INDUSTRIAL HYGIENE SURVEY REPORT

OF

DORCHESTER REFINING COMPANY
Box 1011
Mt. Pleasant, Texas 75455

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DATES OF SURVEY:
September 15-October 5, 1981

REPORT WRITTEN BY:
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Industrial Hygiene Section
Industrywide Studies Branch
Division of Surveillance, Hazard Evaluations and Field Studies
National Institute for Occupational Safety and Health
Centers for Disease Control
Cincinnati, Ohio

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PURPOSE OF SURVEY:	To conduct a comprehensive, industrial hygiene survey of a thermal catalytic cracking unit turnaround.
EMPLOYER REPRESENTATIVE CONTACTED:	John Meriwether, Refinery Superintendent Robert Cooks, Industrial Relation Supervisor David Whittington, Safety Supervisor Billy Dale, Maintenance Superintendent
EMPLOYEE REPRESENTATIVE CONTACTED:	Albert McCollum, President, OCAW, Local 4-471
STANDARD INDUSTRIAL CLASSIFICATION OF REFINERY TURNAROUND EMPLOYEES:	1799 Special Trade Contractors, Not Elsewhere Classified

ABSTRACT

On September 15-October 5, 1981, NIOSH investigators conducted an industrial hygiene survey of turnaround operations of a thermal catalytic cracking unit (TCCU) at a medium size petroleum refinery in Northeast Texas. The purpose of this survey was to characterize the exposure of turnaround workers to various chemical agents. Using NIOSH or modified-NIOSH analytical methods over 40 chemicals were identified and quantified. Over 1100 chemical exposures were measured of which over 640 are presented, by major operations, in summary tables. Chemicals, with the most potential for exposure in excess of current standards, or recommended standards were nitrogen dioxide (NO_2), Chromium VI [Cr(+6)], nickel (Ni), and Coal Tar Pitch Volatiles (CTPV). NO_2 air concentrations ranged from 10.0 ppm to 321.1 ppm with a geometric mean of 35.2 ppm (OSHA TWA-5 ppm) at various welding operations. Cr(+6) air concentrations were in excess of the NIOSH-recommended standards, 0.025 mg/m^3 for water soluble and 0.001 mg/m^3 for certain water insoluble forms, at welding operations. Maximum Ni air concentrations were in excess of the NIOSH-recommended standard, 0.015 mg/m^3 for metal and soluble compounds, at welding operations, reactor cleaning operations, kiln cleaning operations, and catalyst cleaning operations. CTPV air concentrations were in excess of the NIOSH-recommended standard, 0.1 mg/m^3, at residual cleaning operations. Recommendations for air monitoring, use of protective clothing and equipment, checking of ventilation rates and directions, and evaluation of work practices are included.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

INTRODUCTION

National Institute for Occupational Safety and Health (NIOSH) is mandated under Section 20(a)(7) of the Occupational Safety and Health Act of 1970 (PL-91-956) to conduct and publish industry-wide studies of the effects of chronic or low level exposures to industrial materials, processes, and stresses on the potential for illness, disease, or loss of functional capability in aging adults.

The purpose of this study is to characterize worker exposure to various chemicals during the turnaround of catalytic cracking units within petroleum refineries. The term "turnaround" implies that the unit is shutdown, taken off line, reconditioned, and returned to operation. To accomplish a turnaround requires the use of a relative large number of workers within a small area and short time period. A paucity of information on exposure of turnaround workers is currently available, unpublished or published. To fill this void and to determine the type and extent of exposure for turnaround workers, NIOSH initiated a study of workers conducting turnarounds of fluid and thermal catalytic cracking units.

DESCRIPTION OF PLANT

The Dorchester Refining Company petroleum refinery is located on a 125 acre site in Northeast Texas at Mt. Pleasant, just off I-30. The original plant was built in 1936 and went on stream in 1937 with a 4000 barrel/day crude unit for processing heavy, asphaltic-base crudes. The present thermal catalytic cracking unit (TCCU) was constructed in 1953 and went on stream in 1954. Since 1954, an alkylation unit, platformer, unifiner, sulfur extraction, and HDS units have been added to compliment the TCCU. In addition, the through-put for the refinery has been increased to 28,000 barrels/day which classifies the refinery as medium in size. The refinery has the capabilities of processing heavy crudes as well as medium light crude. Major products produced are gasoline, Diesel fuel, road oils, light cycle oil, and wood treating oils. The Standard Industrial Classification (SIC) Code for the facility is 2911. The SIC code for the turnaround operation is 1799.

DESCRIPTION OF WORKFORCE

The Dorchester Refinery employs 167 non-administrative personnel. Of these employees, 73 are in the production group and 49 are in maintenance. About 95% of the workforce are males. The maintenance employees work the day shift only, and production employees work one of three daily shifts and are rotated weekly; so every three weeks, three different shifts are worked.

During normal operation of the TCCU, an operator and two assistant operators are used each shift; and, during the turnaround of the TCCU, these operators are used as key supervisory personnel for new employees hired specifically for the turnaround activities. During the actual turnaround a minimum of 30 workers are required, while during some stages of turnaround, as many as 50 workers may be needed. Key personnel and approximate numbers used during the turnaround are 25 pipe fitters and helpers, 15 general laborers, 8 welders, and 2 insulators. Of these workers, about 30 are temporary hires,

some with experience, especially for the turnaround of the TCCU. During the turnaround, two 10-hour shifts for 6 days a week (Sunday off) are worked for about 5 weeks.

PROCESS UNIT DESCIPTION

The TCCU is used to crack distillates into a wide variety of lighter hydrocarbons such as naphthas, gasolines, heating and diesel oils, feed for alkylation unit, and feed for the polymerization unit. For the purpose of this survey the gas condensation unit was considered part of the TCCU. The synthesization tower (syn tower) is a major component of the gas condensation unit. The feed for the TCCU is usually distillate oil from the crude and vacuum stills. A typical boiling range for the feed is 345-480°C.

The TCCU is a stacked unit about 180 feet in height (14 work levels). The major components of the TCCU from the top down are the separator surge, storage bin, reactor, kiln, and lift pot. To the east of the TCCU is the gas condensation unit which includes the syn tower. Normal access to various work levels of the TCCU is by stairway.

The TCCU operates as a continuous flow process. Relatively large catalyst pellets are continuously conveyed from the lift pot to the separator surge. The catalyst pellets are synthetic aluminum/silica and are approximately 0.185 inch in diameter. The catalyst pellets are fed by gravity to the reactor where the catalyst pellets act as a promoter or accelerator of chemical reactions within the distillate feed. The distillate feed is injected at the top of the reactor and flows concurrently with the catalyst pellets through the reactor where the cracking reactions occur. These reactions occur at a temperature of 475-550°C and a pressure of 10-30 psig. The cracked product is separated from the catalyst pellets and sent to the syn tower for distillation.

From the reactor, the separated catalyst pellets, which are now coated with carbonaceous material, are gravity fed to the kiln. At the kiln, the catalyst pellets are regenerated by allowing them to fall through a controlled combustion chamber at a temperature of 675-760°C and a pressure of 15-35 psig, burning off the coating. The catalyst pellets are then separated from the combustion gases and are returned to the separator surge or storage bin at the top of the TCCU via the lift pot, and the continuous flow process operational sequences are repeated. Figure 1A shows the operational units and the feed and product lines for the TCCU and the syn tower.

The TCCU as a continuous flow process operates at relatively high temperatures and pressures. Also, the TCCU utilizes catalyst pellets which are highly abrasive. With these process parameters and the use of a pelletized catalyst, the operational life of a TCCU is only as long as the life of any of its subcomponents. Normally, the operational life of a TCCU is only about 18 months. At that time, the TCCU is shut down, taken off-line, and reconditioned. Within the petroleum refining industry, this major maintenance operation is called a "turnaround".

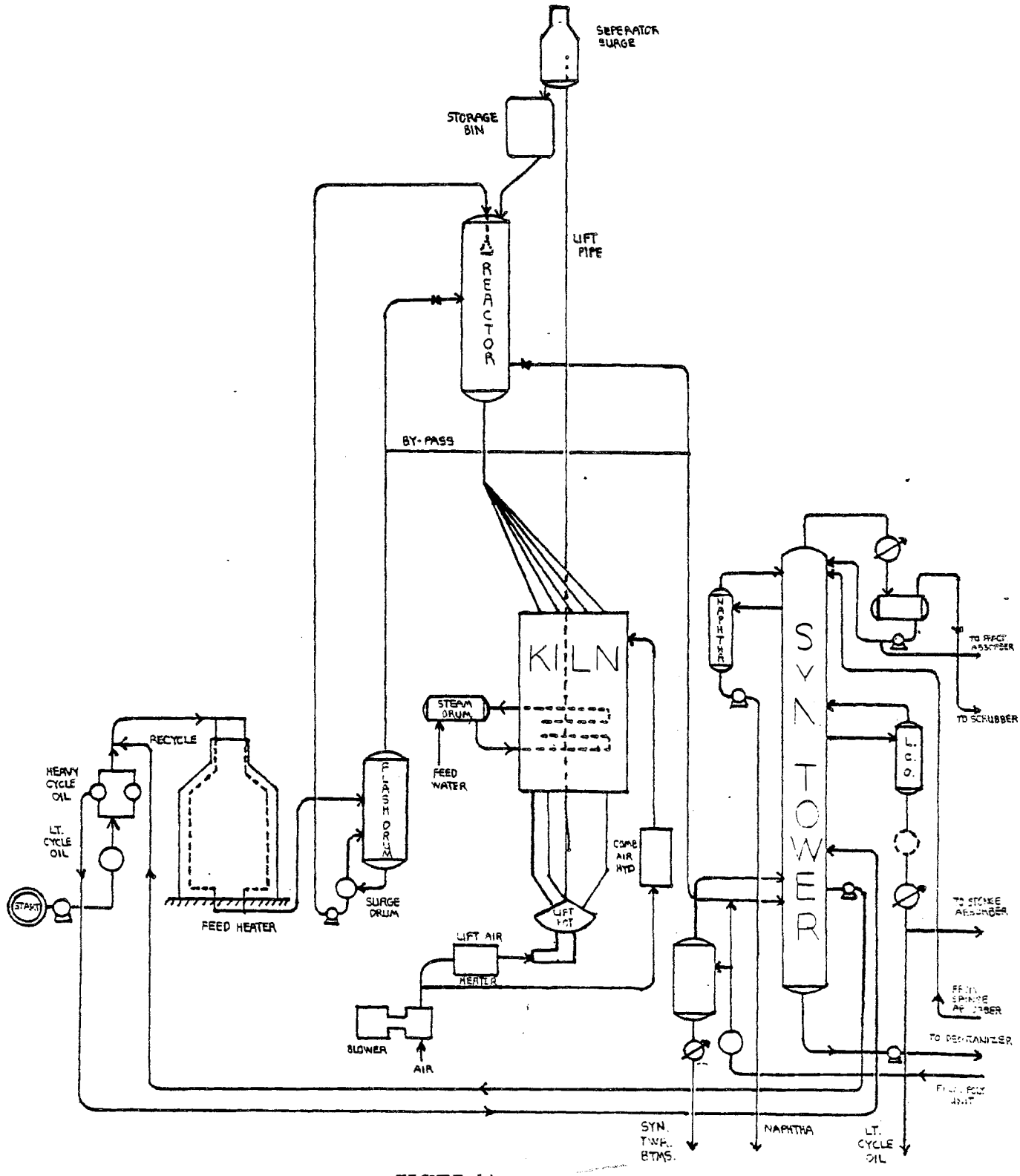


FIGURE 1A
TCCU AREA AT DORCHESTER REFINING COMPANY
ON OCTOBER 5, 1981

TURNAROUND DESCRIPTION

The turnaround of the TCCU consists of three major phases: shut-down, maintenance, and start-up. The shut-down phase is initiated by slowly lowering the operational temperature of the reactor until the catalytic cracking reactions are no longer occurring. The feed and product lines are closed, blinded off, and tagged; and the feed is drained from the TCCU system (see Appendix A for list of blinds). The catalyst pellets are circulated for regeneration purposes and are then stored in the storage bin except for residual catalyst within sub-components. The heating units (e.g., feed heaters, steam drum, and lift-air heater) are shut down, and then steam is circulated through the TCCU system to further reduce the temperature and to strip residual hydrocarbons from the system. Once the light hydrocarbons have been stripped and the system is cool enough, the steam stripping is discontinued. The manways are then opened for additional cooling and for later entry.

As the TCCU system continues to cool, the safety engineer checks to insure that all feed and product lines are closed, blinded off, and tagged. He also inspects each manway measuring temperature, oxygen content, toxic gases and dusts. Once a manway is safe to enter, the safety engineer will tag that manway allowing entry; but this entry may be limited to specific time frames (e.g., the day of the inspection only), including required safety equipment such as respiratory protection equipment, eye protection, gloves, coveralls, and other protective clothing and equipment. Once workers are allowed entry into the TCCU, the maintenance phase of the turnaround begins.

The maintenance phase consist of three general steps: cleaning, removal, and repair/replacement. The catalyst is cleaned out of the separator surge, the reactor, and the kiln. Coke deposits are chipped from the reactor wall and removed. Residual hydrocarbon sludge is removed from the syn tower and other associated columns. Once sub-components have been cleaned, the defective and worn out parts must be replaced; this removal phase requires a substantial amount of hand and pneumatic removal and replacement of nuts and bolts. Also, many sub-component parts must be oxyacetylene or arc cut to be removed. Once sub-component parts have been removed, the replacement parts must be bolted or arc welded in place. Other subcomponents, such as the reactor, may require other repairs. Usually, the gunite insulation (a non-asbestos mineral) on the inside of the reactor wall must be pneumatically chipped out, removed from the reactor, and then replaced by compressed air-spraying of the reactor wall with wet gunite.

The start-up phase is essentially the reverse of the shut-down phase. Blinds are removed, and feed and product lines are reconnected. Manways are closed, and all valves are placed in-line, appropriately on or off. The feed is brought up to temperature, and the unit is brought slowly back on line. At all times the unit is inspected for leaks at flanges, valves, and pumps to insure a minimum of fugitive emissions.

The number of specific items that must be accomplished in a turnaround of a TCCU are numerous. When a turnaround is planned, a "job list" is compiled to facilitate timely completion of the turnaround. Appendix A shows the job list for the TCCU surveyed.

POTENTIAL EXPOSURES AND CONTROLS

During the shut-down of a TCCU, there is the potential for exposure to airborne levels of hydrocarbons including polyaromatic hydrocarbons (PAHs), gases such as carbon monoxide and hydrogen sulfide, and trace metals. Also, there is some potential, as valves are closed and blinds are put in place, for dermal exposure to feed, intermediate, and product petroleum liquids. Workers involved in the shut-down phase are provided respirators, hard hats, safety glasses (and/or goggles), protective gloves, coveralls, safety shoes, and rain suits, if required. In addition, the workers are trained (and usually experienced) in the recognition and correction of safety and health hazards associated with the shut-down of a TCCU. As an adjutant to the shut-down team, the safety engineer or his staff is present during all phases of the shut-down to insure that proper protective clothing and equipment are used and to check for levels of toxic vapors and gases. Although the shut-down phase is fairly short, about 4 days, there is potential for acute and relatively high exposures to toxic vapors and gases and oxygen-deficient atmospheres. The potential hazards are essentially the same for the start-up of a TCCU which requires about 3 days.

The maintenance phase, which lasts for about 4 weeks, presents the greatest potential for chronic exposure to concentrations of dusts, vapors, and gases in excess of allowable limits and recommended standards. The cleaning of the TCCU produces airborne and dermal hazards that include catalyst dust, reactor coke dust, syn tower hydrocarbons, and insulation. Protection from these hazards is the same as described for the shutdown phase. During this phase, large amounts of general dilution ventilation via the manways are used to aid in controlling airborne levels of the dusts and vapors. In addition to these potential chronic exposures, the normal safety hazards associated with maintenance activities are present, e.g., falling tools, trip hazards, and pinch-point hazards.

The removal and repair/replacement of TCCU components presents the same hazards previously described in the maintenance phase and the additional hazards from the arc cutting and welding operations. The hazards associated with arc cutting and welding are intense visible and ultraviolet radiation, noise, welding particles, gases, fumes, and dermal burns from hot metal particles and surfaces. Again the protective clothing, equipment, and ventilation is the same as described in the maintenance phase except for special welding protective equipment such as welding goggles or helmet, leather-head covering, leather jackets, and wool clothing.

The hazards associated with the turnaround of a TCCU are similar to those found in many other industries. However, two inherent conditions potentiate those hazards: 1) most of the turnaround activities are conducted at

heights in excess of 6 feet, as high as 180 feet, and 2) a large percentage of the activities are conducted in confined spaces, especially the cleaning, cutting, and welding operations. These conditions alone greatly increase the risk associated with the hazards described and must be considered in most turnaround activities.

MEDICAL, INDUSTRIAL HYGIENE AND SAFETY PROGRAM

The medical program is administered by the personnel director. Injuries, not requiring a physician, are attended by the safety engineer and/or employees trained in first aid. Other injuries are treated by an on-call physician at Titus County Memorial Hospital which is 1/2 mile from the refinery. Pre-employment and yearly physical examinations are provided for all production and maintenance personnel. The safety and industrial hygiene programs are administered by the safety officer and his assistant. In addition, supervisors are trained in safety and industrial hygiene practices and function as additional personnel within the safety and health programs. Also, in the past, the insurance carrier has provided assistance as requested. Important components of the safety and industrial hygiene programs are eye protection, hearing protection, respirator program, protective equipment program, and confined space entry program. Basically, these programs are designed to meet the requirements of the OSHA Act.

INDUSTRIAL HYGIENE AND ANALYTICAL SAMPLING METHODS

Personal and area air samples were collected to determine the exposure levels of workers during the turnaround of a TCCU. In addition, bulk liquid and solid chemical samples were collected to aid in the identification of chemicals to quantify in the personal and area air samples.

Polynuclear Aromatic Hydrocarbons (PAHs)

PAH air samples were collected per a modification of NIOSH Method P&CAM 217; chromosorb 102 tubes were used as a backup to the silver membrane/glass fiber filters. PAH air and bulk samples were analyzed for cyclohexane, substituted for benzene, solubles per a modification of NIOSH Method P&CAM 217.[1] The cyclohexane solubles assay was evaporated to dryness and reconstituted in pure acetonitrile and analyzed for fluoranthene, pyrene, benz(a)anthracene, chrysene, and benzo(a)pyrene (based on bulk samples and representative air samples) using reverse-phase high-pressure liquid chromatography for separation and identification of chemical compounds. Bulk samples and representative air samples were analyzed for 16 PAHs (acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(c)phenanthene, benz(a)anthracene, chrysene, benzo(e)pyrene, benzo(b) and (a) fluoranthene, benzo(a)pyrene, dibenz(a,h) anthrancene, benz(g,h,i) peryene, and indeno(1,2,3)pyrene; and, the four PAHs above were selected based on those results.

Organic Hydrocarbons (OHs)

OH air samples were collected per NIOSH Method P&CAM 127,[1] which uses charcoal as the collection media. OH air and bulk samples were analyzed according to the NIOSH Method P&CAM 127. The OHs were desorbed from the charcoal or bulk samples with carbon disulfide, and were separated and analyzed by gas chromatography utilizing a flame ionization detector. The samples were analyzed (based on bulk samples and representative air samples) for benzene, toluene, m-xylene and total hydrocarbons as 1,3,5-trimethylbenzene. In addition, general hydrocarbon air levels were measured using Drager^R long-term colorimetric tubes for total hydrocarbons.

Total and Respirable Dusts, Welding Fumes and Trace Metals

Total dust and welding fume samples were collected per NIOSH Method P&CAM 351[1] which uses cellulose acetate membrane filters as the collection media. Respirable dust and welding fume samples were collected for using a cyclone sampler to collect the sample on cellulose acetate membrane filters. Representative air and bulk samples were analyzed per NIOSH Method P&CAM 351 for trace metals by Inductive Coupled Plasma-Atomic Emission Spectrography (ICP-AES) which can identify and quantify a total of 28 metals which include Al, Ba, Cr, Fe, Mn, Ni, P, Pb, and V. Based on the results of the representative air and bulk samples the personal dust and fume samples were analyzed for Al, Fe, Ba, Cr, V and Ni content as well as for total weight. Total weights were determined gravimetrically. Metal contents were determined per NIOSH Method P&CAM 173[1] which uses atomic absorption spectroscopy (AA). Several dust and fume samples were analyzed for hexavalent and trivalent chromium content. The hexavalent chromium collection and analysis was according to NIOSH Method 319 (colorimetric)[1], except cellulose acetate filters were used. After the hexavalent analysis, the filters were washed, ashed, and analyzed by ICP-AES for trivalent chromium.

Carbon Monoxide (CO) and Nitrogen Dioxide (NO_2)

CO and NO_2 air levels were measured using Drager^R long-term (8-hour) colorimetric tubes for those gases, respectively. Low-flow air pumps calibrated at approximately 10 cc/min were used.

HEALTH EFFECTS AND RELEVANT EXPOSURE CRITERIA

The Occupational Safety and Health (OSHA) Permissible Exposure Limits (PELs), the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values^R (TLVs), and the NIOSH-recommended standards for the important chemical exposures (see Results and Discussion of Results) are listed in Table 1.1. Comprehensive health hazard information, toxicologic data, and recommendations for personal protective equipment, first aid procedures, and medical surveillance can be found in the NIOSH Occupational Health Guidelines,[2] Registry of Toxic Effects of Chemical Substances[3] (RTECS), ACGIH TLV Documentation,[4] OSHA/NIOSH Pocket Guide,[5] and occupational health references for the specific chemicals identified in this survey.

