut down for periodic maintenance, the chemical wash that is used to convert hydrogen sulfide to sulfur is temporarily stored until maintenance is complete, and then returned to the process tanks for unit start-up. This prevents the chemical wash from becoming contaminated, thus eliminating additional water treatment, sludge generation and disposal.

**Conversion to Bulk Chemical Storage**
The Refinery has initiated efforts to further convert its storage of lubricating oils and chemical intermediates from 55 gallon drums to bulk storage. This conversion reduces the potential for spills, leaks and contaminated soil resulting from repeated drum handling, reduces the cost of replacing rusty or contaminated drums and minimizes waste from drum disposal.

**Tank Modernization**
The Refinery is undertaking a major, multi-year project to upgrade its tank storage by replacing existing tanks with new welded tanks featuring secondary bottoms to better detect leaks and prevent spills to the ground. Additionally, some external floating roof tanks are being refitted with geodesic domes to reduce hydrocarbon emissions to the atmosphere, reduce damage to tank roofs and minimize the amount of rain water entering the tanks. This reduces the amount of contaminated water drained to the sewer in tank water draws.

**Corporate-wide Waste Exchange**
The Whiting Refinery participates in a corporate-wide computerized waste exchange bulletin board. Through postings on the bulletin board, this exchange mechanism allows material which might otherwise be disposed of to be recycled/reused by other Amoco facilities.

## Waste Sorting Yard

The Refinery has set up a waste sorting yard to allow specific solid wastes to be sorted for recycling. Sorted recyclable materials such as scrap metal and tires are sent to a recycler. Reusable items such as pallets and barrels are reused onsite; compactable items are crushed in the refinery's trash compactor for recycling.

## Catalyst Recycle/Reuse

Catalysts, used in a variety of processes at the refinery, generally lose their effectiveness after repeated use and become spent. Spent catalysts containing silica and/or alumina are used as a raw material in the production of cement. The Refinery sends several tons per day of this spent catalyst to cement manufacturers rather than dispose of it as a waste. Even the finest catalyst particles, collected in electrostatic precipitators on the catalytic crackers, are recycled into cement.

Catalysts can also contain precious and semi-precious metals, such as platinum and cobalt. These catalysts are sent to reclaimers who reclaim the metals for reuse in other catalysts.

## Caustic Reuse

At the WWTP, the use of caustic is critical for pH control to maintain effective biological treatment. Rather than purchase fresh caustic, the Refinery receives spent caustic from the neighboring Amoco Chemical Company plant for use at the WWTP. This eliminates the disposal of the spent caustic in commercial treatment facilities and minimizes the need to purchase additional fresh caustic.

## Reduction in Solids Generation at WWTP

By effectively managing pH control throughout the wastewater handling and treatment system, the Refinery has minimized the formation of solids. Installation of a caustic injection system at the WWTP aeration tanks has been a major factor in managing pH control. In the last three years, the generation of solids at the WWTP has been reduced over 50%, resulting in reduced hazardous waste disposal.

## Chemical Substitution for Chlorine Gas

In the late 1980's, the Refinery converted from chlorine gas to bleach as a biocide in its cooling towers. This has resulted in reduced chlorine emissions.

## Chemical Substitution for Chromium

In the late 1980's, the Refinery eliminated the use of chromium as a corrosion inhibitor in its cooling towers . Chromium has been replaced with zinc and phosphate corrosion inhibitors, which are less toxic. This has reduced chromium emissions to the air and water, and minimized the chromium content in WWTP sludges which are incinerated.

## Office Waste Paper Recycling

Since 1990, the Refinery has sent over 100 tons of office and computer waste paper to an off-site recycler. This minimizes waste disposal and conserves natural resources that would otherwise be used to make new paper products.

## Employee Communication and Training

The refinery conducts several training and communication programs for its employees. Maintenance and operations personnel receive specific training on environmental issues relevant to their tasks. Refinery employees also receive annual safety and environmental training. Through greater environmental awareness, refinery employees have developed workable and effective programs to reduce waste generation and emissions. Many of these programs are highlighted in monthly publications to further increase awareness. Employees can also use this knowledge in their home and community by reducing toxic household waste and promoting participation in community recycling programs.

## Community Activities

Whiting Refinery personnel are involved in many community activities promoting environmental awareness and conservation. Following are a few of these activities:

**Lost Marsh** - A volunteer group of employees, with assistance from the Wildlife Habitat Enhancement Council and several local environmental groups, are restoring ten acres of land near the Refinery to its natural wetlands environment, creating a wildlife habitat. Future projects will be established at the site for local Boy Scouts and Girl Scouts to earn merit badges in biology, botany and ecology.