TABLE 1.1: APPLICABLE OCCUPATIONAL EXPOSURE CRITERIA
AS OF OCTOBER, 1984

CHEMICAL AGENT**	ACGIH TLV[R] TWA[6] (mg/m^3)	NIOSH RECOMMENDED STANDARD-TWA+[5] (mg/m^3)	OSHA STANDARD PEL[5] (mg/m^3)
Al (Welding Fume)	5	-	-
Al (Metal + Oxide)	10	-	-
Ba (Soluble Compounds)	0.5	-	0.5
CO - Carbon Monoxide	55 (50 ppm)	32 (35 ppm)	55 (50 ppm)
Cr (Metal as Cr)	0.5	-	1
Cr + 3 (Compounds as Cr)	0.5	-	1
Cr + 6 (Compounds as Cr)			
Water Soluble	0.05	0.025; 0.05++	-
Certain Water Insoluble	0.05*	0.001*,++	1
CTPV (Benzene Soluble)	0.2*	0.1*	-
Fe (Oxide Fume)	5	-	10
Mn (Fume)	1	-	5 Ceiling
Ni (Metal)	1	0.015	1
Ni (Soluble Compounds)	0.1*	0.015	1
NO_2	5.4 (3 ppm)	1.8++ (1 ppm)	9 (5 ppm)
Nuisance Dust			
Total	10	-	10
Respirable	5	-	5
P (Yellow)	0.1	-	0.1
Pb (Inorganic, Dusts & Fumes)	0.15	0.05	0.05
V (Pentoxide as V)			
Fume	0.05	0.05 ++	0.1 ++
Dust	0.05	0.05 ++	0.5 ++
Welding Fumes (Total)	5	-	5

* Human Carcinogen
** See Appendix B, Table 1A for abbreviations except as noted otherwise.
\+ 10 hour
++ Ceiling Concentration

RESULTS AND DISCUSSION OF RESULTS

All chemical exposure data collected during this survey are presented in Appendix B. The Key to Table 1B, Table 1A, lists the abbreviations for the type of chemical exposure, the job code for the major work operations, and the column heading codes. In Appendix C, a portion of the exposure data in Appendix B is presented in tables which divide the data by major operation and type of chemical exposure. Although over 1100 chemical exposures are presented in Appendix B, only about 640 are presented in Appendix C; chemical exposures that were low or non-detectable or few in number are not summarized. All ventilation data are presented in Appendix D.

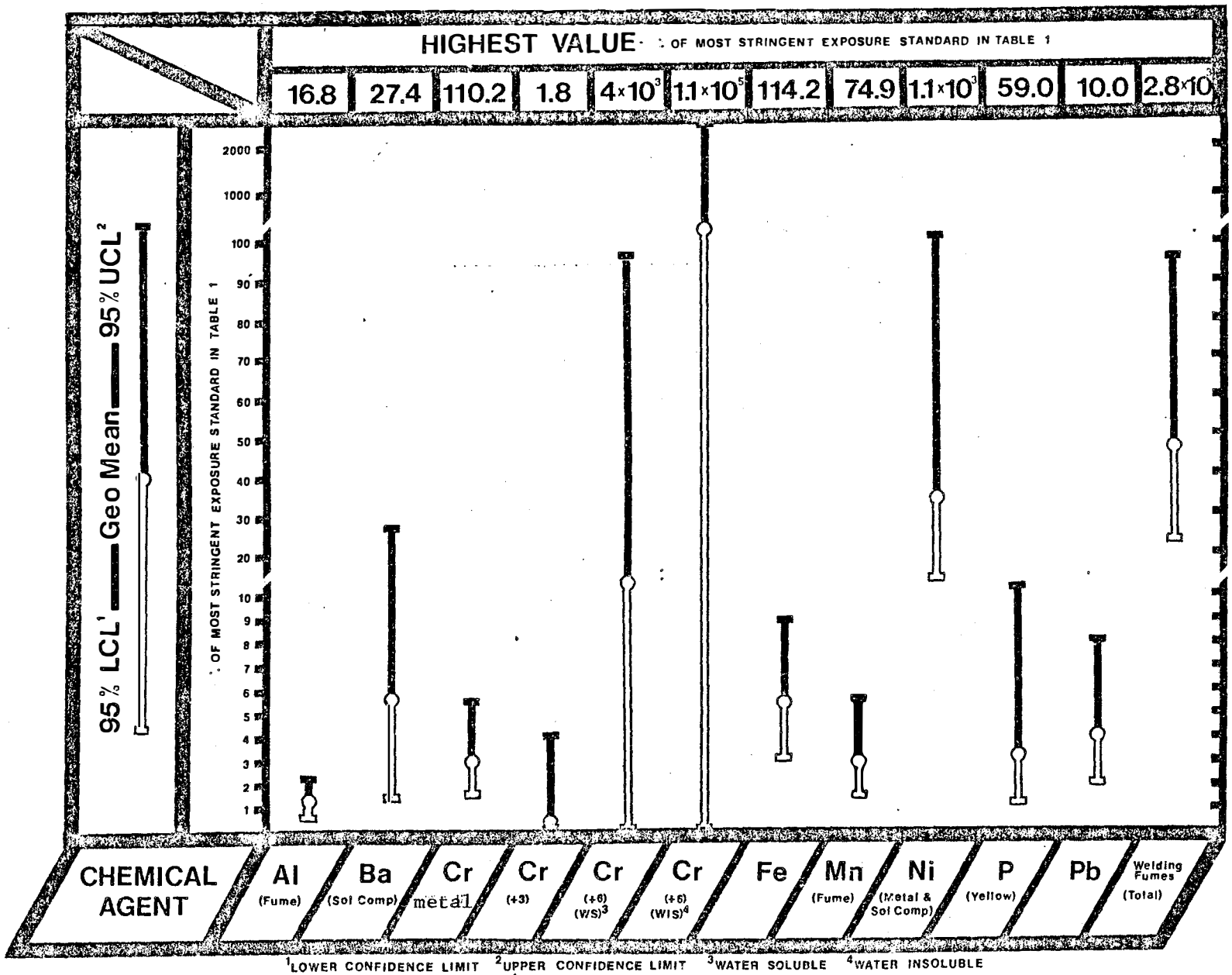
Only important chemical exposures will be discussed in this section. The criteria for selection of these important chemical exposures were: 1) that the chemical exposures were associated with major turnaround activities (See Table 1A), and 2) that the maximum chemical exposures were greater than 10% of the most stringent applicable exposure standard (see Table 1.1).

During this survey, of the gases sampled (CO and NO_2), only NO_2 exposure levels were important. Those exposure levels ranged from 10.0 ppm to 321.1 ppm with a geometric mean of 35.2 ppm at various welding operations (see Table 45, Appendix C). These exposures were characterized with grab samples collected at various welding operations and are not TWAs. However, NIOSH recommends an allowable exposure level of only 0.1 ppm ceiling for 15 minutes. These exposures are indicative that exposures for 15 minutes are likely in excess of the NIOSH-recommended standard.

The remaining important chemical exposures are presented in Figures 1, 2, 3, 4, and 5. These figures are based on per cent (%) of most stringent exposure standard (see Table 1.1). The lower horizontal axis, Chemical Agent, identifies the type of chemical exposure. The vertical axis identifies three important statistical parameters geometric mean, 95% lower confidence limit, and 95% upper confidence limit for each type of chemical exposure. The upper horizontal axis presents the maximum value for each type chemical exposure. For every axis, vertical and horizontal, the exposure levels are in % of most stringent applicable standard, not in ppm or mg/m3. Also, note that the vertical scale is not a continuous scale, but usually has separate scales of 1-10, 10-100, and 100-2000. In addition, for Cr(+6), it is assumed that all of the Cr(+6) is Cr(+6,WS) to compare against the WS standards, or that all the Cr(+6) is Cr(+6, WIS) to compare against the WIS standards.

Figure 1 presents important chemical exposures at welding operations. Note only Cr (metal as Cr), Cr (+6, WS), Cr (+6, WIS), Fe, Ni, and welding fumes have maximum exposure levels in excess of 100% of the applicable standard. Of these only Cr (+6, WIS) has a geometric mean in excess of 100% of the applicable standard. When evaluating these exposure levels, there are four important points that must be considered. One, the welders were provided respirators (TC-21C-202) which protected against welding fume exposures. Two, several of the maximum exposure levels could be in excess of the protection factor provided by those respirators. For Cr (+6, WS), Cr (+6, WIS), Ni, and welding fumes, maximum exposure levels were in excess of 1000 times the most stringent applicable exposure standard. Three, many of these metals have

Figure 1. **Important Chemical Exposure at Welding Operations During the Turnaround of a TCCU.**



additive and/or synergistic effects on human health. Four, although only air levels were measured, some of these metals (e.g., Ni and Cr) can effect human health via the dermal exposure route.

Figure 2 presents the important chemical exposures during the cleaning of the TCCU reactor. These important chemical exposures are Al, Ba, Cr (Metal), Fe, Ni, and Nuisance Dust (Total). All of these, except Cr (Metal), have maximum exposure levels in excess of 100% of the applicable exposure standard. The highest is Nuisance Dust (Total) with a maximum exposure level of 34 times the applicable exposure standard. The highest geometric mean is about 50% of the applicable exposure standard for Nuisance Dust. These workers were provided NIOSH-approved respirators for toxic-dust (TC-21C-202) which should protect against these exposures when properly used. However, dermal exposure must also be considered and protected against, especially dermal exposure to Ni and Cr.

Figure 3 presents the important chemical exposures during cleaning of the TCCU kiln. These important chemical exposures are Al, Ba, Cr (Metal), Fe, Ni, V, and Nuisance Dust (Total). All of these, except Cr (Metal) and Fe, have maximum exposure levels in excess of 100% of the applicable exposure standard. The highest is Al with a maximum exposure level of 15 times the applicable exposure standard. The highest geometric mean is about 60% of the applicable exposure standard for Nuisance Dust (Total). These workers were provided NIOSH-approved toxic-dust respirators (TC-21C-202) which should protect against these exposures when properly used. In addition, the dermal route of exposure must be protected against, especially for Ni.

Figure 4 presents the important chemical exposures during catalyst cleaning operations in and around the TCCU. These important chemical exposures are Al, Ba, Cr (Metal), Fe, Ni, and Nuisance Dust (Respirable and Total). All of these, except Cr (Metal), have maximum exposure levels in excess of 100% of the applicable exposure standard. The highest is Nuisance Dust (Total) with a maximum exposure level of 31 times the applicable exposure standard. The highest geometric mean is about 100% of the applicable exposure standard for Nuisance Dust (Total). The workers involved with catalyst cleanup operations were provided with NIOSH-approved toxic-dust respirators (TC-21C-202) which should protect against these exposures when properly used. In addition, the dermal route of exposure must be protected against, especially for Ni.

Figure 5 presents Coal Tar Pitch Voltile (CTPV) exposure levels for several turnaround operations: shutdown, residual cleaning, and welding operations. Only the maximum exposure level for the residual cleaning operations (245%) was greater than 100% of the applicable exposure standard. The residual cleaning operation geometric mean exposure level was also slightly above 100% of the applicable exposure standard. These workers were provided NIOSH-approved organic-vapor/toxic-dust respirators (TC-21C-202) which should protect against these exposures. However, these workers were also exposed, by respiratory and dermal routes, to other organic chemicals (see Appendix B) and toxic metals (see Figure 1); therefore, additive and/or synergistic effects on human health must be considered. These workers were also provided goggles, coveralls, rubber boots, and gloves to protect against dermal exposure to CTPV. Although personal protective equipment was provided to protect against

Figure 2. Important Chemical Exposure at Reactor Cleaning Operations During the Turnaround of a TCCU.

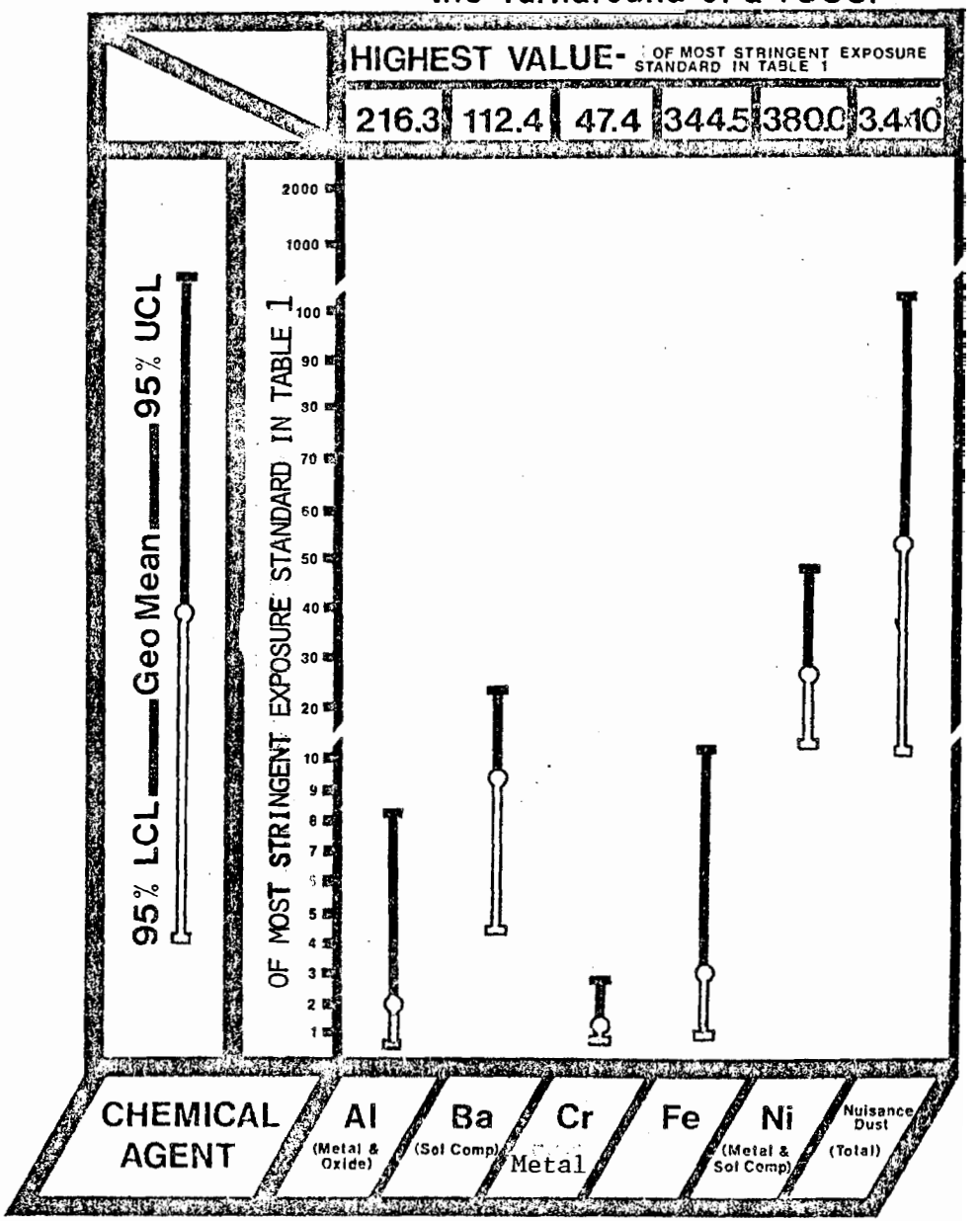


Figure 3. Important Chemical Exposure at Kiln Cleaning Operations During the Turnaround of a TCCU.

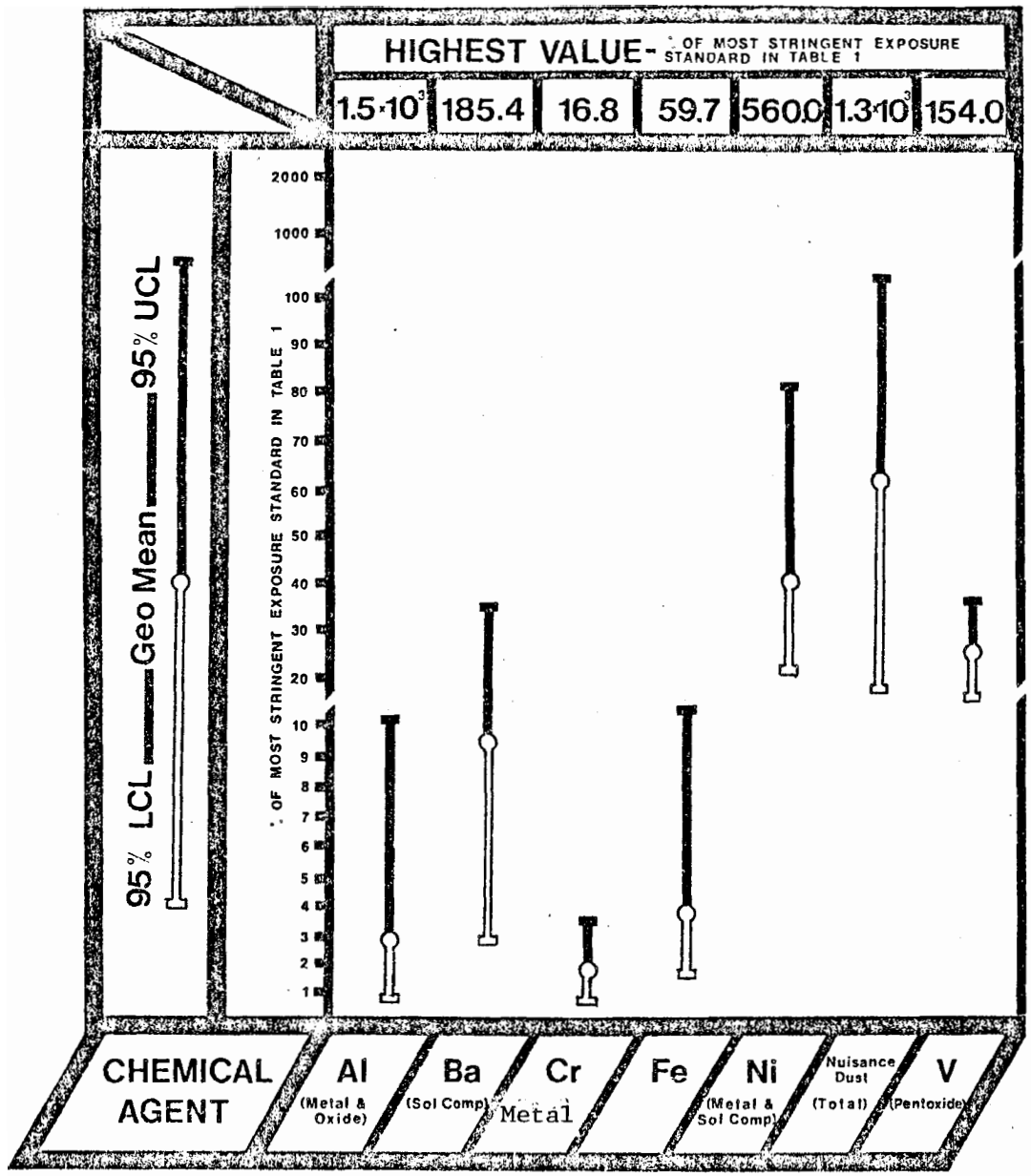


Figure 4. Important Chemical Exposure at Catalyst Cleaning Operations During the Turnaround of a TCCU.

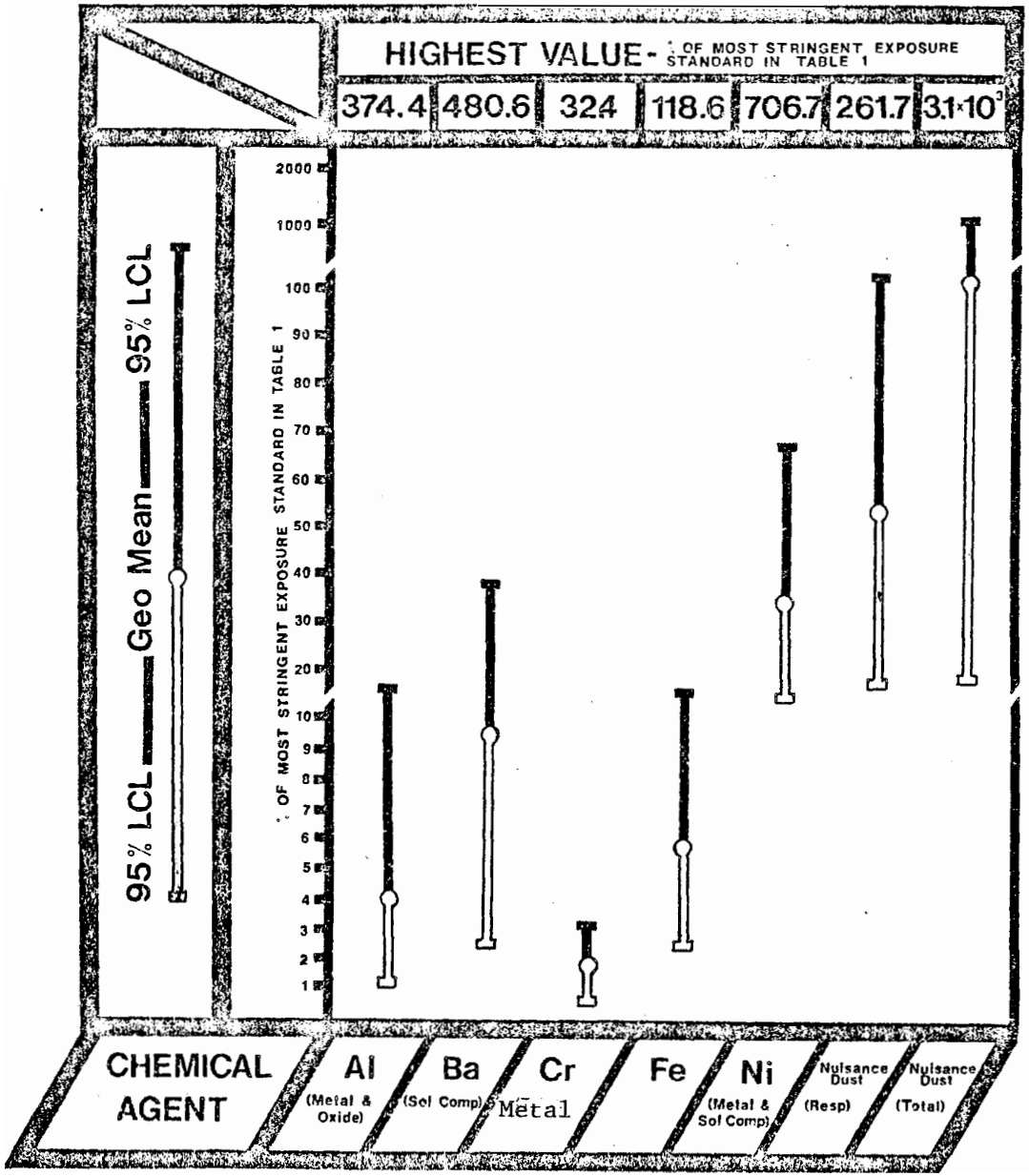
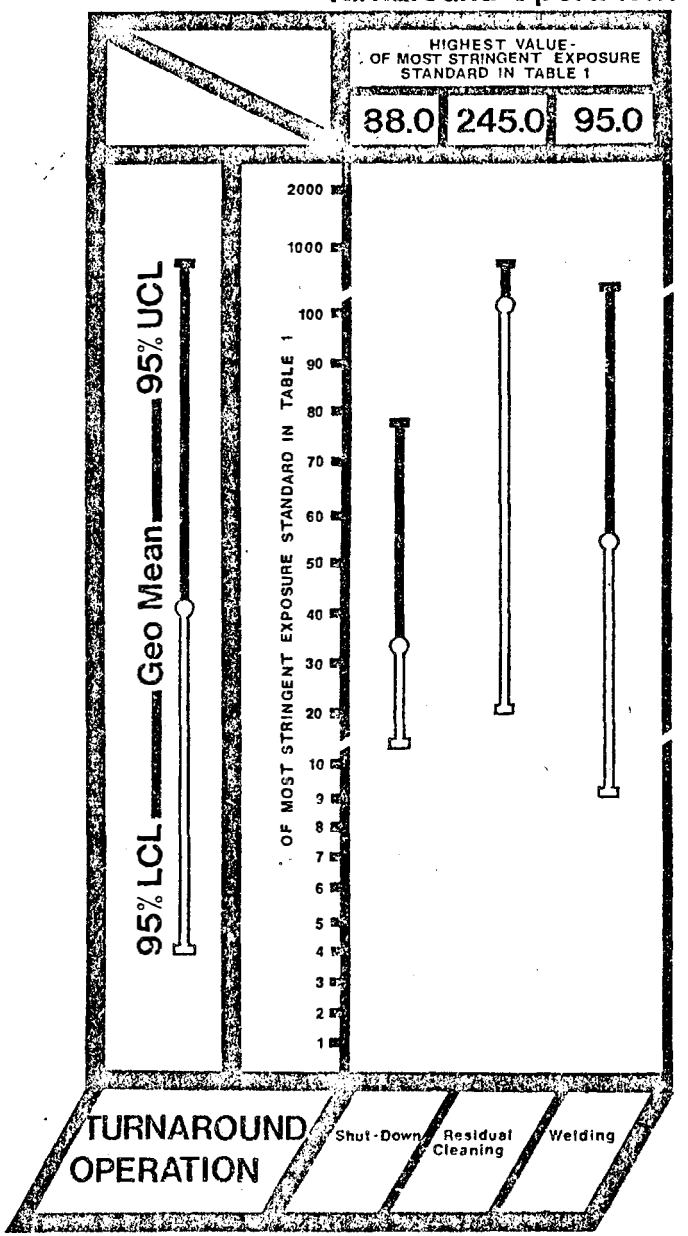


Figure 5. CTPV Exposure at Several TCCU Turnaround Operations



the dermal route of exposure, from observation of the workers' skin there still seemed to be a large amount of dermal exposure during the residual cleaning operation. Of the 16 PAHs identified in bulk samples, all are tumorigenic, many of which are listed as positive animal carcinogens [benz(a)anthracene, benzo(b)fluoranthene, chrysene, benzo(a)pyrene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene] in the 1983 RTECS.[3] The 1983 ACGIH TLV Booklet[6] lists benzo(a)pyrene and chrysene as suspected human carcinogens with no allowable exposure limit recommended. Therefore, it is very important that both the respiratory and dermal routes of exposure for PAHs be addressed to assure adequate worker protection.

Cr(+3), Cr(+6, WS) and Cr(+6, WIS) exposure levels are only presented in Figure 1 for the welding operations. Even for these welding operations, only a few Cr(+3)/Cr(+6) analysis were performed, and then the actual water soluble (WS) or water insoluble fraction (WIS) of Cr(+6) was not determined. The reason for only a few Cr(+3)/Cr(+6) analysis is that it is the only analysis that can be conducted on that filter sample. The Cr(+3)/Cr(+6) analysis destroys the filter, and no additional analysis (i.e., other metals) can be performed. To be on the conservative side of worker health, it was assumed that Cr(+6) could be 100% WIS. However, the major point is that, for the limited Cr(+3)/Cr(+6) analysis performed, Cr(+6) was about 75% of those samples. Since the NIOSH-recommended standard for Cr(+6, WIS) is 0.001 mg/m^3, Cr (Metal) exposure level for welding operations in excess of 0.0013 mg/m^3 should be suspected of exceeding the NIOSH-recommended standard for Cr(+6, WIS). The same analogy should also be applied to all of TCCU turnaround operations which have Cr (Metal) exposures. Since the Cr (Metal) only has to only be greater than 0.2% of its most stringent applicable exposure standard to be suspected of containing Cr(+6, WIS) in excess of its standard (0.001 mg/m^3); Cr (Total), and therefore Cr(+6, WIS), is the most critical exposure in the welding, reactor cleaning, kiln cleaning, and catalyst cleaning operations. In fact, the Cr(+6, WIS) exposures have the potential to be so high that the protection factor of the toxic-dust respirators (TC-21C-202) provided may not adequately protect the worker.

In all except two cases, the ventilation rates ranged from 150-1050 fpm. In the lower part of the kiln called the chicken coop, the ventilation rates were 20 and 45 fpm, respectively (see Appendix D). In addition, in several instances the direction of the air flow was wrong. For example in the syn tower, the workers clean out the bottom of the tower first. During this cleaning phase, the air should enter the top of the tower and exit out the bottom since the air movement will be from low concentration area to high concentration area. After the bottom is cleaned, the worker then cleans out the overhead plates; during this phase the air should enter the bottom of tower and exit out the top. This method should allow for the least concentration of organic vapors in the breathing zone of the workers.

CONCLUSIONS

- Cr(+6) is the most hazardous exposure in the welding operations, reactor cleaning, kiln cleaning, and catalyst cleaning for these reasons:

1) Analytical results indicates that about 75% of the total Cr is Cr(+6) which can contain certain Cr compounds that are recognized human carcinogens.

2) In the welding operations many exposures were greatly in excess of the protection factor provided by the respirators used, as were the exposures, to a lesser extent, for the other operations.

- Ni is the second most hazardous exposure because of excessive exposure levels (See Figure 1-4), its potential as a carcinogen, and the dual exposure routes of respiratory and dermal.

- Coal Tar Pitch Volatiles (CTPV) is also an exposure of concern for the residual cleaning since there were excessive exposures (See Figure 5) and, it is a recognized human carcinogen with dual routes of exposure, respiratory and dermal.

- NO_2 exposures are excessive in some welding operations (See Table 45, Appendix C).

- In some cases, the ventilation provided was inadequate (See Appendix D).

- Because of the large number of different chemical agents present in the turnaround work environment, the potential for additive and synergistic effects must be considered.

RECOMMENDATIONS

Personal breathing zones of the workers at the welding, reactor cleaning, kiln cleaning, and catalyst cleaning operation should be monitored and analyzed for Nuisance Dust (Total), Cr (Metal), and Ni. A small percentage of these samples (10%) should be selected for Cr(+3)/Cr(+6) analysis to determine the Cr(+6) content of the Cr (Total). These Cr(+6) percentages should be used to estimate the Cr(+6) content in the remaining samples.

For those welding, reactor cleaning, kiln cleaning, and catalyst cleaning, operations (and any others identified) in which the toxic-dust respirator will not provide adequate protection factor, air-supplied respirators should be used. Quantitative fit tests should be used to assure the adequacy of all respirators being used. When considering the adequacy of the respirator protection factor, consider the additive and/or synergistic effects of the dermal exposures.

The proper protective clothing and equipment must be used to protect against dermal exposures, especially Ni, Cr, and CTPV since they are recognized human carcinogens with dual routes of exposure, dermal and respiratory.

Ventilation rates and directions should be periodically checked to assure proper direction and at least a flow rate of 100 fpm.

Work practices should be evaluated from an occupational safety and health standpoint to reduce length and level of exposure to toxic dusts, vapors, and gases.

REFERENCES

1. NIOSH Manual of Analytical Methods, Volume 1-7, USDHHS, PHS, CDC, NIOSH, DPSE, 1977-1981.

2. Occupational Diseases - A Guide to Their Recognition, USDHEW, PHS, CDC, NIOSH [DHEW(NIOSH) Publication No. 77-181], June 1977.

3. RTECS - Registry of Toxic Effects of Chemical Substances, 1981-82, Volume 1-3, USDHHS, PHS, CDC, NIOSH, DHHS (NIOSH) Publication No. 83-107, June 1983.

4. Documentation of the Threshold Limit Values for Substances in Workroom Air with Supplement for those Substances Added or Changed Since 1971, ACGIH, 3rd edition, 1974.

5. NIOSH/OSHA Pocket Guide to Chemical Hazards, USDHHS, PHS, CDC, NIOSH and USDOL, OSHA, DHEW (NIOSH) Publication No. 78-210, September 1978.

6. TLVs^{R} - Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment with Intended Changes for 1983-84, ACGIH, 1983.

APPENDIX A

Blinds and Job List

BLINDS IN TCCU TURNAROUND

1. Reactor vapor inlet.
2. Reactor vapor outlet.
3. 10" blowdown line south of #1 H.O. heater.
4. 2" alky feed line on debutanizer orifice.
5. 2" and 3" gasoline lines at cooler.
6. Two 3" light cycle lines at pumps.
7. 1 1/2" gas line at 12" inlet line to flash drum.
8. Crude unit gas line (4") at overhead receiver.
9. Stabilizer and dryer line at low stage discharge cooler.
10. Recycle line to and from alky debutanizer.
11. Gas line at feed heater control valve.
12. Gas line at lift air heater two-way valve.
13. Gas line at comb. air heater two-way valve.
14. STB stripper at pop valve on syn tower.
15. 3" gas line to syn tower overhead receiver.
16. Fract. absorber fuel gas line at 4" valves - 2 blinds.
17. 2" and 3" lines on debutanizer overhead receiver to fuel gas.
18. High stage suction scrubber pop valve and 2" bypass line.
19. 8" flare line at butterfly valve on low stage suction scrubber and 6" bypass valve.
20. Flare line compressor pop valves at 6" valve.
21. 2" gas line from unifiner stabilizer at overhead receiver at syn tower (2" union).
22. Recycle gasoline at the outlet of gasoline cooler.
23. Gas line 2" flange to feed pre-heater.

TCCU TURNAROUND JOB LIST

SEPARATOR SURGE

1. Open, clean, and inspect the separator surge. Cover the outlet nozzle so nothing could fall into seal leg.
2. Renew shroud if required.
3. Check the catalyst gauge cable. Renew pipe that cable goes through.
4. Repair the outlet nozzle and expansion sleeve if needed.
5. Repair catalyst deflector as required.
6. Replace all catalyst deflector plates after repairing back-up plate if needed.
7. Rig up to inspect lift pipe.
8. Check perforated plate and balance of deflector and repair as required.
9. Clean out elutriator lines from separator surge to lift pot.
10. Make "wipe test" on radium tubes to check for leaking radioactivity.
11. Check the separator surge vent line.
12. Remove plugs on catalyst elutriator lines at wish bone and install flanges.

TOP OF REACTOR

1. Remove the inlet catalyst valve and renew perforated plate lining in the reactor catalyst inlet nozzle.
2. Repair catalyst valve.
3. Pull liquid feed nozzle and repair as required and repack if needed.
4. Check gunite lining in top of reactor.
5. Check internal catalyst valve.
6. Repair catalyst "curtain" baffle as needed.

REACTOR

1. Overhaul the 2-way liquid feed valve (H1C5).
2. Clean coke out of reactor.
3. Rattle vapor line from flash drum to reactor.
4. Clean out bottom of reactor.
5. Check lining in reactor, especially at the grid level.
6. Clean steam drum and holes in blowdown line.
7. Remove valve at bottom of reactor and extend line to ground. Block off kiln.
8. Remove spool at reactor vapor outlet; inspect valve and repair as required to put in first class condition.
9. Overhaul the boiler feed control valve at steam drum.
10. Install grating on top of grids.
11. Renew catalyst inlet nozzle liner if needed.
12. Check top seal flow orifice.
13. Clean the level control on steam drum.
14. Replace all 44 catalyst draw-off pipes in bottom of reactor.
15. Check the 2" valve on bottom of steam drum on the blowdown line.
16. Free up the 2" valve on bottom of steel drum on the blowdown line.
17. Pull all the valves on the level control for the steam drum (4 valves).
18. Replace the boiler feed waster line to the steam drum (from pump, up the structure, and to the steam drum).
19. Renew decking at the steam drum deck.

KILN

1. Clean completely.
2. Check piping from reactor bottom to kiln.
3. Put sleeves in catalyst pipes in distributor boxes as needed.

4. Repair welds on distributor box covers if required and outer walls.

5. Make repairs to brickwork.

6. Inspect and repair castings as necessary.

7. Renew burned air pipes as needed.

8. Renew all steam coils and then pressure test.

9. Replace the protective covers on top row of coils.

10. Repair flashing and insulation around coils.

11. Replace and repair thermowells as required.

12. Replace eroded 3" pipes in bottom of kiln as necessary.

13. Check sections of 8" pipe between kiln and lift pot.

14. Inspect the lift air valve and secondary air valve. Pull and clean valves.

15. Repair outer shell lining, especially around hot spots.

16. Repack valves on steam coils as marked.

FLASH DRUM

1. Open, inspect, clean, and reinspect flash drums. Clean gauge glass.

2. Inspect tower bottoms pumps.

3. Clean and inspect vapor line from flash drum to reactor.

4. Clean and inspect mud drum and lines.

5. Clean liquid feed line from bottom to top and open orifice tap.

6. Check outlet piping from flash drums to pumps.

7. Repack all (3) 1/2" valves on superheated steam orifice to flash drum.

8. Check and repair all valves on the liquid feed system.

9. Repair main control valve on liquid feed line to reactor, also repair bypass valve.

LIFT PIPE

1. Inspect the lift pipe and repair as required.

2. Inspect catalyst bell.

3. Clean and renew, if needed, the screen on blower section.

FURNANCE AREA

1. Inspect the furnance tubes, pull plugs on convection to roof tube crossover, pull plugs about middle of roof tubes, pull plugs on roof tube to floor tube crossovers and pull plug on floor tubes.

2. Inspect the vapor line from furnance to flash drum.

3. Make repairs to brickwork in heater as needed.

4. Repair tubes as required.

5. Clean burners in pre-heater and main heater.

6. Clean the fireman control valves on main heater and pre-heater.

7. Check out the flow controllers on north and south side of heater.

8. Free up gas valves to lift air heater and comb heater (will not shut off when you have power failure).

9. Renew gas valves to burners on feed heater as tagged.

GROUND LEVEL EXCHANGER AND PUMP AREA

1. Clean all heater exchangers in this area.

2. Repack all valves and renew flange gaskets as needed.

3. Repack valves and renew flange gaskets and plugs as marked.

4. Check the three blowers to see if they are in shape for continuous service through next run.

5. Overhaul the debutanizer reboiler control valves.

6. Check the debutanizer reflux pumps (case).

OVERHEAD CONDENSER DECK

1. Clean overhead condensers.

2. Bypass boiler blowdown to feed water exchanger and install valve to catch sample.

3. Install new bundle in steam generator or clean.

SYN TOWER

1. Check the vapor line from reactor to syn tower.

2. Open, clean and inspect the syn tower; clean bottom gage glass; inspect all trays.

3. Clean fines suction line and strainer.

4. Inspect and clean syn tower bottoms from tower to quench point including debutanizer reboiler.

5. Clean and inspect syn tower bottoms stripper.

6. Open and inspect the fines settling drum.

7. Change gaskets and fix leaky joints as marked.

8. Repack valves and renew gaskets as marked.

9. Clean the trays and inspect the LCO stripper.

10. Install new control valve (if needed) on syn tower bottom quench line.

11. Replace the valves on the level alarms on the syn tower O.H. reliever.

12. Clean level control on bottom of syn tower.

13. Clean gauge glass on syn tower mid-section.

14. Install block valve at syn tower on the liquid feed bypass line from reactor to syn tower.

GAS CON AREA

1. Clean and test the following coolers:

   (a) Debutanizer overhead condenser.
   (b) High stage discharge cooler.
   (c) Low stage discharge cooler.
   (d) Absorber intercoolers.
   (e) Jacket water cooler.
   (f) Gasoline cooler.
   (g) Lt. cycle oil cooler.
   (h) New stripper O.H. condenser.

2. Clean and inspect the debutanizer reboiler; pull bundle.

3. Inspect the absorber reboiler. Check bundle for possible retubing.

4. Inspect the fract. absorber and debutanizer.

5. Check all syn tower bottoms piping to debutanizer reboiler.

6. Clean highlevel alarm and the level control on highstage suction scrubber.

7. Check all valves on the debutanizer O.H. receiver and clean out all the lines.

8. Clean the level alarms on low-stage suction drum.

9. Replace the valves on the high-level alarm on the ABS. K.O. vessel, gas to fuel.

10. Swap orifice plates in both top and bottom lines to the absorber.

11. Replace the two 1/2" valves on the gaosline treatment line that goes to the DEB. reflux pump suction. Install 1/2" check valve in line.

12. Replace 2" valve on steam line from main stream line, above and at the north end of crk. napt. cooler; steam will have to be off main line.

13. Replace metal plates in the bottom of crk. napt. fans.

14. Install lines and/or valves to convey TCCU gasoline to syn tower overhead receiver.

COMPRESSOR BUILDING

1. Back flush all water jackets on all compressors.

2. Make necessary repairs on compressors that have not been made prior to shutdown.

3. Clean and inspect engine jacket water cooler.

4. Clean and inspect oil cooler; renew valves on water side.

5. Check out, clean, and repair as necessary, the 500 H.P. motors on the compressor.

6. Clean out the 2" line from low-stage suction drum to blow case.

MISCELLANEOUS

1. Open combustion air heater and lift air heater and make required repairs. Clean out the pilot lights and burners on both heaters.

2. Remove all relief valves and send to outside shop for repairs.

3. Install and remove blinds as required throughout the unit as marked.

4. Check all differential pressure tap holes.

5. Make necessary repairs and check on instruments.

6. Check all pumps - this should be done before shutdown where there is a spare. Check LCO pumps.

7. Check out the interlock system.

8. Open pipes and vessels as necessary to permit inspection. Check pipe and vessel thickness with Audigages.

9. Do work as required by Hartford inspector.

10. Install 2" steel valve on superheated steam line to vapor line.

11. Check out relays, etc., in electrical control house.

12. Check out the blower and sent blower motor off.

13. Renew the 1" steam valve on main steamline to the sump pump at elevator. Steam will have to be off main line.

14. Sewer system has to be cleaned out before Saturday the 3rd of October.

15. Clean the fins on the cracked naphtha air coolers.

16. Renew steam trap manifold at the liquid feed deck.

17. Renew the 2" nipple and valve on end of main steam line at cat. elevator. Weld nipple and valve.

18. Replace 3/4" nipple on blower oil cooler, south side of blower.

APPENDIX B

COMPUTER LISTING OF CHEMICAL EXPOSURES, REAGENT CODES, JOB CODES, AND ABBREVIATIONS

TABLE 1A: KEY FOR COMPUTER PRINTOUT

REAGENT CODES	JOB CODES	ABBREVIATIONS
AG - Silver	CFD - Cleaning Flash Drum	A - Units for ANR
AL - Aluminum	CSO - Shaker Operator (Catalyst Cleaning)	ANR - Analytical Results
AS - Arsenic	CSS - Catalyst Clean-up S/S	C - Units for REC
BA - Barium	DCO - Debutanizer (Cleaning Operation)	JOB - Job Code
		MAN - Man Code
BE - Beryllium	FAC - Factionator/Absorber cleaning	OBS - Observation Number
BP - Benzo(a)pyrene	ISR - Insulation Removal and Replacement	REC - Concentration Results (Not TWA)
BZ - Benzene	KBR - Kiln Brick Removal	REG - Reagent Code
B2 - Benz(a)anthracene	KCO - Kiln Cleaning Operation	VOL - Volume Air Sampled
CA - Calcium	KRO - Kiln Rattling Operation	
CD - Cadium	OPA - Operator (Assistant)	
CH - Cyclohexane Solubles	OPU - Operator (Unit)	
CO - Cobalt	RCO - Reactor Cleaning Operation	
CR - Chromium (total)	RPR - Reactor Pipe Removal	
CU - Copper	SDO - Shut Down Operation	
CY - Chrysene	STC - Syn Tower Cleaning	
C3 - Chromium (+3)	WHS - Welder Helper S/S	
C6 - Chromium (+6)	WLP - Welding Lift Pipe	
F4 - Fluoranthene	WOK - Welding Operation Kiln	
FE - Iron	WOO - Welding Operation Outside	
HC - Hydrocarbons	WOR - Welding Operation Reactor	
LI - Lithium	WSI - Welding Shop Inside	
ME - Magnesium	WSO - Welding (Shed/Outdoors)	
MG - Manganese	WSS - Welding Seperator Surge S/S	
MO - Molybdemum	WST - Welding Syn Tower	
NA - Sodium		
NI - Nickel		
P - Phosphorus		
PB - Lead		
PT - Platinium		
PY - Pyrene		
RW - Respirable Dusts and Fumes		
SE - Selenium		
SN - Tin		
TE - Tellurium		
TI - Titanium		
TL - Thallium		
TO - Toluene		
TW - Total Dusts and Fumes		
V - Vanadium		
XY - Xylene		
Y - Yttrium		
ZN - Zinc		
Zr - Zirconium		