**Enviromobile** - The Refinery has donated photovoltaic panels and a compressed natural gas-fired generator for use in the Indiana Department of Environmental Management's (IDEM) Enviromobile. The panels will be used to illustrate solar energy concepts. The generator will be used to power onboard display exhibits and to demonstrate the practical use of a cleaner fuel source for internal combustion engines. The Enviromobile will travel to middle schools in Northwest Indiana to promote greater interest and understanding of environmental concepts and issues.

**CARE Committee** - Refinery personnel are members of the Citizens Advisory for Remediation of the Environment (CARE) Committee. Monthly meetings are held to develop a Remedial Action Plan for the Northwest Indiana Area of Concern, and to participate in a dialogue on related environmental topics.

**Used Oil Recycling Educational Materials** - The Refinery has printed written materials for distribution to local area residents concerning the proper management of used oil. Several meetings were held with Safety Kleen, Refinery personnel, IDEM and Whiting residents to agree on communication materials.

# POLLUTION PREVENTION ACT OF 1990

## (Enacted by Public Law 101-508, November 5, 1990)

**Sec. 6601. Short Title.**

This subtitle may be cited as the "Pollution Prevention Act of 1990".

**Sec. 6602. Findings and Policy.**

(a) Findings.—The Congress finds that:

(1) The United States of America annually produces millions of tons of pollution and spends tens of billions of dollars per year controlling this pollution.

(2) There are significant opportunities for industry to reduce or prevent pollution at the source through cost-effective changes in production, operation, and raw materials use. Such changes offer industry substantial savings in reduced raw material, pollution control, and liability costs as well as help protect the environment and reduce risks to worker health and safety.

(3) The opportunities for source reduction are often not realized because existing regulations, and the industrial resources they require for compliance, focus upon treatment and disposal, rather than source reduction; existing regulations do not emphasize multi-media management of pollution; and businesses need information and technical assistance to overcome institutional barriers to the adoption of source reduction practices.

(4) Source reduction is fundamentally different and more desirable than waste management and pollution control. The Environmental Protection Agency needs to address the historical lack of attention to source reduction.

(5) As a first step in preventing pollution through source reduction, the Environmental Protection Agency must establish a source reduction program which collects and disseminates information, provides financial assistance to States, and implements the other activities provided for in this subtitle.

(b) Policy.—The Congress hereby declares it to be the national policy of the United States that pollution should be prevented or reduced at the source whenever feasible; pollution that cannot be prevented should be recycled in an environmentally safe manner, whenever feasible; pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible; and disposal or other release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner.

**Sec. 6603. Definitions.**

For purposes of this subtitle—

(1) The term "Administrator" means the Administrator of the Environmental Protection Agency.

(2) The term "Agency" means the Environmental Protection Agency.

(3) The term "toxic chemical" means any substance on the list described in section 313(c) of the Superfund Amendments and Reauthorization Act of 1986.

(4) The term "release" has the same meaning as provided by section 329(8) of the Superfund Amendments and Reauthorization Act of 1986.

(5)(A) The term "source reduction" means any practice which—

(i) reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment, or disposal; and

(ii) reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants.

The term includes equipment or technology modifications, process or procedure modifications, reformulation or redesign of products, substitution of raw materials, and improvements in housekeeping, maintenance, training, or inventory control.

(B) The term "source reduction" does not include any practice which alters the physical, chemical, or biological characteristics or the volume of a hazardous substance, pollutant, or contaminant through a process or activity which itself is not integral to and necessary for the production of a product or the providing of a service.

(6) The term "multi-media" means water; air, and land.

(7) The term "SIC codes" refers to the 2-digit code numbers used for classification of economic activity in the Standard Industrial Classification Manual.

**Sec. 6604. EPA Activities.**

(a) Authorities.—The Administrator shall establish in the Agency an office to carry out the functions of the Administrator under this subtitle. The office shall be independent of the Agency's single-medium program offices but shall have the authority to review and advise such offices on their activities to promote a multi-media approach to source reduction. The office shall be under the direction of such officer of the Agency as the Administrator shall designate.

(b) Functions.—The Administrator shall develop and implement a strategy to promote source reduction. As part of the strategy, the Administrator shall—

(1) establish standard methods of measurement of source reduction;

(2) ensure that the Agency considers the effect of its existing and proposed programs on source reduction efforts and shall review regulations of the Agency prior and subsequent to their proposal to determine their effect on source reduction;

(3) coordinate source reduction activities in each Agency Office and coordinate with appropriate offices to promote source reduction practices in other Federal agencies, and generic research and development on techniques and processes which have broad applicability;

(4) develop improved methods of coordinating, streamlining and assuring public access to data collected under Federal environmental statutes;

**Roundtable Discussions** - Refinery personnel participated in discussions to provide feedback to IDEM and EPA Region V on their environmental strategy for Northwest Indiana.