TABLE 1B. TURNAROUND WORKER EXPOSURES
AT DORCHESTER REFINING COMPANY
ON SEPTEMBER 15-OCTOBER 5, 1981

OBS	SAMPLE	REG	MAN	TIME	ANR	CVOL	REC	A	C	JOB
1	5737	AG	A01021	290	1	481.85	0.001	2	1	WOR
2	5855	AG	88A221	575	1	959.13	0.001	2	1	WSS
3	5835	AG	W05181	592	1	925.54	0.001	2	1	WSO
4	5774R	AG	W05301	300	1	506.26	0.001	2	1	WOR
5	5723	AG	W07301	393	1	663.19	0.001	2	1	WOO
6	5747R	AG	W08021	140	1	236.25	0.002	2	1	WLP
7	5763	AL	A01021	195	15	324.00	0.023	2	1	WOR
8	5737	AL	A01021	290	16	481.85	0.033	2	1	WOR
9	5843	AL	A01241	572	4	957.29	0.004	2	1	RCO
10	5786	AL	H01211	570	3100	960.65	3.227	2	1	RCO
11	5779	AL	H05211	576	5300	970.76	5.460	2	1	RCO
12	1268	AL	H05251	430	171	382.48	0.044	2	1	KBR
13	5834	AL	H06171	123	88	208.78	421.489	3	1	CSS
14	1619	AL	H06291	599	160	1004.94	0.159	2	1	CFD
15	5830	AL	H07261	553	75	950.90	0.079	2	1	RCO
16	1613	AL	H07291	310	10	520.09	0.019	2	1	CSS
17	1277R	AL	H07301	158	10	266.63	0.019	2	1	CFD
18	5826	AL	H09181	634	4800	991.20	4.843	2	1	CSO
19	5895R	AL	H09191	625	450	1029.53	0.437	2	1	CSO
20	5863	AL	H09221	583	3200	972.48	3.291	2	1	RCO
21	2942	AL	H09231	317	25	530.09	0.047	2	1	RCO
22	5857	AL	H09231	275	580	459.86	1.261	2	1	RCO
23	5946	AL	H09241	579	1000	969.01	1.032	2	1	RCO
24	1614R	AL	H09251	583	10	979.52	0.005	2	1	RCO
25	5796	AL	H09261	579	15	995.61	0.008	2	1	WOK
26	5795R	AL	H09281	572	320	967.92	0.331	2	1	RPR
27	5846R	AL	H09291	624	66	1046.89	0.063	2	1	CSS
28	1274R	AL	H09301	616	38	1039.51	0.037	2	1	CSO
29	1612	AL	H10251	566	10	950.95	0.005	2	1	KRO
30	5827	AL	H12171	173	1700	278.58	6.102	2	1	CSS
31	5854	AL	H12241	552	120	923.82	0.130	2	1	RCO
32	5801R	AL	H13181	361	470	564.39	0.833	2	1	CSO
33	5784	AL	H13191	631	810	1039.41	0.779	2	1	RCO
34	5788	AL	H14181	635	1400	992.76	1.410	2	1	CSO
35	5894	AL	H14191	630	1600	1037.77	1.542	2	1	CSO
36	5798	AL	H14221	582	21000	970.81	21.631	2	1	RCO
37	5941	AL	H14231	590	34	986.60	0.034	2	1	RCO
38	5859	AL	H14241	578	370	967.33	0.382	2	1	RCO
39	1259R	AL	H14251	576	10	967.76	0.005	2	1	RCO
40	5789	AL	H14261	594	550	1021.40	0.538	2	1	CSS
41	5893	AL	H14281	568	280	961.15	0.291	2	1	RCO
42	1276R	AL	H14301	611	10	1031.07	0.005	2	1	CSO
43	5902	AL	H15191	605	5700	996.59	5.720	2	1	RCO
44	5880	AL	H15211	576	15000	970.76	15.452	2	1	RCO
45	5881R	AL	H15231	584	4	976.57	0.004	2	1	RCO
46	7624R	AL	H15281	561	300	949.31	0.316	2	1	WOK
47	5751R	AL	H16021	227	15	377.17	0.020	2	1	WLP
48	5762R	AL	H16021	224	15	372.19	0.020	2	1	WLP
49	5886R	AL	H16191	623	4300	1026.24	4.190	2	1	RCO
50	5849	AL	H16221	581	190	969.14	0.196	2	1	RCO
51	7623	AL	H16231	572	4100	964.02	4.253	2	1	RCO
52	5938	AL	H16231	615	340	725.94	0.468	2	1	RCO
53	5848R	AL	H16241	578	310	870.60	0.356	2	1	CFD
54	5852	AL	H16261	594	320	1021.40	0.313	2	1	CSS
55	5773	AL	H16301	611	550	1031.07	0.533	2	1	RCO
56	5765R	AL	H17021	295	10	490.16	0.010	2	1	DCO

TABLE 1B. TURNAROUND WORKER EXPOSURES
AT DORCHESTER REFINING COMPANY
ON SEPTEMBER 15-OCTOBER 5, 1981

OBS	SAMPLE	REG	MAN	TIME	ANR	CVOL	REC	A	C	JOB
57	5730R	AL	H17031	394	10.0	650.44	0.0077	2	1	DCO
58	5760R	AL	H18031	384	11.0	633.94	0.0174	2	1	DCO
59	1265	AL	H21251	225	84.0	189.01	0.4444	2	1	RCO
60	5838	AL	H21251	289	1200.0	483.27	2.4831	2	1	WOR
61	5792	AL	H21281	555	42.0	939.15	0.0447	2	1	RPR
62	5875	AL	H22241	552	52.0	923.82	0.0563	2	1	RCO
63	5851	AL	H23231	522	49.0	872.89	0.0561	2	1	CSS
64	1269	AL	KLA261	372	3700.0	639.67	5.7843	2	1	KCO
65	1618	AL	KMA251	505	11.0	848.47	0.0130	2	1	KBR
66	5832	AL	KUA191	445	1100.0	733.03	1.5006	2	1	KCO
67	5861	AL	PF1231	587	25.0	981.59	0.0255	2	1	RCO
68	5839	AL	PF1261	569	12.0	978.41	0.0123	2	1	KCO
69	5793	AL	PF1281	550	10.0	930.69	0.0054	2	1	RPR
70	5847	AL	PF2231	541	6600.0	638.59	10.3353	2	1	RCO
71	5867R	AL	PF4221	547	20.0	912.43	0.0219	2	1	WSS
72	1275R	AL	RLA041	235	24.0	399.04	0.0601	2	1	WOR
73	5956	AL	RLA231	517	15.0	864.53	0.0087	2	1	RCO
74	5546R	AL	RMA021	125	15.0	207.69	0.0361	2	1	WOR
75	5752R	AL	RMA021	178	15.0	295.76	0.0254	2	1	WOR
76	5768R	AL	RMA021	307	15.0	510.09	0.0147	2	1	WOR
77	5800	AL	RMA281	559	45.0	945.92	0.0476	2	1	RPR
78	5819R	AL	RMA291	575	23.0	964.68	0.0238	2	1	RCO
79	5888	AL	RTA281	573	80.0	969.61	0.0825	2	1	RPR
80	1271	AL	RTA301	260	15.0	438.75	0.0171	2	1	WOO
81	5781	AL	SSA181	205	12000.0	320.50	37.4417	2	1	CSS
82	5855	AL	SSA221	575	1841.0	959.13	1.9194	2	1	WSS
83	5940	AL	SSA241	222	110.0	371.54	0.2961	2	1	WSS
84	5860	AL	WO1291	220	44.0	369.09	0.1192	2	1	WOO
85	1270R	AL	WO1291	273	15.0	458.01	0.0164	2	1	WOO
86	5759R	AL	WO2011	90	15.0	790.70	13.0800	2	1	WOR
87	5836	AL	WO2251	299	1400.0	499.99	2.8001	2	1	WOR
88	5805	AL	WO2261	576	260.0	990.45	0.2625	2	1	WOR
89	5761R	AL	WO8021	228	15.0	378.83	0.0198	2	1	WLP
90	5772R	AL	WO8301	275	24.0	464.07	0.0517	2	1	WOO
91	5745	AL	WSA031	406	10.0	670.26	0.0075	2	1	WOO
92	5550R	AL	WO2031	459	10.0	757.75	0.0066	2	1	WOR
93	5542	AL	WO2041	235	10.0	399.04	0.0251	2	1	WOR
94	5787	AL	WO2211	550	17.0	920.47	0.0185	2	1	WOO
95	1264	AL	WO2241	481	15.0	805.00	0.0093	2	1	WSO
96	1263	AL	WO2251	245	4300.0	411.63	10.4462	2	1	WOR
97	5953	AL	WO3231	606	35.0	1013.36	0.0345	2	1	WSS
98	5543R	AL	WO4041	244	7.0	414.32	0.0169	2	1	WOK
99	5767	AL	WO4041	244	20.0	414.32	0.0483	2	1	WOK
100	5853	AL	WO4041	244	16.0	414.32	0.0386	2	1	WOK
101	5835	AL	WO5181	592	13.5	925.54	0.0146	2	1	WSO
102	5775	AL	WO5211	550	88.0	926.94	0.0949	2	1	WSS
103	5807	AL	WO5291	185	23.1	310.38	0.0744	2	1	WSS
104	5774R	AL	WO5301	300	9.8	506.26	0.0194	2	1	WOR
105	5552R	AL	WO7041	489	23.0	830.34	0.0277	2	1	WOK
106	1621	AL	WO7041	489	10.0	830.34	0.0060	2	1	WOK
107	5723	AL	WO7301	393	5.3	663.19	0.0080	2	1	WOO
108	2449R	AL	WO8011	497	15.0	841.30	0.0089	2	1	WSI
109	5747R	AL	WO8021	140	1.1	236.25	0.0055	2	1	WLP
110	5737	AS	A01021	290	1.0	481.85	0.0010	2	1	WOR
111	5855	AS	SSA221	575	1.0	959.13	0.0005	2	1	WSS
112	5835	AS	WO5181	592	1.0	925.54	0.0005	2	1	WSO

TABLE 1B. TURNAROUND WORKER EXPOSURES
AT DORCHESTER REFINING COMPANY
ON SEPTEMBER 15-OCTOBER 5, 1981

OBS	SAMPLE	REG	MAN	TIME	ANR	CVOL	REC	A	C	JOB
113	5807	AB	W05291	185	1.000	310.375	0.002	2	1	WSS
114	5774R	AB	W05301	300	1.000	506.256	0.001	2	1	WOR
115	5723	AB	W07301	393	1.000	663.195	0.001	2	1	WOO
116	5747R	AB	W08021	140	1.000	236.253	0.002	2	1	WLP
117	PP2	BA	A02153	474	80.000	467.307	85.597	3	1	OPA
118	PP5	BA	H02161	470	80.000	458.983	87.149	3	1	SDO
119	PP10	BA	H08171	635	80.000	601.487	66.502	3	1	SDO
120	PP9	BA	H09171	629	80.000	595.804	67.136	3	1	SDO
121	PC10	BA	H10031	289	80.000	420.973	95.018	3	1	WOK
122	PP8	BA	H10171	637	80.000	603.381	66.293	3	1	SDO
123	PP7	BA	H11171	644	80.000	610.012	65.572	3	1	SDO
124	PK10	BA	H12031	509	80.000	790.866	50.577	3	1	WOK
125	PG17	BA	KLA251	546	80.000	539.618	74.126	3	1	KBR
126	PP4	BA	PF1161	479	80.000	467.772	85.512	3	1	SDO
127	PP6	BA	PF2161	465	80.000	454.100	88.086	3	1	SDO
128	PF10	BA	PF3011	85	80.000	148.116	270.059	3	1	FAC
129	PS10	BA	PF3011	455	140.000	543.673	257.508	3	1	STC
130	PP3	BA	PR1161	479	80.000	467.772	85.512	3	1	SDO
131	PG12	BA	RMA221	503	97.000	493.549	196.536	3	1	RCO
132	PG16	BA	RMA241	550	80.000	541.455	73.875	3	1	RCO
133	PG18	BA	RMA261	563	80.000	569.469	70.241	3	1	RCO
134	PP20	BA	RMA291	537	80.000	794.936	50.319	3	1	RCO
135	PG11	BA	STA221	500	80.000	490.605	81.532	3	1	STC
136	PS30	BA	STA301	455	240.000	587.157	408.749	3	1	STC
137	PP1	BA	U01152	379	190.000	373.648	508.499	3	1	OPU
138	PR10	BA	W02011	557	80.000	834.236	47.948	3	1	WOR
139	5737	BE	A01021	290	1.000	481.848	0.001	2	1	WOR
140	5855	BE	SSA221	575	1.000	959.133	0.001	2	1	WSS
141	5835	BE	W05181	592	1.000	925.536	0.001	2	1	WSO
142	5807	BE	W05291	185	1.000	310.375	0.002	2	1	WSS
143	5774R	BE	W05301	300	1.000	506.256	0.001	2	1	WOR
144	5723	BE	W07301	393	1.000	663.195	0.001	2	1	WOO
145	PP2	BP	A02153	474	120.000	467.307	128.395	3	1	OPA
146	PP5	BP	H02161	470	120.000	458.983	130.724	3	1	SDO
147	PP10	BP	H08171	635	120.000	601.487	99.753	3	1	SDO
148	PP9	BP	H09171	629	120.000	595.804	100.704	3	1	SDO
149	PC10	BP	H10031	289	120.000	420.973	142.527	3	1	WOK
150	PP8	BP	H10171	637	120.000	603.381	99.440	3	1	SDO
151	PP7	BP	H11171	644	120.000	610.012	98.359	3	1	SDO
152	PK10	BP	H12031	509	120.000	790.866	75.866	3	1	WOK
153	PG17	BP	KLA251	546	120.000	539.618	111.190	3	1	KBR
154	PP4	BP	PF1161	479	120.000	467.772	128.268	3	1	SDO
155	PF10	BP	PF3011	85	120.000	148.116	405.088	3	1	FAC
156	PS10	BP	PF3011	455	120.000	543.673	110.360	3	1	STC
157	PP6	BP	PF3161	465	120.000	454.100	132.129	3	1	SDO
158	PP3	BP	PR1161	479	120.000	467.772	128.268	3	1	SDO
159	PG12	BP	RMA221	503	120.000	493.549	121.569	3	1	RCO
160	PG16	BP	RMA241	550	120.000	541.455	110.812	3	1	RCO
161	PG18	BP	RMA261	563	120.000	569.469	105.361	3	1	WOR
162	PP20	BP	RMA291	537	120.000	794.936	75.478	3	1	RCO
163	PG11	BP	STA221	500	120.000	490.605	122.298	3	1	STC
164	PS30	BP	STA301	455	120.000	587.157	102.187	3	1	STC
165	PP1	BP	U01152	379	120.000	373.648	160.579	3	1	OPU
166	PR10	BP	W02011	557	120.000	834.236	71.922	3	1	WOR
167	CT05	AZ	A01161	484	0.002	543.553	0.004	1	1	SDO
168	CT07	AZ	A04161	471	0.065	565.750	0.115		1	SDO

TABLE 1B. TURNAROUND WORKER EXPOSURES
AT DORCHESTER REFINING COMPANY
ON SEPTEMBER 15-OCTOBER 5, 1981

OBS	SAMPLE	REG	MAN	TIME	ANR	CVOL	REC	A	C	JOB
169	CT10	BZ	H05171	630	0.012	722.07	0.0000	2	1	SDO
170	CT09	BZ	H06171	907	0.007	988.00	0.0000	2	1	SDO
171	CT12	BZ	H07171	597	0.027	650.32	0.0000	2	1	SDO
172	CT21	BZ	H11211	582	0.038	778.93	0.0000	2	1	STC
173	CT24	BZ	H11221	553	0.029	718.41	0.0000	2	1	STC
174	CT16	BZ	H17191	600	0.041	779.05	0.0001	2	1	STC
175	CT20	BZ	H17211	582	0.036	663.53	0.0001	2	1	STC
176	CT25	BZ	H17221	553	0.027	532.15	0.0001	2	1	STC
177	CT27	BZ	H17241	578	0.001	11.23	0.0000	2	1	STC
178	JT01	BZ	H17251	586	0.040	579.15	0.0001	2	1	STC
179	JT03	BZ	H17281	593	0.030	590.27	0.0001	2	1	STC
180	CT15	BZ	H18191	598	0.035	701.13	0.0000	2	1	STC
181	CT23	BZ	H18211	582	0.022	698.15	0.0000	2	1	STC
182	JT02	BZ	H18261	585	0.040	591.72	0.0001	2	1	STC
183	CT28	BZ	H18261	597	0.001	11.65	0.0000	2	1	STC
184	CT18	BZ	H20191	597	0.041	780.94	0.0001	2	1	STC
185	CT13	BZ	I01171	633	0.009	737.50	0.0000	2	1	SDO
186	CT14	BZ	IS2171	619	0.006	785.68	0.0000	2	1	SDO
187	CT04	BZ	PF1161	484	0.002	543.55	0.0000	2	1	SDO
188	CT06	BZ	PF4161	472	0.047	617.65	0.0001	2	1	SDO
189	CT11	BZ	RH1171	646	0.042	673.10	0.0001	2	1	SDO
190	CT22	BZ	STA211	580	0.019	770.50	0.0000	2	1	STC
191	CT26	BZ	STA231	540	0.001	10.92	0.0000	2	1	STC
192	CT40	BZ	STA301	290	0.001	5.68	0.0001	2	1	STC
193	CT02	BZ	U02153	450	0.002	443.65	0.0000	2	1	OPU
194	CT03	BZ	U03153	422	0.010	416.04	0.0000	2	1	OPU
195	CT07	BZ	W04041	254	0.001	5.02	0.0001	2	1	WOK
196	CT06	BZ	W04051	557	0.001	11.21	0.0000	2	1	WOK
197	5843	B2	A01241	572	15.000	957.29	0.0078	2	1	RCO
198	5786	B2	H01211	570	540.000	960.65	0.5621	2	1	RCO
199	5779	B2	H05211	576	900.000	970.76	0.9271	2	1	RCO
200	5834	B2	H06171	123	15.000	208.78	35.9223	1	1	CSS
201	5830	B2	H07261	553	10.000	950.90	0.0105	2	1	RCO
202	1613	B2	H07291	310	3.000	520.09	0.0029	2	1	CSS
203	1277R	B2	H07301	158	3.000	266.63	0.0056	2	1	C B
204	5826	B2	H09181	634	390.000	991.20	0.3935	2	1	CSO
205	5895R	B2	H09191	625	73.000	1029.53	0.0709	2	1	CSO
206	5863	B2	H09221	583	320.000	972.48	0.3291	2	1	RCO
207	2942	B2	H09231	317	15.000	530.09	0.0141	2	1	RCO
208	5857	B2	H09231	275	110.000	459.86	0.2392	2	1	RCO
209	5946	B2	H09241	579	180.000	969.01	0.1858	2	1	RCO
210	1614R	B2	H09251	583	3.000	979.52	0.0015	2	1	KCO
211	5795R	B2	H09281	572	37.000	967.92	0.0382	2	1	RPR
212	1274R	B2	H09301	616	5.000	1039.51	0.0048	2	1	CSO
213	1612	B2	H10251	566	3.000	950.95	0.0016	2	1	KRO
214	5827	B2	H12171	173	200.000	278.58	0.7179	2	1	CSS
215	5854	B2	H12241	552	89.000	923.82	0.0963	2	1	RCO
216	5801R	B2	H13181	361	43.000	564.39	0.0762	2	1	CSO
217	5788	B2	H14181	635	130.000	992.76	0.1309	2	1	CSO
218	5798	B2	H14221	582	110.000	970.81	0.1133	2	1	RCO
219	5941	B2	H14231	590	15.000	986.60	0.0076	2	1	RCO
220	5859	B2	H14241	578	75.000	967.33	0.0775	2	1	RCO
221	1259R	B2	H14251	576	3.000	967.76	0.0015	2	1	KCO
222	5789	B2	H14261	594	100.000	1021.40	0.0979	2	1	CSS
223	5893	B2	H14281	568	75.000	961.15	0.0780	2	1	RCO
224	1276R	B2	H14301	611	3.000	1031.07	0.0015	2	1	CSO

TABLE 1B. TURNAROUND WORKER EXPOSURES
AT DORCHESTER REFINING COMPANY
ON SEPTEMBER 15-OCTOBER 5, 1981

OBS	SAMPLE	REG	MAN	TIME	ANR	CVOL	REC	A	C	JOB
225	5902	B2	H15191	605	830.0	996.59	0.833	2	1	RCO
226	5880	B2	H15211	576	420.0	970.76	0.433	2	1	KCO
227	5881R	B2	H15231	584	15.0	976.57	0.008	2	1	RCO
228	5886R	B2	H16191	623	570.0	1026.24	0.555	2	1	KCO
229	5849	B2	H16221	581	160.0	969.14	0.165	2	1	RCO
230	7623	B2	H16231	572	530.0	964.02	0.550	2	1	KCO
231	5938	B2	H16231	615	94.0	725.94	0.129	2	1	RCO
232	5848R	B2	H16241	578	42.0	870.60	0.048	2	1	CFD
233	5852	B2	H16261	594	38.0	1021.40	0.037	2	1	CSS
234	5773	B2	H16301	611	84.0	1031.07	0.081	2	1	KCO
235	5765R	B2	H17021	295	3.0	490.16	0.003	2	1	DCO
236	5730R	B2	H17031	394	3.0	650.44	0.002	2	1	DCO
237	5760R	B2	H18031	384	3.0	633.94	0.002	2	1	DCO
238	1265	B2	H21251	225	39.0	189.01	0.206	2	1	KCO
239	5792	B2	H21281	555	79.0	939.15	0.084	2	1	RPR
240	5875	B2	H22241	552	28.0	923.82	0.030	2	1	RCO
241	5851	B2	H23231	522	4.0	872.89	0.005	2	1	CSS
242	1269	B2	KLA261	372	100.0	639.67	0.156	2	1	KCO
243	1618	B2	KMA251	505	3.0	848.47	0.002	2	1	KBR
244	5832	B2	KUA191	445	180.0	733.03	0.246	2	1	KCO
245	5861	B2	PF1231	587	15.0	981.59	0.008	2	1	RCO
246	5839	B2	PF1261	569	3.0	978.41	0.002	2	1	KCO
247	5793	B2	PF1281	550	3.0	930.69	0.002	2	1	RPR
248	5847	B2	PF2231	541	59.0	638.59	0.092	2	1	RCO
249	5956	B2	RLA231	517	15.0	864.53	0.009	2	1	RCO
250	5800	B2	RMA281	559	130.0	945.92	0.137	2	1	RPR
251	5819R	B2	RMA291	575	9.0	964.68	0.009	2	1	RCO
252	5888	B2	RTA281	573	17.0	969.61	0.018	2	1	RPR
253	5781	B2	SSA181	205	770.0	320.50	2.403	2	1	CSS
254	5853	B2	W04041	244	21.0	414.32	0.051	2	1	WOK
255	5543R	B2	W04041	244	15.0	414.32	0.018	2	1	WOK
256	5767	B2	W04041	244	15.0	414.32	0.018	2	1	WOK
257	5737	CA	A01021	290	12.2	481.85	0.025	2	1	WOR
258	5855	CA	SSA221	575	125.0	959.13	0.130	2	1	WSS
259	5835	CA	W05181	592	64.4	925.54	0.070	2	1	WSO
260	5807	CA	W05291	185	33.9	310.38	0.109	2	1	WSS
261	5774R	CA	W05301	300	1.2	506.26	0.002	2	1	WOR
262	5723	CA	W07301	393	4.7	663.19	0.007	2	1	WOO
263	5747R	CA	W08021	140	4.3	236.25	0.018	2	1	WLP
264	5737	CD	A01021	290	1.0	481.85	0.001	2	1	WOR
265	5855	CD	SSA221	575	1.0	959.13	0.001	2	1	WSS
266	5835	CD	W05181	592	1.0	925.54	0.001	2	1	WSO
267	5807	CD	W05291	185	1.0	310.38	0.002	2	1	WSS
268	5774R	CD	W05301	300	1.0	506.26	0.001	2	1	WOR
269	5723	CD	W07301	393	1.0	663.19	0.001	2	1	WOO
270	5747R	CD	W08021	140	1.0	236.25	0.002	2	1	WLP
271	PP2	CH	A02153	474	40.0	467.31	85.597	2	1	OPA
272	PP5	CH	H02161	470	20.0	458.98	43.575	2	1	SDO
273	PP10	CH	H08171	635	100.0	601.49	166.255	2	1	SDO
274	PP9	CH	H09171	629	20.0	595.80	16.784	2	1	SDO
275	PC10	CH	H10031	289	40.0	420.97	95.018	2	1	WOK
276	PP8	CH	H10171	637	20.0	603.38	33.147	2	1	SDO
277	PP7	CH	H11171	644	20.0	610.01	16.393	2	1	SDO
278	PK10	CH	H12031	509	20.0	790.87	25.289	2	1	WOK
279	PG17	CH	KLA251	546	20.0	539.62	18.532	2	1	KBR
280	PP4	CH	PF1161	479	40.0	467.77	85.512	2	1	SDO

TABLE 1B. TURNAROUND WORKER EXPOSURES
AT DORCHESTER REFINING COMPANY
ON SEPTEMBER 15-OCTOBER 5, 1981

OBS	SAMPLE	REG	MAN	TIME	ANR	CVOL	REC	A	C	JOB
281	PF10	CH	PF3011	85	20.0	148.12	135.029	2	1	FAC
282	PP10	CH	PF3011	455	40.0	543.67	73.574	2	1	STC
283	PP6	CH	PF3161	465	40.0	454.10	88.086	2	1	SDU
284	PP3	CH	PR1161	479	40.0	467.77	85.512	2	1	SDU
285	PG12	CH	RMA221	503	40.0	493.55	81.046	2	1	RCU
286	PG16	CH	RMA241	550	20.0	541.46	18.469	2	1	RCU
287	PG18	CH	RMA261	563	40.0	569.47	70.241	2	1	WOR
288	PP20	CH	RMA291	537	20.0	794.94	25.159	2	1	RCU
289	PG11	CH	STA221	500	120.0	490.60	244.596	2	1	STC
290	PP30	CH	STA301	455	40.0	587.16	68.125	2	1	STC
291	PP1	CH	U01152	379	120.0	373.65	0.321	2	1	OPU
292	PR10	CH	W02011	557	20.0	834.24	23.974	2	1	WOR
293	5763	CO	A01021	195	3.0	324.00	0.005	2	1	WOR
294	5737	CO	A01021	290	1.0	481.85	0.001	2	1	WOR
295	1268	CO	H05251	430	3.0	382.48	0.004	2	1	RBR
296	1619	CO	H06291	599	3.0	1004.94	0.001	2	1	CFD
297	5796	CO	H09261	579	3.0	995.61	0.002	2	1	WOK
298	7624R	CO	H15281	561	3.0	949.31	0.002	2	1	WOK
299	5751R	CO	H16021	227	3.0	377.17	0.004	2	1	WCP
300	5762R	CO	H16021	224	3.0	372.19	0.004	2	1	WLP
301	5838	CO	H21251	289	3.0	483.27	0.003	2	1	WOR
302	5867R	CO	PF4221	547	3.0	912.43	0.002	2	1	WSS
303	1275R	CO	RLA041	235	3.0	399.04	0.004	2	1	WOR
304	5549R	CO	RMA021	125	3.0	207.69	0.007	2	1	WOR
305	5752R	CO	RMA021	178	3.0	295.76	0.005	2	1	WOR
306	576AR	CO	RMA021	307	3.0	510.09	0.003	2	1	WOR
307	1271	CO	RTA301	260	3.0	438.75	0.003	2	1	WOU
308	5855	CO	SSA221	575	1.0	959.13	0.001	2	1	WSS
309	5940	CO	SSA241	222	3.0	371.54	0.004	2	1	WSS
310	1270R	CO	W01291	273	3.0	458.01	0.003	2	1	WOU
311	5860	CO	W01291	220	3.0	369.09	0.004	2	1	WOU
312	5759R	CO	W02011	90	3.0	152.35	0.010	2	1	WOR
313	5836	CO	W02251	299	3.0	499.99	0.003	2	1	WOR
314	5805	CO	W02261	576	3.0	990.45	0.002	2	1	WOR
315	5761R	CO	W08021	228	3.0	378.83	0.004	2	1	WLP
316	5772R	CO	W08301	275	3.0	464.07	0.003	2	1	WOU
317	5745	CO	WSA031	406	3.0	670.26	0.002	2	1	WOU
318	5550R	CO	W02031	459	63.0	757.75	0.083	2	1	WOR
319	5542	CO	W02041	235	3.0	399.04	0.004	2	1	WOR
320	5787	CO	W02211	550	3.0	920.47	0.002	2	1	WOU
321	1264	CO	W02241	481	3.0	805.00	0.002	2	1	WSU
322	1263	CO	W02251	245	3.0	411.63	0.004	2	1	WOR
323	5953	CO	W03231	606	3.0	1013.36	0.001	2	1	WSS
324	5835	CO	W05181	592	48.2	925.54	0.052	2	1	WSU
325	5775	CO	W05211	550	3.0	926.94	0.002	2	1	WSS
326	5807	CO	W05291	185	1.0	310.38	0.002	2	1	WSS
327	5774R	CO	W05301	300	1.0	506.26	0.001	2	1	WOR
328	1621	CO	W07041	489	3.0	830.34	0.002	2	1	WOK
329	5552R	CO	W07041	489	3.0	830.34	0.002	2	1	WOK
330	5723	CO	W07301	393	1.0	663.19	0.001	2	1	WOU
331	2449R	CO	W08011	497	3.0	841.30	0.002	2	1	WSI
332	5747R	CO	W08021	140	1.0	236.25	0.002	2	1	WLP
333	5763	CR	A01021	195	28.0	324.00	0.086	2	1	WOR
334	5737	CR	A01021	290	15.5	481.85	0.032	2	1	WOR
335	5843	CR	A01241	572	3.0	957.29	0.002	2	1	RCO
336	5786	CR	H01211	570	22.0	960.65	0.023	2	1	RCO

TABLE 1B. TURNAROUND WORKER EXPOSURES
AT DORCHESTER REFINING COMPANY
ON SEPTEMBER 15-OCTOBER 5, 1981

OBS	SAMPLE	REQ	MAN	TIME	ANR	CVOL	REC	A	C	JOB
337	5779	CR	H05211	576	47	970.76	0.04843	2	1	RCO
338	1268	CR	H05251	430	3	382.48	0.00392	2	1	KBR
339	5834	CR	H06171	123	3	208.78	7.18447	3	1	CSS
340	1619	CR	H06291	599	3	1004.94	0.00149	2	1	CFD
341	5830	CR	H07261	553	3	950.90	0.00158	2	1	RCO
342	1613	CR	H07291	310	3	520.09	0.00288	2	1	CSS
343	1277R	CR	7 1	158	3	266.63	0.00563	2	1	CFD
344	5826	CR	H09181	634	27	991.20	0.02724	2	1	CSO
345	5895R	CR	H09191	625	5	1029.53	0.00486	2	1	CSO
346	5863	CR	H09221	583	28	972.48	0.02879	2	1	RCO
347	2942	CR	H09231	317	3	530.09	0.00283	2	1	RCO
348	5857	CR	H09231	275	6	459.86	0.01305	2	1	RCO
349	5946	CR	H09241	579	11	969.01	0.01135	2	1	RCO
350	1614R	CR	H09251	583	3	979.92	0.00153	2	1	KCO
351	5796	CR	H09261	579	4	995.61	0.00402	2	1	WOK
352	5795R	CR	H09281	572	3	967.92	0.00155	2	1	RPR
353	5846R	CR	H09291	624	3	1046.89	0.00143	2	1	CSS
354	1274R	CR	H09301	616	3	1039.51	0.00144	2	1	CSO
355	1612	CR	H10251	566	3	950.95	0.00158	2	1	KRO
356	5827	CR	H12171	173	13	278.98	0.04667	2	1	CSS
357	5854	CR	H12241	552	4	923.82	0.00433	2	1	RCO
358	5801R	CR	H13181	361	3	564.39	0.00266	2	1	CSO
359	5784	CR	H13191	631	15	1039.41	0.01443	2	1	RCO
360	5784	CR	H14181	635	8	992.76	0.00806	2	1	CSO
361	5894	CR	H14191	630	23	1037.77	0.02216	2	1	CSO
362	5794	CR	H14221	582	230	970.81	0.23692	2	1	RCO
363	5941	CR	H14231	590	3	986.60	0.00152	2	1	RCO
364	5859	CR	H14241	578	4	967.33	0.00414	2	1	RCO
365	1259R	CR	H14251	576	3	967.76	0.00155	2	1	KCO
366	5789	CR	H14261	594	9	1021.40	0.00490	2	1	CSS
367	5893	CR	H14281	568	4	961.15	0.00416	2	1	RCO
368	1276R	CR	H14301	611	3	1031.07	0.00291	2	1	CSO
369	5902	CR	H15191	605	82	996.59	0.08228	2	1	KCO
370	5880	CR	H15211	576	82	970.76	0.08447	2	1	KCO
371	5881R	CR	H15231	584	3	976.57	0.00154	2	1	RCO
372	7624R	CR	H15281	561	3	949.31	0.00158	2	1	WOK
373	5762R	CR	H16021	224	43	372.19	0.11553	2	1	WLP
374	5751R	CR	H16021	227	3	377.17	0.00398	2	1	WLP
375	5886R	CR	H16191	623	57	1026.24	0.05554	2	1	KCO
376	5849	CR	H16221	581	3	969.14	0.00310	2	1	RCO
377	7623	CR	H16231	572	29	964.02	0.03008	2	1	KCO
378	5938	CR	H16231	615	4	725.94	0.00551	2	1	RCO
379	5848R	CR	H16241	578	7	870.60	0.00804	2	1	CFD
380	5852	CR	H16261	594	3	1021.40	0.00294	2	1	CSS
381	5773	CR	H16301	611	11	1031.07	0.01067	2	1	KCO
382	5765R	CR	H17021	295	3	490.16	0.00306	2	1	DCO
383	5730R	CR	H17031	394	4	650.44	0.00615	2	1	DCO
384	5760R	CR	H18031	384	3	633.94	0.00237	2	1	DCO
385	1265	CR	H21251	225	3	189.01	0.00794	2	1	KCO
386	5838	CR	H21251	289	9	483.27	0.01862	2	1	WOR
387	5792	CR	H21281	555	3	939.15	0.00319	2	1	RPR
388	5875	CR	H22241	552	3	923.82	0.00162	2	1	RCO
389	5851	CR	H23231	522	4	872.89	0.00458	2	1	CSS
390	1269	CR	KLA261	372	7	639.67	0.01094	2	1	KCO
391	1618	CR	KMA251	505	3	848.47	0.00177	2	1	KBR
392	5832	CR	KUA191	445	18	733.03	0.02456	2	1	KCO

TABLE 1B. TURNAROUND WORKER EXPOSURES
AT DORCHESTER REFINING COMPANY
ON SEPTEMBER 15-OCTOBER 5, 1981

OBS	SAMPLE	REG	MAN	TIME	ANR	CVOL	REC	A	C	JOB
393	5861	CR	PF1231	587	3.0	981.59	0.00	2	1	RCO
394	5839	CR	PF1261	569	3.0	978.41	0.00	2	1	KCO
395	5793	CR	PF1281	550	3.0	930.69	0.00	2	1	RPR
396	5847	CR	PF2231	541	37.0	638.59	0.06	2	1	RCO
397	5867R	CR	PF4221	547	53.0	912.43	0.06	2	1	WSS
398	1275R	CR	RLA041	235	220.0	399.04	0.55	2	1	WOR
399	5956	CR	RLA231	517	3.0	864.53	0.00	2	1	RCO
400	5752R	CR	RMA021	178	33.0	295.76	0.11	2	1	WOR
401	5768R	CR	RMA021	307	38.0	510.09	0.07	2	1	WOR
402	5549R	CR	RMA021	125	3.0	207.69	0.01	2	1	WOR
403	5800	CR	RMA281	559	3.0	945.92	0.00	2	1	RPR
404	5819R	CR	RMA291	575	4.0	964.68	0.00	2	1	RCO
405	5888	CR	RTA281	573	3.0	969.61	0.00	2	1	RPR
406	1271	CR	RTA301	260	3.0	438.79	0.00	2	1	WOO
407	5781	CR	SSA181	205	52.0	320.50	0.16	2	1	CSS
408	5855	CR	SSA221	575	5.1	959.11	0.01	2	1	WSS
409	5940	CR	SSA241	222	5.0	371.54	0.01	2	1	WSS
410	5860	CR	WO1291	220	110.0	369.09	0.30	2	1	WOO
411	1270R	CR	WO1291	273	3.0	458.01	0.00	2	1	WOO
412	5759R	CR	WO2011	90	67.0	152.35	0.44	2	1	WOR
413	5836	CR	WO2251	299	10.0	499.99	0.02	2	1	WOR
414	5805	CR	WO2261	576	4.0	990.45	0.00	2	1	WOR
415	5761R	CR	WO8021	228	25.0	378.83	0.07	2	1	WLP
416	5772R	CR	WO8301	275	3.0	464.07	0.00	2	1	WOO
417	5745	CR	WSA031	406	46.0	670.26	0.07	2	1	WOO
418	5550R	CR	WO2031	459	110.0	757.73	0.15	2	1	WOR
419	5542	CR	WO2041	235	120.0	399.04	0.30	2	1	WOR
420	1264	CR	WO2241	481	3.0	805.00	0.00	2	1	WSO
421	5953	CR	WO3231	606	3.0	1013.36	0.00	2	1	WSS
422	5543R	CR	WO4041	244	3.0	414.32	0.00	2	1	WOK
423	5835	CR	WO5181	592	35.1	925.54	0.04	2	1	WSO
424	5775	CR	WO5211	550	15.0	926.94	0.02	2	1	WSS
425	5774R	CR	WO5301	300	4.7	506.26	0.01	2	1	WOR
426	5723	CR	WO7301	393	15.9	663.19	0.02	2	1	WOO
427	2449R	CR	WO8011	497	3.0	841.30	0.00	2	1	WSI
428	5747R	CR	WO8021	140	14.9	236.25	0.06	2	1	WLP
429	5737	CU	AO1021	290	3.8	481.85	0.01	2	1	WOR
430	5835	CU	WO5181	592	2.1	925.54	0.00	2	1	WSO
431	5774R	CU	WO5301	300	1.5	506.26	0.00	2	1	WOR
432	5747R	CU	WO8021	140	2.2	236.25	0.01	2	1	WLP
433	PP5	CY	HO2161	470	240.0	458.98	261.45	3	1	SDO
434	PP9	CY	HO9171	629	240.0	595.80	201.41	3	1	SDO
435	PC10	CY	H10031	289	240.0	420.97	285.05	3	1	WOK
436	pp8	CY	H10171	637	240.0	603.38	198.88	3	1	SDO
437	PP7	CY	H11171	644	240.0	610.01	196.72	3	1	SDO
438	PG17	CY	KLA251	546	240.0	539.62	222.38	3	1	KBR
439	PF10	CY	PF3011	85	240.0	148.12	810.18	3	1	FAC
440	pp6	CY	PF3161	465	240.0	454.10	264.26	3	1	SDO
441	PG12	CY	RMA221	503	200.0	493.55	405.23	3	1	RCO
442	PG18	CY	RMA261	563	240.0	569.47	210.72	3	1	WOR
443	P830	CY	STA301	455	600.0	587.16	1021.87	3	1	STC
444	pR10	CY	WO2011	557	240.0	834.24	143.84	3	1	WOR
445	5548	C3	AO1021	125	0.1	206.53	0.00	2	1	WOR
446	5856	C3	SSA221	407	1.7	678.90	0.00	2	1	WSS
447	5870	C3	WO5221	578	39.7	964.14	0.04	2	1	WSS
448	1611	C3	WO5301	293	0.1	494.44	0.00	2	1	WOO

TABLE 1B. TURNAROUND WORKER EXPOSURES
AT DORCHESTER REFINING COMPANY
ON SEPTEMBER 15-OCTOBER 5, 1981

OBS	SAMPLE	REG	MAN	TIME	ANAL	CVOL	REC	A	CL	JOB
449	5551	C3	W08031	432	1.0	780.30	0.00	2	1	WOR
450	5548	C6	A01021	125	0.1	206.53	0.00	2	1	WOR
451	5856	C6	BSA221	407	0.9	678.90	0.00	2	1	WSS
452	5814	C6	BSA291	310	13.0	520.09	0.02	2	1	WSS
453	5758R	C6	W02011	465	26.0	24.43	1.06	2	1	WOR
454	5553R	C6	W02031	46	0.2	78.20	0.00	2	1	WOR
455	5870	C6	W05221	578	16.4	964.14	0.02	2	1	WSS
456	1258	C6	W05241	153	47.0	256.06	0.18	2	1	WSS
457	1611	C6	W05301	293	0.1	494.44	0.00	2	1	WOO
458	5777R	C6	W05301	245	0.4	413.44	0.00	2	1	WOR
459	7617	C6	W06291	525	0.2	880.79	0.00	2	1	WOK
460	5551	C6	W08031	432	0.2	780.30	0.00	2	1	WOR
461	2450R	C6	W08301	296	0.2	499.51	0.00	2	1	WOO
462	pp2	FA	A02153	474	160.0	467.31	171.19	3	1	OPA
463	PP9	FA	H09171	629	140.0	595.80	234.98	3	1	SOO
464	pp8	FA	H10171	637	160.0	603.38	132.59	3	1	SOO
465	PK10	FA	H12031	509	160.0	790.87	101.15	3	1	WOK
466	PP4	FA	PF1161	479	160.0	467.77	171.02	3	1	SOO
467	PF10	FA	PF3011	85	160.0	144.12	540.19	3	1	FAC
468	pg10	FA	pF3011	455	160.0	543.67	147.15	3	1	STC
469	PP6	FA	PF3161	465	160.0	454.10	176.17	3	1	SOO
470	PP3	FA	PR1161	479	160.0	467.77	171.02	3	1	SOO
471	PG12	FA	RMA221	503	230.0	493.55	466.01	3	1	RCO
472	PG16	FA	RMA241	550	160.0	541.46	147.75	3	1	RCO
473	PG18	FA	RMA261	563	160.0	569.47	140.48	3	1	WOR
474	PP20	FA	RMA291	537	160.0	794.94	100.64	3	1	RCO
475	PG11	FA	STA221	500	160.0	490.60	163.06	3	1	STC
476	pg30	FA	STA301	455	3740.0	587.16	6369.67	3	1	STC
477	PP1	FA	U01152	379	160.0	373.65	214.10	3	1	OPU
478	PR10	FA	W02011	557	160.0	634.24	95.90	3	1	WOR
479	5763	FE	A01021	195	310.0	324.00	0.96	2	1	WOR
480	5737	FE	A01021	290	278.0	481.85	0.58	2	1	WOR
481	5843	FE	A01241	572	8.0	957.29	0.01	2	1	RCO
482	5786	FE	H01211	570	360.0	960.65	0.37	2	1	RCO
483	5779	FE	H05211	576	1200.0	970.76	1.24	2	1	RCO
484	1268	FE	H05251	430	40.0	387.79	0.10	2	1	KBR
485	5834	FE	H06171	123	11.0	208.78	52.69	3	1	CSS
486	1619	FE	H06291	599	630.0	1004.94	0.63	2	1	CFD
487	5830	FE	H07261	553	150.0	950.90	0.16	2	1	KCO
488	1613	FE	H07291	310	10.0	520.09	0.02	2	1	CSS
489	1277R	FE	H07301	158	23.0	266.63	0.09	2	1	CFD
490	5826	FE	H09181	634	940.0	991.20	0.95	2	1	CSO
491	5895R	FE	H09191	625	200.0	1029.53	0.19	2	1	CSO
492	5863	FE	H09221	583	450.0	972.48	0.46	2	1	RCO
493	2942	FE	H09231	317	43.0	530.09	0.08	2	1	KCO
494	5857	FE	H09231	275	670.0	459.86	1.46	2	1	RCO
495	5946	FE	H09241	579	1700.0	969.01	1.75	2	1	KCO
496	1614R	FE	H09251	583	5.0	979.92	0.01	2	1	KCO
497	5796	FE	H09261	579	17.0	995.61	0.02	2	1	WOK
498	5795R	FE	H09281	572	790.0	967.92	0.82	2	1	RPR
499	5846R	FE	H09291	624	300.0	1046.89	0.29	2	1	CSS
500	1274R	FE	H09301	616	230.0	1039.51	0.22	2	1	CSO
501	1612	FE	H10251	566	16.0	950.95	0.02	2	1	KRO
502	5827	FE	H12171	173	160.0	278.58	0.57	2	1	CSS
503	5854	FE	H12241	552	55.0	923.82	0.06	2	1	RCO
[illegible]	[illegible]	FE	H12301	761	71.0	564.19	0.13	2	1	CSO