**Citizens Advisory Committee** - The Citizens Advisory Committee provides a forum for the community and Amoco to discuss issues of concern. Membership includes representatives from the Refinery; the local Oil, Chemical and Atomic Workers Union; the cities of Hammond, East Chicago and Whiting; and local residents. At each bi-monthly meeting, Refinery representatives provide an update on remediation projects and the overall status of Refinery operations.

**Indianapolis Boulevard** - The Refinery treats groundwater, manages excess excavated soils and provides a list of contractors to IDEM to support the Boulevard sewer/street replacement project.

**Wolf Lake Enhancement Committee** - Refinery personnel are members of this Committee which serves to provide expertise on managing the cleanup and restoration of Wolf Lake and George Lake.

**Hammond Pride City-Wide** - The Refinery donates bags for clean-up efforts and participates in periodic meetings to discuss environmental education projects forHammond-area residents.

**Hammond Chamber of Commerce Environmental Committee** - Refinery personnel participate in bi-monthly meetings to provide input on environmental issues of concern to the City of Hammond.

**East Chicago Mayor's Environmental Advisory Committee** - Refinery personnel participate in monthly meetings to provide input on environmental issues of concern to the City of East Chicago.

**Indiana Environmental Institute (IEI) Forum** - Refinery personnel participate in this broad-based forum, facilitated by IEI, which encourages industry, consultants and environmental groups to develop concensus positions on environmental issues facing Indiana.

<u>Summary</u>

Pollution prevention plays a very valuable role in the Refinery's environmental strategy and performance. Environmental awareness has been raised in the day-to-day operations of the Refinery, and finding innovative, cost-effective solutions to minimize or eliminate the generation of waste has become a way of doing business. The examples summarized here illustrate the Refinery's successes and ongoing commitment to pollution prevention practices. We look forward to continuing our pollution prevention progress to improve and protect the environment for our employees, the users of our products and the communities in which we operate.

(5) facilitate the adoption of source reduction techniques by businesses. This strategy shall include the use of the Source Reduction Clearinghouse and State matching grants provided in this subtitle to foster the exchange of information regarding source reduction techniques, the dissemination of such information to businesses, and the provision of technical assistance to businesses. The strategy shall also consider the capabilities of various businesses to make use of source reduction techniques;

(6) identify, where appropriate, measurable goals which reflect the policy of this subtitle, the tasks necessary to achieve the goals, dates at which the principal tasks are to be accomplished, required resources; organizational responsibilities, and the means by which progress in meeting the goals will be measured;

(8) establish an advisory panel of technical experts comprised of representatives from industry, the States, and public interest groups, to advise the Administrator on ways to improve collection and dissemination of data;

(9) establish a training program on source reduction opportunities, including workshops and guidance documents, for State and Federal permit issuance, enforcement, and inspection officials working within all agency program offices.

(10) identify and make recommendations to Congress to eliminate barriers to source reduction including the use of incentives and disincentives;

(11) identify opportunities to use Federal procurement to encourage source reduction;

(12) develop, test and disseminate model source reduction auditing procedures designed to highlight source reduction opportunities; and

(13) establish an annual award program to recognize a company or companies which operate outstanding or innovative source reduction programs.

**Sec. 6605. Grants to States For State Technical Assistance Programs.**

(a) General Authority.—The Administrator shall make matching grants to States for programs to promote the use of source reduction techniques by businesses.

(b) Criteria.—When evaluating the requests for grants under this section, the Administrator shall consider, among other things, whether the proposed State program would accomplish the following:

(1) Make specific technical assistance available to businesses seeking information about source reduction opportunities, including funding for experts to provide onsite technical advice to business seeking assistance and to assist in the development of source reduction plans.

(2) Target assistance to businesses for whom lack of information is an impediment to source reduction.

(3) Provide training in source reduction techniques. Such training may be provided through local engineering schools or any other appropriate means.

(c) Matching Funds.—Federal funds used in any State program under this section shall provide no more than 50 per centum of the funds made available to a State in each year of that State's participation in the program.

(d) Effectiveness.—The Administrator shall establish appropriate means for measuring the effectiveness of the State grants made under this section in promoting the use of source reduction techniques by businesses.

(e) Information.—States receiving grants under this section shall make information generated under the grants available to the Administrator.

**Sec. 6606. Source Reduction Clearinghouse.**

(a) Authority.—The Administrator shall establish a Source Reduction Clearinghouse to compile information including a computer data base which contains information on management, technical, and operational approaches to source reduction. The Administrator shall use the clearinghouse to—

(1) serve as a center for source reduction technology transfer;

(2) mount active outreach and education programs by the States to further the adoption of source reduction technologies; and

(3) collect and compile information reported by States receiving grants under section 6605 on the operation and success of State source reduction programs.

(b) Public Availability.—The Administrator shall make available to the public such information on source reduction as is gathered pursuant to this subtitle and such other pertinent information and analysis regarding source reduction as may be available to the Administrator. The data base shall permit entry and retrieval of information to any person.