TABLE 1B. TURNAROUND WORKER EXPOSURES
AT DORCHESTER REFINING COMPANY
ON SEPTEMBER 15-OCTOBER 5, 1981

OBS	SAMPLE	REG	MAN	TIME	ANR	CVOL	REC	A	C	JOB
505	5784	FE	H13191	631	580	1039.41	0.5580	2	1	RCO
506	5786	FE	H14181	635	180	992.76	0.1813	2	1	CSO
507	5894	FE	H14191	630	1	1037.77	0.9443	2	1	CSO
508	5798	FE	H14221	582	5300	970.81	5.4594	2	1	RCO
509	5941	FE	H14231	590	55	986.60	0.0557	2	1	RCO
510	5859	FE	H14241	578	500	967.33	0.5169	2	1	RCO
511	1259R	FE	H14251	576	3	967.76	0.0031	2	1	RCO
512	5789	FE	H14261	594	1500	1021.40	1.4686	2	1	CSS
513	5893	FE	H14281	568	340	961.15	0.3537	2	1	RCO
514	1276R	FE	H14301	611	48	1031.07	0.0466	2	1	CSO
515	5902	FE	H15191	605	2000	996.59	2.0069	2	1	RCO
516	5880	FE	H15211	576	2900	970.76	2.9874	2	1	RCO
517	5881R	FE	H15231	584	3	976.57	0.0015	2	1	RCO
518	7624R	FE	H15281	561	120	949.31	0.1264	2	1	WOK
519	5751R	FE	H16021	227	3	377.17	0.0080	2	1	WLP
520	5762R	FE	H16021	224	66	372.19	0.1773	2	1	WLP
521	5886R	FE	H16191	623	1500	1026.24	1.4617	2	1	RCO
522	5849	FE	H16221	581	69	969.14	0.0712	2	1	RCO
523	7623	FE	H16231	572	710	964.02	0.7365	2	1	RCO
524	5938	FE	H16231	615	630	725.94	0.8678	2	1	RCO
525	5848R	FE	H16241	578	280	870.60	0.3216	2	1	CFO
526	5852	FE	H16261	594	54	1021.40	0.0529	2	1	CSS
527	5773	FE	H16301	611	1700	1031.07	1.6488	2	1	RCO
528	5765R	FE	H17021	295	440	490.16	0.8977	2	1	DCO
529	5730R	FE	H17031	394	470	650.44	0.7226	2	1	DCO
530	5760R	FE	H18031	384	180	633.94	0.2839	2	1	DCO
531	1265	FE	H21251	225	17	189.01	0.0899	2	1	RCO
532	5838	FE	H21251	289	220	483.27	0.4552	2	1	WOR
533	5792	FE	H21281	555	80	939.15	0.0852	2	1	RPR
534	5875	FE	H22241	552	24	923.82	0.0260	2	1	RCO
535	5851	FE	H23231	522	310	872.89	0.3551	2	1	CSS
536	1269	FE	KLA261	372	510	639.67	0.7973	2	1	RCO
537	1618	FE	KMA251	505	13	848.47	0.0153	2	1	KBR
538	5832	FE	KUA191	445	490	733.03	0.6685	2	1	RCO
539	5861	FE	PF1231	587	44	981.59	0.0448	2	1	RCO
540	5839	FE	PF1261	569	6	978.41	0.0061	2	1	RCO
541	5793	FE	PF1281	550	5	930.69	0.0054	2	1	RPR
542	5847	FE	PF2231	541	11000	638.59	17.2255	2	1	RCO
543	5867R	FE	PF4221	547	81	912.43	0.0888	2	1	WSS
544	1275R	FE	RLA041	235	1900	399.04	4.7614	2	1	WOR
545	5956	FE	RLA231	517	6	864.53	0.0069	2	1	RCO
546	5549R	FE	RMA021	125	9	207.69	0.0433	2	1	WOR
547	5752R	FE	RMA021	178	65	295.76	0.2198	2	1	WOR
548	5768R	FE	RMA021	307	200	510.09	0.3921	2	1	WOR
549	5800	FE	RMA281	559	130	945.92	0.1374	2	1	RPR
550	5819R	FE	RMA291	575	120	964.68	0.1244	2	1	RCO
551	5888	FE	RTA281	573	83	969.61	0.0856	2	1	RPR
552	1271	FE	RTA301	260	3	438.75	0.0034	2	1	WOO
553	5781	FE	SSA181	205	1900	320.50	5.9283	2	1	CSS
554	5855	FE	SSA221	575	734	959.13	0.7653	2	1	WSS
555	5940	FE	SSA241	222	350	371.54	0.9420	2	1	WSS
556	5860	FE	WO1291	220	150	369.09	0.4064	2	1	WOO
557	1270R	FE	WO1291	273	3	458.01	0.0033	2	1	WOO
558	5759R	FE	WO2011	90	870	152.35	5.7106	2	1	WOR
559	5836	FE	WO2251	299	230	499.99	0.4600	2	1	WOR
560	5805	FE	WO2261	576	150	990.45	0.1514	2	1	WOR

TABLE 1B. TURNAROUND WORKER EXPOSURES
AT DORCHESTER REFINING COMPANY
ON SEPTEMBER 15-OCTOBER 5, 1981

OBS	SAMPLE	REG	MAN	TIME	ANN	CVOL	REC	A	C	JOB
561	5761R	FE	W08021	228	31.00	378.83	0.08183	2	1	WLP
562	5772R	FE	WO8301	275	570.00	464.07	1.22827	2	1	WOO
563	5749	FE	WSA031	406	75.00	670.26	0.11190	2	1	WOO
564	5550R	FE	W02031	459	87.00	757.75	0.11481	2	1	WOR
565	5542	FE	W02041	235	970.00	399.04	2.43084	2	1	WOR
566	5787	FE	W02211	550	320.00	920.47	0.34765	2	1	WOO
567	1264	FE	W02241	481	120.00	805.00	0.14907	2	1	WSO
568	1263	FE	W02251	245	650.00	411.63	1.57908	2	1	WOR
569	5953	FE	W03231	606	580.00	1013.36	0.57235	2	1	WSS
570	5543R	FE	W04041	244	110.00	414.32	0.26549	2	1	WOK
571	5767	FE	W04041	244	2300.00	414.32	5.55125	2	1	WOK
572	5853	FE	W04041	244	57.00	414.32	0.13757	2	1	WOK
573	5835	FE	W05181	592	174.00	925.54	0.18800	2	1	WSO
574	5775	FE	W05211	550	2200.00	926.94	2.37340	2	1	WSS
575	5807	FE	W05291	185	117.00	310.38	0.37696	2	1	WSS
576	5774R	FE	W05301	300	840.00	506.26	1.65924	2	1	WOR
577	1621	FE	W07041	489	440.00	830.34	0.52990	2	1	WOK
578	5552R	FE	W07041	489	360.00	830.34	0.43356	2	1	WOK
579	5723	FE	W07301	393	77.40	663.19	0.11671	2	1	WOO
580	2449R	FE	W08011	497	31.00	841.30	0.03685	2	1	WSI
581	5747R	FE	W08021	140	19.10	236.29	0.08085	2	1	WLP
582	CT01	HC	A01152	374	0.30	453.52	0.00066	2	1	OPA
583	CT05	HC	H01161	484	0.21	543.55	0.39003	1	1	SDO
584	CT08	HC	H03161	462	0.40	487.26	0.00082	2	1	SDO
585	CT07	HC	H04161	471	3.17	565.75	5.61202	1	1	SDO
586	CT10	HC	H05171	630	0.22	722.07	0.00031	2	1	SDO
587	CT09	HC	H06171	907	0.32	988.00	0.00032	2	1	SDO
588	CT12	HC	H07171	597	0.55	650.32	0.00085	2	1	SDO
589	CT19	HC	H11191	599	2.00	713.91	0.00280	2	1	STC
590	CT21	HC	H11211	582	2.11	778.93	0.00271	2	1	STC
591	CT24	HC	H11221	553	1.08	718.41	0.00150	2	1	STC
592	CT16	HC	H17191	600	2.24	779.05	0.00288	2	1	STC
593	CT20	HC	H17211	582	2.09	663.53	0.00314	2	1	STC
594	CT25	HC	H17221	553	0.98	532.15	0.00184	2	1	STC
595	CT27	HC	H17241	578	0.12	11.23	0.00539	2	1	STC
596	JT01	HC	H17251	586	2.13	579.15	0.00368	2	1	STC
597	JT03	HC	H17281	593	1.14	590.27	0.00193	2	1	STC
598	CT15	HC	H18191	598	2.17	701.13	0.00310	2	1	STC
599	CT23	HC	H18211	582	0.97	698.15	0.00139	2	1	STC
600	JT02	HC	H18261	585	4.11	591.72	0.00695	2	1	STC
601	CT28	HC	H18261	597	0.12	11.65	0.00519	2	1	STC
602	JT04	HC	H18301	580	1.50	575.74	0.00261	2	1	STC
603	CT18	HC	H20191	597	2.25	780.94	0.00288	2	1	STC
604	CT13	HC	IS1171	633	0.55	737.50	0.00074	2	1	SDO
605	CT14	HC	IS2171	619	0.22	785.68	0.00027	2	1	SDO
606	CT04	HC	PF1161	484	0.11	543.55	0.00021	2	1	SDO
607	CT06	HC	PF4161	472	3.13	617.65	0.00506	2	1	SDO
608	CT11	HC	RM1171	646	1.10	673.10	0.00164	2	1	SDO
609	CT17	HC	STA191	494	3.80	560.05	0.00679	2	1	STC
610	CT22	HC	STA211	580	0.96	770.50	0.00124	2	1	STC
611	CT26	HC	STA231	540	0.12	10.92	0.00554	2	1	STC
612	CT40	HC	STA301	290	0.12	5.68	0.01065	2	1	STC
613	CT02	HC	U02153	450	0.11	443.65	0.00025	2	1	OPU
614	CT03	HC	U03153	422	0.55	416.04	0.00132	2	1	OPU
615	CT87	HC	W04041	254	0.12	5.02	0.01206	2	1	WOK
616	CT86	HC	W04051	557	0.12	11.21	0.00540	2	1	WOK

TABLE 1B. TURNAROUND WORKER EXPOSURES
AT DORCHESTER REFINING COMPANY
ON SEPTEMBER 15-OCTOBER 5, 1981

OBS	SAMPLE	REG	MAN	TIME	ANR	CVOL	REC	A	C	JOB
617	CT83	HC	W08011	260	0.1	9.32	0.009398	2	1	WSO
618	5737	LI	A01021	290	1.0	481.85	0.001038	2	1	WOR
619	5855	LI	SSA221	575	1.0	959.13	0.000521	2	1	WSS
620	5835	LI	W05181	592	1.0	925.54	0.000540	2	1	WSO
621	5807	LI	W05291	185	1.0	310.38	0.001611	2	1	WSS
622	5774R	LI	W05301	300	1.0	506.26	0.000988	2	1	WOR
623	5723	LI	W07301	393	1.0	663.19	0.000754	2	1	WOO
624	5747R	LI	W08021	140	1.0	236.25	0.002116	2	1	WLP
625	5737	MG	A01021	290	1.0	481.85	0.001038	2	1	WOR
626	5855	MG	SSA221	575	32.0	959.13	0.033363	2	1	WSS
627	5835	MG	W05181	592	15.9	925.54	0.016747	2	1	WSO
628	5807	MG	W05291	185	2.3	310.38	0.007410	2	1	WSS
629	5774R	MG	W05301	300	1.0	506.26	0.000988	2	1	WOR
630	5723	MG	W07301	393	1.0	663.19	0.000754	2	1	WOO
631	5747R	MG	W08021	140	1.0	236.25	0.002116	2	1	WLP
632	5763	MN	A01021	195	5.0	324.00	0.015432	2	1	WOR
633	5737	MN	A01021	290	12.0	481.85	0.024904	2	1	WOR
634	1268	MN	H05251	430	2.0	382.48	0.002615	2	1	KBR
635	1619	MN	H06291	509	49.0	1004.94	0.048759	2	1	CFO
636	5796	MN	H09261	579	4.0	995.61	0.004018	2	1	WOK
637	7620R	MN	H15281	561	2.0	949.31	0.002107	2	1	WOK
638	5762R	MN	H16021	224	34.0	372.19	0.091352	2	1	WLP
639	5751R	MN	H16021	227	2.0	377.17	0.002651	2	1	WLP
640	5838	MN	H21251	289	2.0	483.27	0.004138	2	1	WOR
641	5867R	MN	PF4221	547	48.0	912.43	0.052607	2	1	WSS
642	5752R	MN	RMA021	178	27.0	295.76	0.091292	2	1	WOR
643	5768R	MN	RMA021	307	21.0	510.09	0.041169	2	1	WOR
644	5549R	MN	RMA021	125	2.0	207.69	0.004815	2	1	WOR
645	1271	MN	RTA301	260	2.0	438.75	0.002279	2	1	WOO
646	5855	MN	SSA221	575	6.4	959.13	0.006673	2	1	WSS
647	5940	MN	SSA241	222	16.0	371.54	0.043064	2	1	WSS
648	5860	MN	W01291	220	90.0	369.09	0.243840	2	1	WOO
649	1270R	MN	W01291	273	2.0	458.01	0.002183	2	1	WOO
650	5759R	MN	W02011	90	57.0	152.35	0.374144	2	1	WOR
651	5836	MN	W02251	299	2.0	499.99	0.004000	2	1	WOR
652	5805	MN	W02261	576	10.0	990.45	0.010096	2	1	WOR
653	5761R	MN	W08021	228	18.0	378.83	0.047514	2	1	WLP
654	5772R	MN	W08301	275	100.0	464.07	0.215486	2	1	WOO
655	5787	MN	W02211	550	37.0	920.47	0.040197	2	1	WOO
656	1264	MN	W02241	481	16.0	805.00	0.019876	2	1	WSO
657	1263	MN	W02251	245	6.0	411.63	0.014576	2	1	WOR
658	5953	MN	W03231	606	63.0	1013.36	0.062169	2	1	WSS
659	5835	MN	W05181	592	30.2	925.54	0.032630	2	1	WSO
660	5775	MN	W05211	550	640.0	926.94	0.690445	2	1	WSS
661	5807	MN	W05291	185	76.0	310.38	0.244865	2	1	WSS
662	5774R	MN	W05301	300	379.0	506.26	0.748634	2	1	WOR
663	5723	MN	W07301	393	1.0	663.19	0.000754	2	1	WOO
664	2449R	MN	W08011	497	5.0	841.30	0.005943	2	1	WSI
665	5747R	MN	W08021	140	13.9	236.25	0.058835	2	1	WLP
666	5737	MO	A01021	290	1.4	481.85	0.002905	2	1	WOR
667	5855	MO	SSA221	575	6.4	959.13	0.006673	2	1	WSS
668	5835	MO	W05181	592	51.9	925.54	0.056076	2	1	WSO
669	5807	MO	W05291	185	1.0	310.38	0.001611	2	1	WSS
670	5774R	MO	W05301	300	1.0	506.26	0.000988	2	1	WOR
671	5723	MO	W07301	393	1.0	663.19	0.000754	2	1	WOO
672	5747R	MO	W08021	140	1.0	236.25	0.002116	2	1	WLP

TABLE 1B. TURNAROUND WORKER EXPOSURES
AT DORCHESTER REFINING COMPANY
ON SEPTEMBER 15-OCTOBER 5, 1981

OBS	SAMPLE	REG	MAN	TIME	ANR	CVOL	REC	A	C	JOB
673	5737	NA	A01021	290	16.5	481.85	0.03424	2	1	WOR
674	5855	NA	SSA221	575	173.1	959.13	0.18048	2	1	WSS
675	5835	NA	W05181	592	23.8	925.54	0.02571	2	1	WSO
676	5807	NA	W05291	185	56.4	310.38	0.18172	2	1	WSS
677	5774R	NA	W05301	300	5.1	506.26	0.01007	2	1	WOR
678	5723	NA	W07301	393	1.0	663.19	0.00075	2	1	WOO
679	5747R	NA	W08021	140	24.4	236.25	0.10328	2	1	WLP
680	5737	NI	A01021	290	14.2	481.85	0.02947	2	1	WOR
681	5843	NI	A01241	572	3.0	957.29	0.00157	2	1	RCO
682	5786	NI	H01211	570	16.0	960.65	0.01666	2	1	RCO
683	5779	NI	H05211	576	39.0	970.76	0.04017	2	1	RCO
684	5834	NI	H06171	123	3.0	208.78	7.18447	3	1	CSS
685	5830	NI	H07261	553	3.0	950.90	0.00158	2	1	RCO
686	1613	NI	H07291	310	3.0	520.09	0.00288	2	1	CSS
687	1277R	NI	H07301	158	3.0	266.63	0.00563	2	1	CFO
688	5826	NI	H09181	634	17.0	991.20	0.01715	2	1	CSO
689	5895R	NI	H09191	625	3.0	1029.53	0.00291	2	1	CSO
690	5863	NI	H09221	583	18.0	972.48	0.01851	2	1	RCO
691	2942	NI	H09231	317	3.0	530.09	0.00283	2	1	RCO
692	5857	NI	H09231	275	4.0	459.86	0.00870	2	1	RCO
693	5946	NI	H09241	579	8.0	969.01	0.00826	2	1	RCO
694	1614R	NI	H09251	583	3.0	979.52	0.00153	2	1	RCO
695	5795R	NI	H09281	572	3.0	967.92	0.00155	2	1	RPR
696	5846R	NI	H09291	624	3.0	1046.89	0.00143	2	1	CSS
697	1274R	NI	H09301	616	3.0	1039.91	0.00144	2	1	CSO
698	1612	NI	H10251	566	3.0	950.95	0.00158	2	1	KRO
699	5827	NI	H12171	173	11.0	278.58	0.03949	2	1	CSS
700	5854	NI	H12241	552	3.0	923.82	0.00162	2	1	RCO
701	5801R	NI	H13181	361	3.0	564.39	0.00266	2	1	CSO
702	5784	NI	H13191	631	8.0	1039.41	0.00770	2	1	KCO
703	5788	NI	H14181	635	4.0	992.76	0.00403	2	1	CSO
704	5894	NI	H14191	630	18.0	1037.77	0.01734	2	1	CSO
705	5798	NI	H14221	582	55.0	970.81	0.05665	2	1	RCO
706	5941	NI	H14231	590	3.0	986.60	0.00152	2	1	RCO
707	5859	NI	H14241	570	4.0	967.33	0.00414	2	1	RCO
708	1259R	NI	H14251	576	3.0	967.76	0.00155	2	1	KCO
709	5789	NI	H14261	594	4.0	1021.40	0.00392	2	1	CSS
710	5893	NI	H14281	568	3.0	961.15	0.00156	2	1	KCO
711	1276R	NI	H14301	611	3.0	1031.07	0.00145	2	1	CSO
712	5902	NI	H15191	605	40.0	996.59	0.04014	2	1	KCO
713	5880	NI	H15211	576	82.0	970.76	0.08447	2	1	RCO
714	5881R	NI	H15231	584	3.0	976.57	0.00154	2	1	RCO
715	5886R	NI	H16191	623	30.0	1026.24	0.02923	2	1	KCO
716	5849	NI	H16221	581	3.0	969.14	0.00155	2	1	RCO
717	7623	NI	H16231	572	28.0	964.02	0.02905	2	1	KCO
718	5938	NI	H16231	615	3.0	725.94	0.00207	2	1	RCO
719	5848R	NI	H16241	578	3.0	870.60	0.00172	2	1	CFO
720	5852	NI	H16261	594	3.0	1021.40	0.00147	2	1	CSS
721	5773	NI	H16301	611	3.0	1031.07	0.00145	2	1	KCO
722	5765R	NI	H17021	295	3.0	490.16	0.00306	2	1	DCO
723	5730R	NI	H17031	394	3.0	650.44	0.00461	2	1	DCO
724	5760R	NI	H18031	384	3.0	633.94	0.00237	2	1	DCO
725	1265	NI	H21254	225	3.0	189.01	0.00794	2	1	KCO
726	5792	NI	H21281	555	3.0	939.15	0.00160	2	1	RPR
727	5875	NI	H22241	552	3.0	923.82	0.00162	2	1	RCO
728	5851	NI	H23231	522	3.0	872.89	0.00172	2	1	CSS

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AT DORCHESTER REFINING COMPANY
ON SEPTEMBER 15-OCTOBER 5, 1981

OBS	SAMPLE	REG	MAN	TIME	ANN	CVOL	REC	A	C	JOB
729	1269	NI	KLA261	372	5.0	639.666	0.01	2	1	RCO
730	1618	NI	1	505	3.0	848.466	0.00	2	1	KBR
731	5832	NI	KUA191	445	9.0	733.026	0.01	2	1	RCO
732	5861	NI	PF1231	587	3.0	981.588	0.00	2	1	RCO
733	5839	NI	PF1261	569	3.0	978.414	0.00	2	1	RCO
734	5793	NI	PF1281	550	3.0	930.694	0.00	2	1	RPR
735	5847	NI	PF2231	541	10.0	638.588	0.02	2	1	RCO
736	5956	NI	RLA231	517	3.0	864.533	0.00	2	1	RCO
737	5800	NI	RMA281	559	3.0	945.923	0.00	2	1	RPR
738	5819R	NI	RMA291	575	3.0	964.680	0.00	2	1	RCO
739	588A	NI	RTA281	573	3.0	969.614	0.00	2	1	RPR
740	5781	NI	SSA181	205	34.0	320.498	0.11	2	1	CSS
741	5855	NI	SSA221	575	6.7	959.133	0.01	2	1	WSS
742	5767	NI	W04041	244	200.0	414.321	0.48	2	1	WOK
743	5543R	NI	W04041	244	3.0	414.321	0.00	2	1	WOK
744	5853	NI	W04041	244	3.0	414.321	0.00	2	1	WOK
745	5835	NI	W05181	592	9.5	925.536	0.01	2	1	WSO
746	5807	NI	W05291	185	20.8	310.375	0.07	2	1	WSS
747	5774R	NI	W05301	300	1.0	506.256	0.00	2	1	WOR
748	5723	NI	W07301	393	1.0	663.195	0.00	2	1	WOO
749	5747R	NI	W08021	140	5.7	236.253	0.02	2	1	WLP
750	5737	P	A01021	290	1.0	481.848	0.00	2	1	WOR
751	5855	P	SSA221	575	56.6	959.133	0.06	2	1	WSS
752	5835	P	W05181	592	1.6	925.536	0.00	2	1	WSO
753	5807	P	W05291	185	1.6	310.375	0.01	2	1	WSS
754	5774R	P	W05301	300	1.5	506.256	0.00	2	1	WOR
755	5723	P	W07301	393	1.0	663.195	0.00	2	1	WOO
756	5747R	P	W08021	140	1.0	236.253	0.00	2	1	WLP
757	5737	PB	A01021	290	1.0	481.848	0.00	2	1	WOR
758	5855	PB	SSA221	575	5.1	959.133	0.01	2	1	WSS
759	5835	PB	W05181	592	3.3	925.536	0.00	2	1	WSO
760	5807	PB	W05291	185	1.0	310.375	0.00	2	1	WSS
761	5774R	PB	W05301	300	1.1	506.256	0.00	2	1	WOR
762	5723	PB	W07301	393	1.2	663.195	0.00	2	1	WOO
763	5747R	PB	W08021	140	1.0	236.253	0.00	2	1	WLP
764	5737	PT	A01021	290	1.0	481.848	0.00	2	1	WOR
765	5855	PT	SSA221	575	1.0	959.133	0.00	2	1	WSS
766	5835	PT	W05181	592	1.0	925.536	0.00	2	1	WSO
767	5807	PT	W05291	185	1.0	310.375	0.00	2	1	WSS
768	5774R	PT	W05301	300	1.0	506.256	0.00	2	1	WOR
769	5723	PT	W07301	393	1.0	663.195	0.00	2	1	WOO
770	5747R	PT	W08021	140	1.0	236.253	0.00	2	1	WLP
771	PP2	PY	A02153	474	320.0	467.307	342.39	3	1	OPA
772	PP5	PY	H02161	470	320.0	458.983	348.60	3	1	SDO
773	PR10	PY	H06171	557	320.0	834.236	191.79	3	1	WOR
774	PP10	PY	H08171	635	320.0	601.487	266.01	3	1	SDO
775	PP9	PY	H09171	629	430.0	595.804	721.71	3	1	SDO
776	pC10	PY	H10031	289	330.0	420.973	783.90	3	1	WOK
777	PP8	PY	H10171	637	320.0	603.381	265.17	3	1	SDO
778	PP7	PY	H11171	644	320.0	610.012	262.29	3	1	SDO
779	PK10	PY	H12031	509	320.0	790.866	202.31	3	1	WOK
780	pG17	PY	KLA251	546	320.0	539.618	296.51	3	1	KBR
781	PP4	PY	PF1161	479	320.0	467.772	342.05	3	1	SDO
782	pF10	PY	PF3011	85	320.0	148.116	1080.23	3	1	FAC
783	P810	PY	PF3011	455	320.0	543.673	294.29	3	1	STC
784	pp6	PY	PF3161	465	320.0	454.100	352.35	3	1	SDO

TABLE 1B. TURNAROUND WORKER EXPOSURES
AT DORCHESTER REFINING COMPANY
ON SEPTEMBER 15-OCTOBER 5, 1981

OBS	SAMPLE	REG	MAN	TIME	ANR	CVOL	REC	A	C	JOB
785	PP3	PY	PR1161	479	320	467.77	342.05	3	1	SDU
786	PG12	PY	RMA221	503	320	493.55	324.18	3	1	RCO
787	PG16	PY	RMA241	550	280	541.46	517.12	3	1	RCO
788	PG18	PY	RMA261	563	320	569.47	280.96	3	1	WOR
789	PP20	PY	RMA291	537	320	794.94	201.27	3	1	RCO
790	PG11	PY	STA221	500	320	490.60	326.13	3	1	STC
791	P930	PY	STA301	455	320	587.16	272.50	3	1	STC
792	PP1	PY	U01152	379	320	373.65	428.21	3	1	OPU
793	5834	RW	H06171	123	1050	208.78	5029.13	3	1	CSS
794	1277R	RW	H07301	158	80	266.63	0.30	2	1	CFD
795	5895R	RW	H09191	625	4670	1029.53	4.54	2	1	CBO
796	1614R	RW	H09251	583	120	979.52	0.12	2	1	KCO
797	5795R	RW	H09281	572	7340	967.92	7.58	2	1	RPR
798	5846R	RW	H09291	624	1970	1046.89	1.88	2	1	CSS
799	1274R	RW	H09301	616	1160	1039.51	1.12	2	1	CSO
800	5801R	RW	H13181	361	3890	564.39	6.89	2	1	CSO
801	5788	RW	H14181	635	12990	992.76	13.08	2	1	CSO
802	1259R	RW	H14251	576	50	967.76	0.05	2	1	KCO
803	1276R	RW	H14301	611	240	1031.07	0.23	2	1	CSO
804	5881R	RW	H15231	584	10	976.57	0.01	2	1	RCO
805	7624R	RW	H15281	561	3400	949.31	3.58	2	1	WOK
806	5751R	RW	H16021	227	20	377.17	0.05	2	1	WLP
807	5762R	RW	H16021	224	640	372.19	1.72	2	1	WLP
808	5886R	RW	H16191	623	42770	1026.24	41.68	2	1	KCU
809	7623	RW	H16231	572	38720	964.02	40.17	2	1	RCO
810	5848R	RW	H16241	578	3640	870.60	4.18	2	1	CFD
811	5765R	RW	H17021	295	880	490.16	1.80	2	1	DCO
812	5730R	RW	H17031	394	1030	650.44	1.58	2	1	DCO
813	5760R	RW	H18031	384	470	633.94	0.74	2	1	DCO
814	5867R	RW	PF4221	547	780	912.43	0.85	2	1	WSS
815	1275R	RW	RLA041	235	3970	399.04	9.95	2	1	WOR
816	5549R	RW	RMA021	125	70	207.69	0.34	2	1	WOR
817	5752R	RW	RMA021	178	460	295.76	1.56	2	1	WOR
818	5768R	RW	RMA021	307	1040	510.09	2.04	2	1	WOR
819	5819R	RW	RMA291	575	660	964.68	0.68	2	1	RCO
820	1270R	RW	WO1291	273	30	458.01	0.07	2	1	WOO
821	5759R	RW	WO2011	90	1750	152.35	11.49	2	1	WOR
822	5761R	RW	WO8021	228	310	378.83	0.82	2	1	WLP
823	5772R	RW	WO8301	275	3010	464.07	6.49	2	1	WOO
824	5550R	RW	WO2031	459	1150	757.75	1.52	2	1	WOR
825	5543R	RW	WO4041	244	390	414.32	0.94	2	1	WOK
826	5853	RW	WO4041	244	810	414.32	1.96	2	1	WOK
827	5774R	RW	WO5301	300	1264	506.26	2.50	2	1	WOR
828	5552R	RW	WO7041	489	1550	830.34	1.87	2	1	WOK
829	2449R	RW	WO8011	497	100	841.30	0.12	2	1	WSI
830	5747R	RW	WO8021	140	209	236.25	0.88	2	1	WLP
831	5737	SE	A01021	290	1	481.85	0.00	2	1	WOR
832	5855	SE	SSA221	575	1	959.13	0.00	2	1	WSS
833	5835	SE	WO5181	592	1	925.54	0.00	2	1	WSO
834	5807	SE	WO5291	185	1	310.38	0.00	2	1	WSS
835	5774R	SE	WO5301	300	1	506.26	0.00	2	1	WOR
836	5723	SE	WO7301	393	1	663.19	0.00	2	1	WOO
837	5747R	SE	WO8021	140	1	236.25	0.00	2	1	WLP
838	5737	SN	A01021	290	1	481.85	0.00	2	1	WOR
839	5855	SN	SSA221	575	1	959.13	0.00	2	1	WSS
840	5835	SN	WO5181	592	1	925.54	0.00	2	1	WSO

TABLE 1B. TURNAROUND WORKER EXPOSURES
AT DORCHESTER REFINING COMPANY
ON SEPTEMBER 15-OCTOBER 5, 1981

OBS	SAMPLE	REG	MAN	TIME	ANN	CVOL	REC	A	C	JOB
841	5807	SN	W05291	185	1.00	310.375	0.00161	2	1	WSS
842	5774R	SN	W05301	300	1.00	506.256	0.00099	2	1	WOR
843	5723	SN	W07301	393	1.00	663.195	0.00075	2	1	WOO
844	5747R	SN	W08021	140	1.00	236.253	0.00212	2	1	WLP
845	5737	TE	A01021	290	1.00	481.848	0.00104	2	1	WOR
846	5855	TE	SSA221	575	1.00	959.133	0.00052	2	1	WSS
847	5835	TE	W05181	592	1.00	925.536	0.00054	2	1	WSO
848	5807	TE	W05291	185	1.00	310.375	0.00161	2	1	WSS
849	5774R	TE	W05301	300	1.00	506.256	0.00099	2	1	WOR
850	5723	TE	W07301	393	1.00	663.195	0.00075	2	1	WOO
851	5747R	TE	W08021	140	1.00	236.253	0.00210	2	1	WLP
852	5737	TI	A01021	290	4.90	481.848	0.01017	2	1	WOR
853	5855	TI	SSA221	575	12.90	959.133	0.01345	2	1	WSS
854	5835	TI	W05181	592	15.80	925.536	0.01707	2	1	WSO
855	5807	TI	W05291	185	24.10	310.375	0.07765	2	1	WSS
856	5774R	TI	W05301	300	22.10	506.256	0.04365	2	1	WOR
857	5723	TI	W07301	393	1.00	663.195	0.00075	2	1	WOO
858	5747R	TI	W08021	140	2.10	236.253	0.00889	2	1	WLP
859	5737	TL	A01021	290	1.00	481.848	0.00104	2	1	WOR
860	5855	TL	SSA221	575	1.00	959.133	0.00052	2	1	WSS
861	5835	TL	W05181	592	1.00	925.536	0.00054	2	1	WSO
862	5807	TL	W05291	185	1.00	310.375	0.00161	2	1	WSS
863	5774R	TL	W05301	300	1.00	506.256	0.00099	2	1	WOR
864	5723	TL	W07301	393	1.00	663.195	0.00075	2	1	WOO
865	5747R	TL	W08021	140	1.00	236.253	0.00212	2	1	WLP
866	CT05	TO	H01161	484	0.01	543.553	0.00920	1	1	SOO
867	CT07	TO	H04161	471	0.07	565.750	0.12373	1	1	SDO
868	CT10	TO	H05171	630	0.01	722.068	0.00001	2	1	SDO
869	CT09	TO	H06171	907	0.01	988.001	0.00001	2	1	SDO
870	CT12	TO	H07171	597	0.08	650.316	0.00003	2	1	SDO
871	CT21	TO	H11211	582	0.04	778.926	0.00005	2	1	STC
872	CT24	TO	H11221	553	0.03	718.408	0.00004	2	1	STC
873	CT16	TO	H17191	600	0.11	779.052	0.00014	2	1	STC
874	CT20	TO	H17211	582	0.01	663.530	0.00009	2	1	STC
875	CT25	TO	H17221	553	0.03	532.154	0.00006	2	1	STC
876	CT27	TO	H17241	578	0.01	11.232	0.00049	2	1	STC
877	JT01	TO	H17251	586	0.05	579.151	0.00009	2	1	STC
878	JT03	TO	H17281	593	0.06	590.269	0.00010	2	1	STC
879	CT15	TO	H18191	598	0.08	701.127	0.00011	2	1	STC
880	CT23	TO	H18211	582	0.01	694.276	0.00004	2	1	STC
881	JT02	TO	H18261	585	0.03	591.722	0.00005	2	1	STC
882	CT28	TO	H18261	597	0.01	11.647	0.00043	2	1	STC
883	CT18	TO	H20191	597	0.11	780.941	0.00014	2	1	STC
884	CT13	TO	IS1171	633	0.02	737.499	0.00003	2	1	SDO
885	CT14	TO	IS2171	619	0.01	785.684	0.00001	2	1	SDO
886	CT04	TO	PF1161	484	0.01	543.553	0.00001	2	1	SDO
887	CT06	TO	PF4161	472	0.05	617.654	0.00008	2	1	SDO
888	CT11	TO	RM1171	646	0.04	673.097	0.00006	2	1	SDO
889	CT22	TO	STA211	580	0.02	770.499	0.00003	2	1	STC
890	CT26	TO	STA231	540	0.01	10.916	0.00046	2	1	STC
891	CT40	TO	STA301	290	0.01	5.683	0.00088	2	1	STC
892	CT02	TO	U02153	450	0.01	443.646	0.00001	2	1	OPU
893	CT03	TO	U03153	422	0.02	416.041	0.00005	2	1	OPU
894	CT87	TO	W04041	254	0.01	5.018	0.00100	2	1	WOK
895	CT86	TO	W04051	557	0.01	11.209	0.00045	2	1	WOK
896	5763	TW	A01021	195	770.00	324.001	2.37653	2	1	WOR

TABLE 1B. TURNAROUND WORKER EXPOSURES
AT DORCHESTER REFINING COMPANY
ON SEPTEMBER 15-OCTOBER 5, 1981

OBS	SAMPLE	REG	MAN	TIME	ANA	CVOL	REC	A	C	JOB
897	5737	TW	A01021	290	3700	481.65	7.679	2	1	WOR
898	5843	TW	A01241	572	260	957.29	0.272	2	1	RCO
899	5786	TW	H01211	570	44910	960.65	46.750	2	1	RCO
900	5779	TW	H05211	576	50040	970.76	51.547	2	1	KCU
901	1268	TW	H05251	430	330	382.48	0.863	2	1	KBR
902	1619	TW	H06291	599	11580	1004.94	11.523	2	1	CFD
903	5830	TW	H07261	553	6790	950.90	7.141	2	1	RCO
904	1613	TW	H07291	310	140	520.09	0.269	2	1	CSS
905	5826	TW	H09181	634	44930	991.20	45.329	2	1	CSO
906	5863	TW	H09221	583	46570	972.48	47.888	2	1	RCU
907	5942	TW	H09231	317	530	530.09	1.000	2	1	KCO
908	5857	TW	H09231	275	6900	459.86	15.005	2	1	RCU
909	5946	TW	H09241	579	13620	969.01	14.056	2	1	RCO
910	5796	TW	H09261	579	230	995.61	0.231	2	1	WOK
911	1612	TW	H10251	566	290	950.95	0.305	2	1	KRO
912	5827	TW	H12171	173	16840	278.38	60.450	2	1	CSS
913	5854	TW	H12241	552	1900	923.82	2.057	2	1	RCO
914	5784	TW	H13191	631	9560	1039.41	9.197	2	1	KCO
915	5894	TW	H14191	630	16650	1037.77	16.044	2	1	CSO
916	5798	TW	H14221	582	326070	970.81	335.874	2	1	RCO
917	5941	TW	H14231	590	730	986.60	0.740	2	1	RCO
918	5859	TW	H14241	578	4910	967.33	5.076	2	1	RCO
919	5789	TW	H14261	594	65480	1021.40	64.108	2	1	CSS
920	5893	TW	H14281	568	5240	961.15	5.452	2	1	KCU
921	5902	TW	H15191	605	59680	996.59	59.884	2	1	KCO
922	5880	TW	H15211	576	130750	970.76	134.689	2	1	KCO
923	5849	TW	H16221	581	4290	969.14	4.427	2	1	RCO
924	5938	TW	H16231	615	6350	725.94	8.747	2	1	RCO
925	5852	TW	H16261	594	3140	1021.40	3.074	2	1	CSS
926	5773	TW	H16301	611	10660	1031.07	10.339	2	1	KCU
927	1265	TW	H21251	225	5000	189.01	26.453	2	1	KCO
928	5838	TW	H21251	289	17090	483.27	35.363	2	1	WOR
929	5792	TW	H21281	555	1020	939.15	1.086	2	1	RPR
930	5875	TW	H22241	552	990	923.82	1.072	2	1	RCO
931	5851	TW	H23231	522	1230	872.89	1.409	2	1	CSS
932	1269	TW	KLA261	372	40970	639.67	64.049	2	1	KCU
933	1618	TW	KMA251	505	140	848.47	0.165	2	1	KBR
934	5832	TW	KUA191	445	11940	733.03	15.743	2	1	KCU
935	5861	TW	PF1231	587	370	981.59	0.377	2	1	RCO
936	5839	TW	PF1261	569	130	978.41	0.133	2	1	KCU
937	5793	TW	PF1281	550	90	930.69	0.097	2	1	RPR
938	5847	TW	PF2231	541	147180	638.59	230.477	2	1	RCO
939	5956	TW	RLA231	517	130	864.53	0.150	2	1	RCO
940	5800	TW	RMA281	559	1180	945.92	1.247	2	1	RPR
941	5868	TW	RTA281	573	1280	969.61	1.320	2	1	RPR
942	5871	TW	RTA301	260	20	438.75	0.046	2	1	WOU
943	5781	TW	SSA181	205	98750	320.50	308.114	2	1	CSS
944	5855	TW	SSA221	575	3047	959.13	3.177	2	1	WSS
945	5940	TW	SSA241	222	1640	371.54	4.414	2	1	WSS
946	5814	TW	SSA291	310	380	520.09	0.731	2	1	WSS
947	5860	TW	WO1291	220	1970	369.09	5.337	2	1	WOO
948	5836	TW	WO2251	299	31700	499.99	63.401	2	1	WOR
949	5805	TW	WO2261	576	3180	990.45	3.211	2	1	WOR
950	5745	TW	WSA031	406	700	670.26	1.044	2	1	WOU
951	5754R	TW	WO2011	465	10340	790.70	0.033	2	1	WOR
952	5553R	TW	WO2031	46	10	78.20	0.128	2	1	WOR

TABLE 1B. TURNAROUND WORKER EXPOSURES
AT DORCHESTER REFINING COMPANY
ON SEPTEMBER 15-OCTOBER 5, 1981

OBS	SAMPLE	REG	MAN	TIME	ANR	CVOL	REC	A	C	JOB
953	5542	TW	W02041	235	3820.0	399.04	9.573	2	1	WOR
954	5787	TW	W02211	550	1390.0	920.47	1.510	2	1	WOU
955	1264	TW	W02241	481	650.0	809.00	0.807	2	1	WSO
956	1263	TW	W02251	245	56700.0	411.63	137.744	2	1	WOR
957	5953	TW	W03231	606	2460.0	1013.36	2.428	2	1	WSS
958	5767	TW	W04041	244	5780.0	414.32	13.951	2	1	WOK
959	5835	TW	W05181	592	486.4	925.54	0.526	2	1	WSO
960	5775	TW	W05211	550	6460.0	926.94	6.969	2	1	WSS
961	1258	TW	W05241	153	5640.0	256.06	22.026	2	1	WSS
962	5807	TW	W05291	185	440.1	310.38	1.418	2	1	WSS
963	5777R	TW	W05301	245	880.0	413.44	2.128	2	1	WOR
964	7617	TW	W06291	525	2360.0	880.74	2.679	2	1	WOK
965	1621	TW	W07041	489	1650.0	830.34	1.987	2	1	WOK
966	5723	TW	W07301	393	86.0	663.19	0.130	2	1	WOU
967	2450R	TW	W08301	296	530.0	499.51	1.061	2	1	WOO
968	5763	V	A01021	195	20.0	324.00	0.031	2	1	WOR
969	5737	V	A01021	290	1.0	481.85	0.001	2	1	WOR
970	5843	V	A01241	572	20.0	957.29	0.010	2	1	RCO
971	5786	V	H01211	570	20.0	960.65	0.010	2	1	RCO
972	5779	V	H05211	576	23.0	970.76	0.024	2	1	KCO
973	1268	V	H05251	430	20.0	382.48	0.026	2	1	KBR
974	5834	V	H06171	123	20.0	208.78	47.896	3	1	CSS
975	1619	V	H06291	599	20.0	1004.94	0.010	2	1	CFO
976	5830	V	H07261	553	10.0	950.90	0.005	2	1	KCO
977	1613	V	H07291	310	10.0	520.09	0.010	2	1	CSS
978	1277R	V	H07301	158	10.0	266.63	0.019	2	1	CFO
979	5826	V	H09181	634	20.0	991.20	0.010	2	1	C8O
980	5895R	V	H09191	625	20.0	1029.53	0.010	2	1	CSO
981	5863	V	H09221	583	23.0	972.48	0.024	2	1	RCO
982	2942	V	H09231	317	20.0	530.09	0.019	2	1	KCO
983	5857	V	H09231	275	20.0	459.86	0.022	2	1	RCO
984	5946	V	H09241	579	20.0	969.01	0.010	2	1	KCO
985	1614R	V	H09251	583	10.0	979.92	0.005	2	1	KCO
986	5795R	V	H09281	572	10.0	967.92	0.005	2	1	RPR
987	5846R	V	H09291	624	10.0	1046.09	0.005	2	1	CSS
988	1274R	V	H09301	616	10.0	1039.51	0.005	2	1	CSO
989	1612	V	H10251	566	10.0	950.95	0.005	2	1	KRO
990	5827	V	H12171	173	20.0	278.98	0.036	2	1	CSS
991	5854	V	H12241	552	20.0	923.82	0.011	2	1	RCO
992	5801R	V	H13181	361	20.0	564.39	0.018	2	1	C8O
993	5784	V	H13191	631	20.0	1039.41	0.010	2	1	KCO
994	5788	V	H14181	635	20.0	992.76	0.010	2	1	CSO
995	5894	V	H14191	630	20.0	1037.77	0.010	2	1	CSO
996	5798	V	H14221	582	69.0	970.81	0.071	2	1	RCO
997	5796	V	H14221	579	20.0	995.61	0.010	2	1	WOK
998	5941	V	H14231	590	20.0	986.60	0.010	2	1	RCO
999	5859	V	H14241	578	20.0	967.33	0.010	2	1	RCO
1000	1259R	V	H14251	576	10.0	967.76	0.005	2	1	KCO
1001	5789	V	H14261	594	10.0	1021.40	0.009	2	1	CSS
1002	5893	V	H14281	568	10.0	961.15	0.005	2	1	KCO
1003	1276R	V	H14301	611	10.0	1031.07	0.005	2	1	CSO
1004	5902	V	H15191	605	32.0	996.59	0.032	2	1	KCO
1005	5880	V	H15211	576	75.0	970.76	0.077	2	1	RCO
1006	5881R	V	H15231	584	20.0	976.57	0.010	2	1	RCO
1007	7624R	V	H15281	561	20.0	949.31	0.011	2	1	WOK
1008	5751R	V	H16021	227	20.0	177.17	0.027	2	1	WLP