**Sec. 6607. Source Reduction and Recycling Data Collection.**

(a) Reporting Requirements.—Each owner or operator of a facility required to file an annual toxic chemical release form under section 313 of the Superfund Amendments and Reauthorization Act of 1986 ("SARA") for any toxic chemical shall include with each such annual filing a toxic chemical source reduction and recycling report for the preceding calendar year. The toxic chemical source reduction and recycling report shall cover each toxic chemical required to be reported in the annual toxic chemical release form filed by the owner or operator under section 313(c) of that Act. This section shall take effect with the annual report filed under section 313 for the first full calendar year beginning after the enactment of this subtitle.

(b) Items Included in Report.—The toxic chemical source reduction and recycling report required under subsection (a) shall set forth each of the following on a facility-by-facility basis for each toxic chemical:

(1) The quantity of the chemical entering any waste stream (or otherwise released into the environment) prior to recycling, treatment, or disposal during the calendar year for which the report is filed and the percentage change from the previous year. The quantity reported shall not include any amount reported under paragraph (7). When actual measurements of the quantity of a toxic chemical entering the waste streams are not readily available, reasonable estimates should be made on best engineering judgment.

(2) The amount of the chemical from the facility which is recycled (at the facility or elsewhere) during such calendar year, the percentage change from the previous year, and the process of recycling used.

(3) The source reduction practices used with respect to that chemical during such year at the facility. Such practices shall be reported in accordance with the following categories unless the Administrator finds other categories to be more appropriate.

(A) Equipment, technology, process, or procedure modifications.

(B) Reformulation or redesign of products.

(C) Substitution of raw materials.

(D) Improvement in management, training, inventory control, materials handling, or other general operational phases of industrial facilities.

(4) The amount expected to be reported under paragraph (1) and (2) for the two calendar years immediately following the calendar year for which the report is filed. Such amount shall be expressed as a per-

centage change from the amount reported in paragraphs (1) and (2).

(5) A ratio of production in the reporting year to production in the previous year. The ratio should be calculated to most closely reflect all activities involving the toxic chemical. In specific industrial classifications subject to this section, where a feedstock or some variable other than production is the primary influence on waste characteristics or volumes, the report may provide an index based on that primary variable for each toxic chemical. The Administrator is encouraged to develop production indexes to accommodate individual industries for use on a voluntary basis.

(6) The techniques which were used to identify source reduction opportunities. Techniques listed should include, but are not limited to, employee recommendations, external and internal audits, participative team management, and material balance audits. Each type of source reduction listed under paragraph (3) should be associated with the techniques or multiples of techniques used to identify the source reduction technique.

(7) The amount of any toxic chemical released into the environment which resulted from a catastrophic event, remedial action, or other one time event, and is not associated with production processes during the reporting year.

(8) The amount of the chemical from the facility which is treated (at the facility or elsewhere) during such calendar year and the percentage change from the previous year. For the first year of reporting under this subsection, comparison with the previous year is required only to the extent such information is available.

(c) SARA Provisions.— The provisions of sections 322, 325(c), and 326 of the Superfund Amendments and Reauthorization Act of 1986 shall apply to the reporting requirements of this section in the same manner as to the reports required under section 313 of that Act. The Administrator may modify the form required for purposes of reporting information under section 313 of that Act to the extent he deems necessary to include the additional information required under this section.

(d) Additional Optional Information.— Any person filing a report under this section for any year may include with the report additional information regarding source reduction, recycling, and other pollution control techniques in earlier years.

(e) Availability of Data.—Subject to section 322 of the Superfund Amendments and Reauthorization Act of 1986, the Administrator shall make data collected under this section publicly available in the same manner as the data collected under section 313 of the Superfund Amendments and Reauthorization Act of 1986.

**Sec. 6608. EPA Report.**

(a) Biennial Reports.—The Administrator shall provide Congress with a report within eighteen months after enactment of this subtitle and biennially thereafter, containing a detailed description of the actions taken to implement the strategy to promote source reduction developed under section 4(b) and the results of such actions. The report shall include an assessment of the effectiveness of the clearinghouse and grant program established under this subtitle in promoting the goals of the strategy, and shall evaluate data gaps and data duplication with respect to data collected under Federal environmental statutes.

(b) Subsequent Reports.—Each biennial report submitted under subsection (a) after the first report shall contain each of the following:

(1) An analysis of the data collected under section 6607 on an industry-by-industry basis for not less than five SIC codes or other categories as the Administrator deems appropriate. The analysis shall begin with those SIC codes or other categories of facilities which generate the largest quantities of toxic chemical waste. The analysis shall include an evaluation of trends in source reduction by industry, firm size, production, or other useful means. Each such subsequent report shall cover five SIC codes or other categories which were not covered in a prior report until all SIC codes or other categories have been covered.

(2) An analysis of the usefulness and validity of the data collected under section 6607 for measuring trends in source reduction and the adoption of source reduction by business.

(3) Identification of regulatory and nonregulatory barriers to source reduction, and of opportunities for using existing regulatory programs, and incentives and disincentives to promote and assist source reduction.

(4) Identification of industries and pollutants that require priority assistance in multi-media source reduction.

(5) Recommendations as to incentives needed to encourage investment and research and development in source reduction.

(6) Identification of opportunities and development of priorities for research and development in source reduction methods and techniques.

(7) An evaluation of the cost and technical feasibility, by industry and processes, of source reduction opportunities and current activities and an identification of any industries for which there are significant barriers to source reduction with an analysis of the basis of this identification.

(8) An evaluation of methods of coordinating, streamlining, and improving public access to data collected under Federal environmental statutes.

(9) An evaluation of data gaps and data duplication with respect to data collected under Federal environmental statutes.

In the report following the first biennial report provided for under this subsection, paragraphs (3) through (9) may be included at the discretion of the Administrator.

**Sec. 6609. Savings Provisions.**

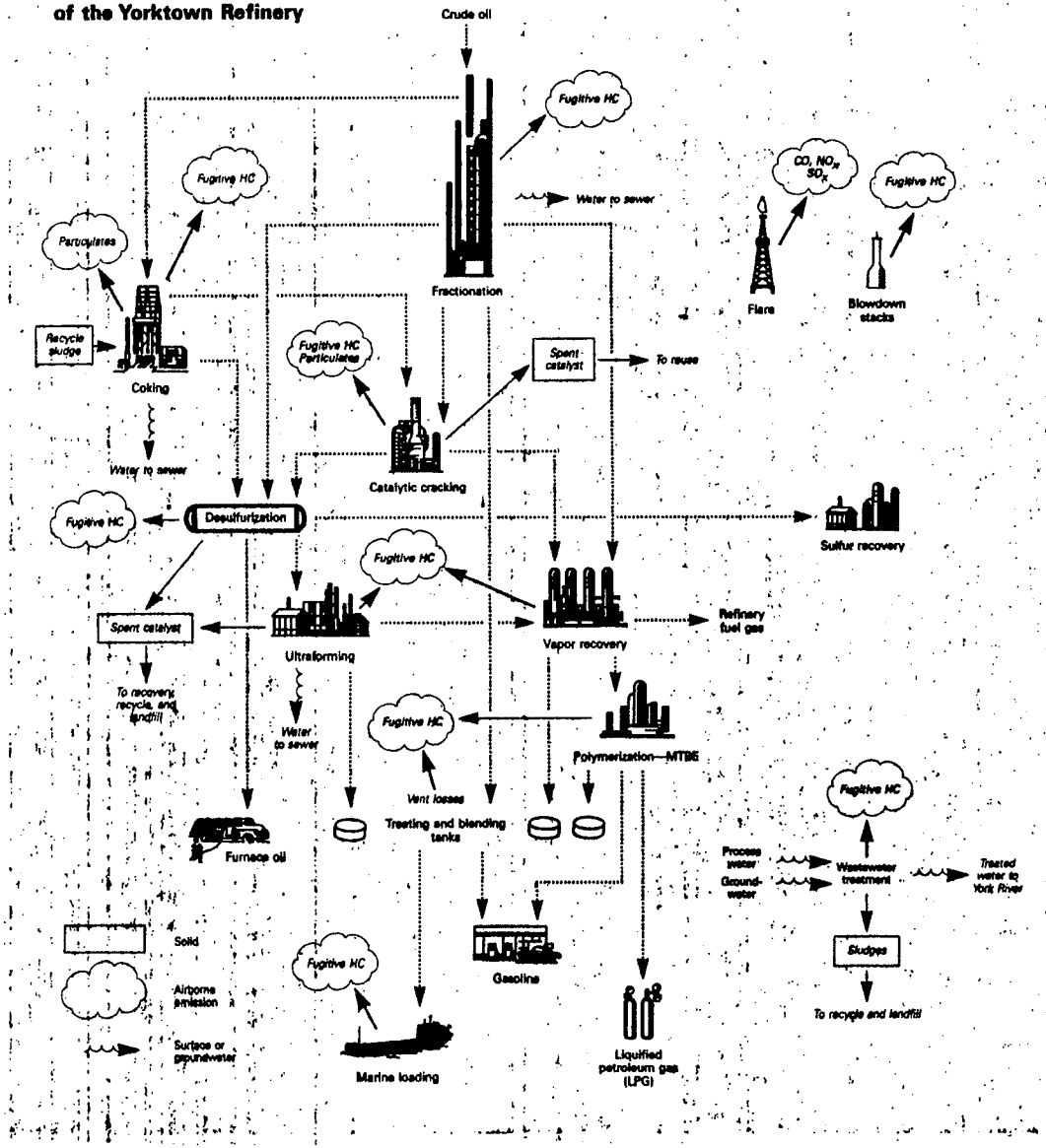
(a) Nothing in this subtitle shall be construed to modify or interfere with the implementation of title III of the Superfund Amendments and Reauthorization Act of 1986.

(b) Nothing contained in this subtitle shall be construed, interpreted or applied to supplant, displace, preempt or otherwise diminish the responsibilities and liabilities under other State or Federal law, whether statutory or common.

**Sec. 6610. Authorization of Appropriations.**

There is authorized to be appropriated to the Administrator $8,000,000 for each of the fiscal years 1991, 1992, and 1993 for functions carried out under this subtitle (other than State Grants), and $8,000,000 for each of the fiscal years 1991, 1992, and 1993, for grant programs to States issued pursuant to section 6605.

## Simplified flow diagram and emission sources of the Yorktown Refinery




Amoco, EPA, and Virginia authorities agreed that controlling barge-loading emissions offered the most effective—though not the lowest-cost—option. A second tier of options included (1) installing improved seals on selected storage tanks, (2) instituting a leak detection and repair program to address small leaks sometimes found on valves and flanges, and (3) upgrading emergency process vents to reduce hydrocarbon losses to the air.

The group agreed that all four of these options are reasonably effective pollution-prevention projects that could prevent or capture almost 6,900 tons of emissions annually for about $510 per ton.

## Key findings

### Better environmental results can be achieved at lower cost.

**Example:** The Yorktown refinery study showed that new approaches could produce about 90 percent of the mandatory emissions reductions for 20 percent to 25 percent of today's costs. Current regulations require controls of 7,300 tons per year at an average cost of $2,400 per ton. Similar total reductions could be accomplished for about $510 per ton.

**Recommendation:** Explore opportunities to produce better environmental results more cost-effectively. EPA might evaluate options for setting a goal or target for reducing emissions and then allow the facility to develop a strategy to meet the target.

### The current system encourages short-term fixes at the expense of more effective solutions.

**Example:** Most regulatory and statutory programs require compliance within six months to three years after a rule is finalized. This is shorter than the design, engineering, and construction time frames needed for many environmental management projects. These projects often suffer delays when regulatory interpretation and design criteria are unclear, or new technologies are involved.

**Recommendation:** Reconsider compliance time frames.

### Current practices discourage innovative solutions to complex environmental problems.

**Example:** Since the 1970s, Amoco's environmental investments have been focused on meeting single-issue regulatory requirements as they were developed. There has been and continues to be little coordinated management of multiple regulatory requirements because the regulations themselves do not recognize or allow for this, and sound data has not been available.

**Recommendation:** Consider providing incentives for conducting facilitywide assessments and emission-reduction strategies.

### Better data can improve environmental management decisions.

**Example:** One current regulation requires refineries to control benzene emissions from their water-treating systems. However, this study found that those systems are a relatively small source of benzene emissions. By looking at the entire facility, the study's emissions assessment identified both the most significant sources of benzene *and* more cost-effective ways to manage them.

**Recommendation:** Improve environmental data collection techniques, analysis, and management, and consider additional research.

### Government and industry can accomplish more by working together.

**Example:** This is the first joint industry/government project to study pollution-prevention opportunities at an industrial facility. The study helped Amoco and EPA each better understand what the other faces. By agreeing at the beginning of the project that everyone might not always agree, participants showed a willingness to discuss issues and focus on data and factual information.

**Recommendation:** Encourage additional private-public partnerships on environmental management.

## Summary

We all share the same environment, and want what is best for it. But because our resources are limited, we must choose the way these resources are invested for environmental quality. The Amoco/EPA project took a significant step toward identifying new ways to set priorities for opportunities that make sound environmental improvements.

The project showed the value and the challenge of government and industry partnerships. Through the use of these partnerships, perhaps we can learn to better prioritize and manage the environmental work that needs to be done.

*The Yorktown facility is a 53,000-barrel-a-day oil refinery, located on a 1,400-acre site along the York River in York County, Va., near Chesapeake Bay. The refinery produces gasoline, heating oil, petroleum coke and LPG fuel, most of which are shipped by water for distribution throughout the Mid-Atlantic states.*

*The Yorktown refinery was chosen partly because of its proximity to Washington, D.C. This location enabled federal officials to get firsthand information about the refinery's operations and environmental effects. The refinery's size and product mix are typical of petroleum industry operations, yet the facility was small enough to permit overall study within the two-year time frame.*

## Acknowledgments

Many people and organizations contributed to the success of the Yorktown pollution-prevention project, including the following:

**U.S. Environmental Protection Agency**
Office of Air and Radiation
Office of Solid Waste and Emergency Response
National Advisory Council on Environmental Policy and Technology
Office of Research and Development
Office of Policy, Planning and Evaluation
Office of Water
Office of Pesticides and Toxic Substances
Office of Air Quality Planning and Standards
Region III

**Amoco Corporation**
Yorktown Refinery
Research and Development
Environmental Affairs and Safety
Public and Government Affairs
Analytical Services
Groundwater Management Services
Refining and Transportation Engineering
Whiting Refinery

**Commonwealth of Virginia**
State Water Control Board
Department of Waste Management
Department of Air Pollution Control

**Academic Institutions**
Virginia Institute of Marine Science, College of William and Mary
University of California at Los Angeles
University of Michigan

Integral to the success of the project was the contribution made by members of an outside Peer Review Committee selected by Resources for the Future, a "think-tank" based in Washington, D.C.

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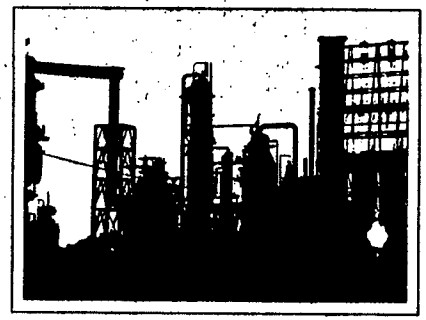
# Amoco – U.S. EPA
# Joint Pollution Prevention Project
# Yorktown, Virginia



## Project Summary

## Project purpose

A cleaner environment is a goal we all share. However, government and industry often are at odds over the most effective way to improve air, land, and water quality.

In November 1989, Amoco Corporation and the U.S. Environmental Protection Agency (EPA) demonstrated unprecedented cooperation between government and industry in the interest of a cleaner environment. That's when the two organizations began studying ways to reduce pollution from a source they had never before closely examined together—a functioning industrial facility, namely Amoco's Yorktown, Va., refinery.

Specifically, the Amoco/EPA project sought to:

—Determine the types, amounts, and sources of emissions that the refinery releases to the air, land, and water.

—Develop options to reduce these releases.

—Determine the benefits, impacts, and costs of different options to select the most effective.

—Identify factors that encourage or discourage pollution-prevention initiatives.

—Increase participants' knowledge of refinery and regulatory systems.

## Project approach

The Yorktown project was ambitious. The two-year study cost about $2.3 million, with Amoco and EPA paying 70 percent and 30 percent, respectively.

More than 200 people and 35 organizations participated in the project, including representatives from universities, the Commonwealth of Virginia, and public interest groups, as well as Amoco and EPA. (See the list in this brochure.) The diverse skills of the participants reflected the belief that solving difficult environmental problems must draw on many of society's partners.

The project was divided into two phases. Phase One, which ran through year-end 1990, emphasized information gathering. Through an extensive sampling and monitoring program, about 1,000 air, water, groundwater, and soil samples were each tested for 15 to 20 chemicals. The project work group from Amoco, EPA, and Virginia met monthly to plan the program, discuss the data, and interpret the results.

Phase One sought to associate specific chemical emissions with their exact sources in the refinery. This proved to be difficult for airborne releases (which account for nearly 90 percent of this refinery's emissions) for two reasons:

First, refinery products are defined by specific properties (such as octane, color, and freeze point) rather than by specific chemical compositions. Therefore, refiners do not routinely track the thousands of chemicals found in refinery products and emissions.

Second, measuring the thousands of potential emission sources within a refinery is not feasible, because the quantity released by any one source is extremely small. For example, hydrocarbons released from the Yorktown refinery to the air, land, and water only amount to about 0.3 percent by weight of the total crude oil processed.

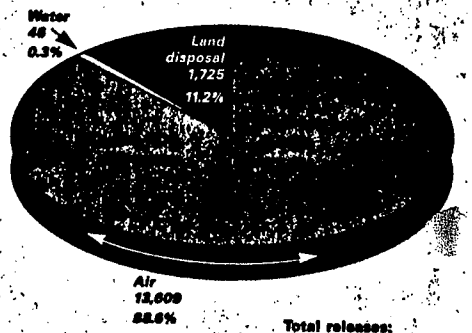
Despite the overwhelming nature of the task, the Amoco/EPA team managed to compile an inventory of refinery emissions using a combination of sampling, measurements, dispersion modeling, and EPA estimating techniques. In Yorktown's case, the project found measurements of more general classes of materials, such as volatile organic compounds emitted by a source, can be a more effective gauge of emission-reduction progress than tracking many different chemicals separately.

A brainstorming meeting attended by about 120 people from many disciplines and organizations launched the project's second phase. Phase Two was designed to review findings, develop emission-reduction options, and set priorities for these options.

The workshop approach worked well by developing emission-reduction options more quickly than EPA or industry could produce working alone. The initial suggestions were later refined and analyzed by the Amoco/EPA work group. Ultimately, the work group agreed on the most sensible and useful options for managing refinery emissions at the Yorktown site, as well as on the ranking of the most- and least cost-effective choices.

## Releases entering the environment from Yorktown Refinery

(tons per year)




**Total releases: 15,380 tons per year**

PLEASE PRINT OR TYPE IN THE UNSHADED AREAS ONLY. You may report some or all of this information on separate sheets *(use the same format)* instead of completing these pages. SEE INSTRUCTIONS.

EPA I.D. NUMBER *(copy from Item 1 of Form 1)*: IND000810861

*Form Approved OMB No. 158-R0173*

OUTFALL NO. 001

## V. INTAKE AND EFFLUENT CHARACTERISTICS *(continued from page 3 of Form 2-C)*

PART A - You must provide the results of at least one analysis for every pollutant in this table. Complete one table for each outfall. See instructions for additional details.

| 1. POLLUTANT | 2. EFFLUENT a. MAXIMUM DAILY VALUE (1) CONCENTRATION | (2) MASS | b. MAXIMUM 30 DAY VALUE *(if available)* (1) CONCENTRATION | (2) MASS | c. LONG TERM AVRG. VALUE *(if available)* (1) CONCENTRATION | (2) MASS | d. NO. OF ANALYSES | 3. UNITS *(specify if blank)* a. CONCENTRATION | b. MASS | 4. INTAKE *(optional)* a. LONG TERM AVERAGE VALUE (1) CONCENTRATION | (2) MASS | b. NO. OF ANALYSES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a. Biochemical Oxygen Demand *(BOD)* | 29 | 3,580 | 5.8 | 721 | 2.7 | 283 | 805 | mg/L | lbs | | | |
| b. Chemical Oxygen Demand *(COD)* | 135 | 18,515 | 67.2 | 7,973 | 48.0 | 4,951 | 484 | mg/L | lbs | | | (b) |
| c. Total Organic Carbon *(TOC)* | 12.0 | 681 | | | | | 1 | mg/L | lbs | | | |
| d. Total Suspended Solids *(TSS)* | 71 | 4,904[f] | 24.6 | 2,059 | 8.6 | 857 | 807 | mg/L | lbs | | | (b) |
| e. Ammonia *(as N)* | 13 | 1,446 | 4.12 | 551 | 0.6 | 68.34 | 806 | mg/L | lbs | | | |
| f. Flow | VALUE 32.4 | | VALUE 22.54 | | VALUE 12.61 | | 1,126 | mgd | | VALUE 12.61 | | 1126 |
| g. Temperature *(winter)* | VALUE 35.0 [h] | | VALUE 33.1 | | VALUE 25.9 | | 845 | °C | | VALUE | | |
| h. Temperature *(summer)* | VALUE 37.0 [h] | | VALUE 33.6 | | VALUE 32.2 | | 276 | °C | | VALUE | | |
| i. pH | MINIMUM 6.7 | MAXIMUM 8.1 | MINIMUM 7.3 | MAXIMUM 7.9 | | | 483 | STANDARD UNITS | | | | |

PART B - Mark "X" in column 2-a for each pollutant you know or have reason to believe is present. Mark "X" in column 2-b for each pollutant you believe to be absent. If you ma column 2-a for any pollutant, you must provide the results of at least one analysis for that pollutant. Complete one table for each outfall. See the instructions for additio details and requirements.

| 1. POLLUTANT AND CAS NO. *(if available)* | 2. MARK 'X' a. BELIEVED PRESENT | b. BELIEVED ABSENT | 3. EFFLUENT a. MAXIMUM DAILY VALUE (1) CONCENTRATION | (2) MASS | b. MAXIMUM 30 DAY VALUE *(if available)* (1) CONCENTRATION | (2) MASS | c. LONG TERM AVRG. VALUE *(if available)* (1) CONCENTRATION | (2) MASS | d. NO. OF ANALYSES | 4. UNITS a. CONCENTRATION | b. MASS | 5. INTAKE *(optional)* a. LONG TERM AVERAGE VALUE (1) CONCENTRATION | (2) MASS | b. NO. OF ANALYSES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a. Bromide (24959-67-9) | X | | 3 | 481 | | | 1.57 | 233 | 19 | mg/L | lbs | | | |
| b. Chlorine, Total Residual | | X | <0.04 | <2.3 | | | | | 1 | mg/L | lbs | | | |
| c. Color | X | | <5 | | | | | | 1 | color/unit | | | | |
| d. Fecal Coliform | X | | 7 | | | | | | 1 | No./100mL | | | | (b) |
| e. Fluoride (16984-48-8) | X | | 0.3 | 17.0 | | | | | 1 | mg/L | lbs | | | (b) |
| f. Nitrate-Nitrite *(as N)* | X | | 0.5/<1.0 | 28.4/<56.7 | | | | | 1 | mg/L | lbs | | | (b) |

CONTINUE ON REVE



EPA Form 3510-2C (6-80)

AUG 2 3 ...