TABLE 1B. TURNAROUND WORKER EXPOSURES
AT DORCHESTER REFINING COMPANY
ON SEPTEMBER 15-OCTOBER 5, 1981

OBS	SAMPLE	REQ	MAN	TIME	ANN	CVOL	REC	A	C	JOB
1009	5762R	V	H16021	224	20.0	372.19	0.026868	2	1	WLP
1010	5886R	V	H16191	623	26.0	1026.24	0.025335	2	1	KCO
1011	5849	V	H16221	581	20.0	969.14	0.01031 8	2	1	RCO
1012	7623	V	H16231	572	26.0	964.02	0.026970	2	1	KCO
1013	5938	V	H16231	615	20.0	725.94	0.013775	2	1	RCO
1014	5804R	V	H16241	578	10.0	870.60	0.005743	2	1	CFO
1015	5852	V	H16261	594	10.0	1021.40	0.004895	2	1	CSS
1016	5773	V	H16301	611	10.0	1031.07	0.004849	2	1	KCO
1017	5765R	V	H17021	295	10.0	490.16	0.010201	2	1	DCO
1018	5730R	V	H17031	394	10.0	650.44	0.007687	2	1	DCO
1019	5760R	V	H18031	384	10.0	633.94	0.007887	2	1	DCO
1020	1265	V	H21251	225	10.0	189.01	0.026453	2	1	KCO
1021	5838	V	H21251	289	20.0	483.27	0.020692	2	1	WOR
1022	5792	V	H21281	555	10.0	939.15	0.005324	2	1	RPR
1023	5875	V	H22241	552	20.0	923.82	0.010825	2	1	RCO
1024	5851	V	H23231	522	10.0	879.89	0.005728	2	1	CSS
1025	1269	V	KLA261	372	10.0	639.67	0.015633	2	1	KCO
1026	1618	V	KMA251	505	10.0	848.47	0.005893	2	1	KBR
1027	5832	V	KUA191	445	20.0	733.03	0.013642	2	1	KCO
1028	5861	V	PF1231	587	20.0	981.59	0.010188	2	1	RCO
1029	5839	V	PF1261	569	10.0	978.41	0.005110	2	1	KCO
1030	5793	V	PF1281	550	10.0	930.69	0.005372	2	1	RPR
1031	5847	V	PF2231	541	20.0	638.59	0.015660	2	1	RCO
1032	5867R	V	PF4221	547	20.0	912.43	0.010960	2	1	WSS
1033	5956	V	RLA231	517	20.0	864.53	0.011567	2	1	RCO
1034	5509R	V	RMA021	125	20.0	207.69	0.048148	2	1	WOR
1035	5752R	V	RMA021	178	20.0	295.76	0.033812	2	1	WOR
1036	5768R	V	RMA021	307	20.0	510.09	0.019604	2	1	WOR
1037	5800	V	RMA281	559	10.0	948.92	0.005286	2	1	RPR
1038	5819R	V	RMA291	575	10.0	964.68	0.005183	2	1	RCO
1039	5868	V	RTA281	573	10.0	969.61	0.005157	2	1	RPR
1040	1271	V	RTA301	260	20.0	438.75	0.022792	2	1	WOO
1041	5781	V	SSA181	205	35.0	320.50	0.109205	2	1	CSS
1042	5855	V	SSA221	575	34.3	959.13	0.035761	2	1	WSS
1043	5940	V	SSA241	222	20.0	371.54	0.026915	2	1	WSS
1044	1270R	V	WO1291	273	20.0	458.01	0.021833	2	1	WOO
1045	5860	V	WO1291	220	20.0	369.09	0.027093	2	1	WOO
1046	5759R	V	WO2011	90	20.0	152.35	0.065639	2	1	WOR
1047	5836	V	WO2251	299	20.0	499.99	0.020000	2	1	WOR
1048	5805	V	WO2261	576	20.0	990.45	0.010096	2	1	WOR
1049	5761R	V	WO8021	228	20.0	378.83	0.026397	2	1	WLP
1050	5772R	V	WO8301	275	20.0	464.07	0.021549	2	1	WOO
1051	5787	V	WO2211	550	20.0	920.47	0.010864	2	1	WOO
1052	1264	V	WO2241	481	20.0	805.00	0.012422	2	1	WSO
1053	1263	V	WO2251	245	47.0	411.63	0.114180	2	1	WOR
1054	5953	V	WO3231	606	20.0	1013.36	0.009868	2	1	WSS
1055	5503R	V	WO4041	248	20.0	414.32	0.024136	2	1	WOK
1056	5767	V	WO4041	248	20.0	414.32	0.024136	2	1	WOK
1057	5853	V	WO4041	248	20.0	414.32	0.024136	2	1	WOK
1058	5835	V	WO5181	592	1.0	925.54	0.000540	2	1	WSO
1059	5775	V	WO5211	550	20.0	926.94	0.010788	2	1	WSS
1060	5807	V	WO5291	185	1.0	310.38	0.001611	2	1	WSS
1061	5774R	V	WO5301	300	1.0	506.26	0.000988	2	1	WOR
1062	5723	V	WO7301	393	1.0	663.19	0.000754	2	1	WOO
1063	2409R	V	WO8011	497	20.0	841.30	0.011886	2	1	WSI
1064	5747R	V	WO8021	140	1.0	236.25	0.002116	2	1	WLP

TABLE 1B. TURNAROUND WORKER EXPOSURES
AT DORCHESTER REFINING COMPANY
ON SEPTEMBER 15-OCTOBER 5, 1981

OBS	SAMPLE	REG	MAN	TIME	ANN	CVOL	REC	A	C	JOB
1065	CT05	XY	H01161	484	0.01	543.553	0.0091987	1	1	SDO
1066	CT07	XY	H04161	471	0.04	565.750	0.0707026	1	1	SDO
1067	CT10	XY	H05171	630	0.01	722.068	0.0000069	2	1	SDO
1068	CT09	XY	H06171	907	0.01	988.001	0.0000051	2	1	SDO
1069	CT12	XY	H07171	597	0.01	650.316	0.0000077	2	1	SDO
1070	CT21	XY	H11211	582	0.03	778.926	0.0000385	2	1	STC
1071	CT24	XY	H11221	553	0.02	718.408	0.0000278	2	1	STC
1072	CT16	XY	H17191	600	0.09	779.052	0.0001155	2	1	STC
1073	CT20	XY	H17211	582	0.02	663.530	0.0000301	2	1	STC
1074	CT25	XY	H17221	553	0.02	532.154	0.0000376	2	1	STC
1075	CT27	XY	H17241	578	0.01	11.232	0.0004451	2	1	STC
1076	JT01	XY	H17231	586	0.04	579.151	0.0000691	2	1	STC
1077	CT15	XY	H18191	598	0.06	701.127	0.0000856	2	1	STC
1078	JT02	XY	H18261	585	0.04	591.722	0.0000676	2	1	STC
1079	CT13	XY	I81171	633	0.02	737.499	0.0000271	2	1	SDO
1080	CT14	XY	I92171	619	0.01	785.684	0.0000064	2	1	SDO
1081	CT06	XY	PF4161	472	0.03	617.654	0.0000486	2	1	SDO
1082	CT22	XY	STA211	580	0.02	770.499	0.0000260	2	1	STC
1083	CT26	XY	STA231	540	0.01	10.916	0.0004581	2	1	STC
1084	CT40	XY	STA301	290	0.01	5.683	0.0008799	2	1	STC
1085	CT02	XY	U02153	450	0.01	443.646	0.0000113	2	1	OPU
1086	CT03	XY	U03153	422	0.02	416.041	0.0000481	2	1	OPU
1087	CTA7	XY	W04041	254	0.01	5.018	0.0009964	2	1	WOR
1088	CTA6	XY	W04051	557	0.01	11.209	0.0004461	2	1	WOR
1089	5737	Y	A01021	290	1.00	481.848	0.0010377	2	1	WOR
1090	5855	Y	SSA221	575	1.00	959.133	0.0005213	2	1	WSS
1091	5835	Y	W05181	592	1.00	925.536	0.0005402	2	1	WSO
1092	5807	Y	W05291	185	1.00	310.375	0.0016110	2	1	WSS
1093	5774R	Y	W05301	300	1.00	506.256	0.0009876	2	1	WOR
1094	5723	Y	W07301	393	1.00	663.195	0.0007539	2	1	WOO
1095	5747R	Y	W08021	140	1.00	236.253	0.0021164	2	1	WLP
1096	5737	ZN	A01021	290	1.00	481.848	0.0010377	2	1	WOR
1097	5855	ZN	SSA221	575	10.00	959.133	0.0104261	2	1	WSS
1098	5835	ZN	W05181	592	2.20	925.536	0.0023770	2	1	WSO
1099	5807	ZN	W05291	185	5.30	310.375	0.0170761	2	1	WSS
1100	5774R	ZN	W05301	300	1.00	506.256	0.0009876	2	1	WOR
1101	5723	ZN	W07301	393	1.00	663.195	0.0007539	2	1	WOO
1102	5747R	ZN	W08021	140	1.00	236.253	0.0021164	2	1	WLP
1103	5737	ZR	A01021	290	1.00	481.848	0.0010377	2	1	WOR
1104	5855	ZR	SSA221	575	1.00	959.133	0.0005213	2	1	WSS
1105	5835	ZR	W05181	592	1.00	925.536	0.0005402	2	1	WSO
1106	5807	ZR	W05291	185	1.00	310.375	0.0016110	2	1	WSS
1107	5774R	ZR	W05301	300	1.00	506.256	0.0009876	2	1	WOR
1108	5723	ZR	W07301	393	1.00	663.195	0.0007539	2	1	WOO
1109	5747R	ZR	W08021	140	1.00	236.253	0.0021164	2	1	WLP

APPENDIX C

SUMMARY CHEMICAL EXPOSURES
OF TURNAROUND WORKERS AT
DORCHESTER REFINING COMPANY ON
September 15-October 5, 1981

TABLES 1-45

TABLE 1
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT SAMPLE #	ALUMINUM JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5763	WELDING OPERATION REACTOR	02	1	195	324.001	< 15.000	< 0.046	< 0.023
5737	WELDING OPERATION REACTOR	02	1	290	481.848	16.000	0.033	0.033
5796	WELDING OPERATION REACTOR	26	1	579	995.610	< 15.000	< 0.015	< 0.008
5795R	REACTOR PIPE REMOVAL	28	1	572	967.922	320.000	0.331	0.331
7624R	WELDING OPERATION KILN	28	1	561	949.308	300.000	0.316	0.316
5751R	WELDING LIFT PIPE	02	1	227	377.171	15.000	0.040	
5762R	WELDING LIFT PIPE	02	1	224	372.186	< 15.000	< 0.040	< 0.020
5838	WELDING OPERATION REACTOR	25	1	289	483.269	1200.000	2.483	2.483
5792	REACTOR PIPE	28	1	555	939.155	42.000	0.045	0.045
5793	REACTOR PIPE REMOVAL	28	1	550	930.694	< 10.000	< 0.011	< 0.005
5867R	WELDING SEPARATOR SURGE(S/S)	22	1	547	912.427	20.000	0.022	0.022
1275R	WELDING OPERATION REACTOR	04	1	235	399.039	24.000	0.060	0.060

TABLE 1
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT ALUMINUM

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5549R	WELDING OPERATION REACTOR	02	1	125	207.693	< 15.000	< 0.072	
5752R	WELDING OPERATION REACTOR	02	1	178	295.755	< 15.000	< 0.051	
5768R	WELDING OPERATION REACTOR	02	1	307	510.094	< 15.000	< 0.029	< 0.022
5800	REACTOR PIPE REMOVAL	28	1	559	945.923	45.000	0.048	0.048
5888	REACTOR PIPE REMOVAL	28	1	573	969.614	80.000	0.083	0.083
1271	WELDING OPERATION OUTSIDE	30	1	260	438.755	< 15.000	< 0.034	< 0.017
5855	WELDING SEPARATOR SURGE(S/S)	22	1	575	959.133	1841.000	1.919	1.919
5940	WELDING SEPARATOR SURGE(S/S)	24	1	222	371.537	110.000	0.296	0.296
1270R	WELDING OPERATION OUTSIDE	29	1	273	458.013	< 15.000	< 0.033	
5860	WELDING OPERATION OUTSIDE	29	1	220	369.095	44.000	0.119	0.062
5759R	WELDING OPERATION REACTOR	01	1	90	790.700	< 15.00	< 26.160	< 13.080
5836	WELDING OPERATION REACTOR	25	1	299	499.991	1400.00	2.800	2.800

TABLE 1
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT SAMPLE #	ALUMINUM JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5805	WELDING OPERATION REACTOR	26	1	576	990.451	260.000	0.263	0.263
5761R	WELDING LIFT PIPE	02	1	228	378.832	< 15.000	< 0.040	< 0.020
5772R	WELDING OPERATION OUTSIDE	30	1	275	464.068	24.000	0.052	0.052
5745	WELDING OPERATION OUTSIDE	03	1	406	670.255	< 10.000	< 0.015	< 0.007
5550R	WELDING OPERATION REACTOR	03	1	459	757.752	< 10.000	< 0.013	< 0.007
5542	WELDING OPERATION REACTOR	04	1	235	399.039	10.000	0.025	0.025
5787	WELDING OPERATION OUTSIDE	21	1	550	920.474	17.000	0.018	0.018
1264	WELDING (SHED/OUT-DOORS)	24	1	481	804.996	< 15.000	< 0.019	< 0.009
1263	WELDING OPERATION REACTOR	25	1	245	411.632	4300.000	10.446	10.446
5953	WELDING SEPARATOR SURGE(S/S)	23	1	606	1013.360	35.000	0.035	0.035
5543R	WELDING OPERATION KILN	04	1	244	414.321	< 7.000	< 0.017	
5767	WELDING OPERATION	04	1	244	414.321	20.000	0.048	

TABLE 1
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT ALUMINUM

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5853	WELDING OPERATION KILN	04	1	244	414.321	16.000	0.039	< 0.035
5835	WELDING (SHED/OUT-DOORS)	18	1	592	925.536	13.500	0.015	0.015
5775	WELDING SEPARATOR SURGE(S/S)	21	1	550	926.939	88.000	0.095	0.095
5807	WELDING SEPARATOR SURGE(S/S)	29	1	185	310.375	23.100	0.074	0.074
5774R	WELDING OPERATION REACTOR	30	1	300	506.256	9.800	0.019	0.019
1621	WELDING OPERATION KILN	04	1	489	830.340	< 10.000	< 0.012	
5552R	WELDING OPERATION KILN	04	1	489	830.340	23.000	0.028	< 0.017
5723	WELDING OPERATION OUTSIDE	30	1	393	663.195	< 5.300	< 0.008	0.008
2449R	WELDING SHOP (INSIDE)	01	1	497	841.299	< 15.000	< 0.018	< 0.009
5747R	WELDING LIFT PIPE	02	1	140	236.253	< 1.300	< 0.006	0.006

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	39	13.080	0.005	0.842	2.669	0.427	0.056	7.691	0.030	0.107

TABLE 2

FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT BARIUM

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5795R	REACTOR PIPE REMOVAL	28	1	572	967.922	37.000	0.038	0.038
5792	REACTOR PIPE REMOVAL	28	1	555	939.155	79.000	0.084	0.084
5793	REACTOR PIPE REMOVAL	28	1	550	930.694	< 3.000	< 0.003	< 0.002
5800	REACTOR PIPE REMOVAL	28	1	559	945.923	130.000	0.137	0.137
5888	REACTOR PIPE REMOVAL	28	1	573	969.614	17.000	0.018	0.018
5543R	WELDING OPERATION KILN	04	1	244	414.321	< 15.000	< 0.036	
5767	WELDING OPERATION KILN	04	1	244	414.321	< 15.000	< 0.036	
5853	WELDING OPERATION KILN	04	1	244	414.321	21.000	0.051	< 0.029

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	6	0.137	0.002	0.052	0.050	0.021	0.028	4.402	0.006	0.131

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

TABLE 3
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT CALCIUM

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5737	WELDING OPERATION REACTOR	02	1	290	481.848	12.200	0.025	0.025
5855	WELDING SEPARATOR SURGE(S/S)	22	1	575	959.133	125.000	0.130	0.130
5835	WELDING (SHED/OUT-DOORS)	18	1	592	925.536	64.400	0.070	0.070
5807	WELDING SEPARATOR SURGE(S/S)	29	1	185	310.375	33.900	0.109	0.109
5774R	WELDING OPERATION REACTOR	30	1	300	506.256	1.200	0.002	0.002
5723	WELDING OPERATION OUTSIDE	30	1	393	663.195	4.700	0.007	0.007
5747R	WELDING LIFT PIPE	02	1	140	236.253	4.300	0.018	0.018

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	7	0.130	0.002	0.052	0.052	0.020	0.026	4.402	0.007	0.102

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

TABLE 4
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT	CHROMIUM (TOTAL)							
SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5763	WELDING OPERATION REACTOR	02	1	195	324.001	28.000	0.086	0.086
5737	WELDING OPERATION REACTOR	02	1	290	481.848	15.500	0.032	0.032
5796	WELDING OPERATION KILN	26	1	579	995.610	4.000	0.004	0.004
5795R	REACTOR PIPE REMOVAL	28	1	572	967.922	< 3.000	< 0.003	< 0.002
7624R	WELDING OPERATION KILN	28	1	561	949.308	< 3.000	< 0.003	< 0.002
5751R	WELDING LIFT PIPE	02	1	227	377.171	< 3.000	< 0.008	
5762R	WELDING LIFT PIPE	02	1	224	372.186	43.000	0.116	0.059
5838	WELDING OPERATION REACTOR	25	1	289	483.269	9.000	0.019	0.019
5792	REACTOR PIPE REMOVAL	28	1	555	939.155	3.000	0.003	0.003
5793	REACTOR PIPE REMOVAL	28	1	550	930.694	< 3.000	< 0.003	< 0.002
5867R	WELDING SEPARATOR SURGE(S/S)	22	1	547	912.427	53.000	0.058	0.058
1275R	WELDING OPERATION REACTOR	04	1	235	399.039	220.000	0.551	0.551

TABLE 4
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT	CHROMIUM (TOTAL)							
SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5549R	WELDING OPERATION REACTOR	02	1	125	207.693	3.000	0.014	
5752R	WELDING OPERATION REACTOR	02	1	178	295.755	33.000	0.112	
5768R	WELDING OPERATION REACTOR	02	1	307	510.094	38.000	0.074	0.072
5800	REACTOR PIPE REMOVAL	28	1	559	945.923	< 3.000	< 0.003	< 0.002
5888	REACTOR PIPE REMOVAL	28	1	573	969.614	< 3.000	< 0.003	< 0.002
1271	WELDING OPERATION OUTSIDE	30	1	260	438.755	< 3.000	< 0.007	< 0.003
5855	WELDING SEPARATOR SURGE(S/S)	22	1	575	959.133	5.300	0.006	0.006
5940	WELDING SEPARATOR SURGE(S/S)	24	1	222	371.537	5.000	0.013	0.013
1270R	WELDING OPERATION OUTSIDE	29	1	273	458.013	< 3.000	< 0.007	
5860	WELDING OPERATION OUTSIDE	29	1	220	369.095	110.000	0.298	< 0.135
5759R	WELDING OPERATION REACTOR	01	1	90	152.248	67.000	0.440	0.440
5836	WELDING OPERATION REACTOR	25	1	299	499.991	10.000	0.020	0.020

TABLE 4
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT	CHROMIUM (TOTAL)							
SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5805	WELDING OPERATION REACTOR	26	1	576	990.451	4.000	0.004	0.004
5761R	WELDING LIFT PIPE	02	1	228	378.832	25.000	0.066	0.066
5772R	WELDING OPERATION OUTSIDE	30	1	275	464.068	< 3.000	< 0.006	< 0.003
5745	WELDING OPERATION OUTSIDE	03	1	406	670.255	46.000	0.069	0.069
5550R	WELDING OPERATION REACTOR	03	1	459	757.752	110.000	0.145	0.145
5542	WELDING OPERATION REACTOR	04	1	235	399.039	120.000	0.301	0.301
1264	WELDING (SHED/OUT-DOORS)	24	1	481	804.996	< 3.000	< 0.004	< 0.002
5953	WELDING SEPARATOR SURGE(S/S)	23	1	606	1013.360	< 3.000	< 0.003	< 0.001
5543R	WELDING OPERATION KILN	04	1	244	414.321	< 3.000	< 0.007	< 0.004
5835	WELDING (SHED/OUT-DOORS)	18	1	592	925.536	35.100	0.038	0.038
5775	WELDING SEPARATOR SURGE(S/S)	21	1	550	926.939	15.000	0.016	0.016
5774R	WELDING OPERATION REACTOR	30	1	300	506.256	4.700	0.009	0.009

TABLE 4
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT CHROMIUM (TOTAL)

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5723	WELDING OPERATION OUTSIDE	30	1	393	663.195	15.500	0.023	0.023
2449R	WELDING SHOP (INSIDE)	01	1	497	841.299	< 3.000	< 0.004	< 0.002
5747R	WELDING LIFT PIPE	02	1	140	236.253	14.900	0.063	0.063

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	35	0.551	0.001	0.064	0.124	0.021	0.015	6.253	0.008	0.027

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

TABLE 5
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT CHROMIUM(+3)

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5548	WELDING OPERATION REACTOR	02	1	125	206.535	< 0.100	< 0.001	< 0.001
5856	WELDING SEPARATOR SURGE(S/S)	22	1	407	678.899	1.700	0.003	0.003
5870	WELDING SEPARATOR SURGE(S/S)	22	1	578	964.137	39.700	0.041	0.041
1611	WELDING OPERATION OUTSIDE	30	1	293	494.443	< 0.100	< 0.001	< 0.001
5551	WELDING OPERATION REACTOR	03	1	432	780.301	1.000	0.001	0.001

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	5	0.041	0.000	0.009	0.018	0.008	0.001	10.480	0.000	0.020

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

TABLE 6
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT CHROMIUM(+6)

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5548	WELDING OPERATION REACTOR	02	1	125	206.535	<0.100	<0.001	<0.001
5856	WELDING SEPARATOR SURGE(S/S)	22	1	407	678.899	0.900	0.001	0.001
5814	WELDING SEPARATOR SURGE(S/S)	29	1	310	520.088	13.000	0.025	0.025
5758R	WELDING OPERATION REACTOR	01	1	465	24.426	26.000	1.064	1.064
5553R	WELDING OPERATION REACTOR	03	1	46	78.200	< 0.200	< 0.005	< 0.003
5870	WELDING SEPARATOR SURGE(S/S)	22	1	578	964.137	16.400	0.017	0.017
1258	WELDING SEPARATOR SURGE(S/S)	24	1	153	256.059	47.000	0.184	0.184
1611	WELDING OPERATION OUTSIDE	30	1	293	494.443	< 0.100	< 0.001	
5777R	WELDING OPERATION REACTOR	30	1	245	413.442	< 0.400	< 0.001	< 0.001
7617	WELDING OPERATION KILN	29	1	525	880.795	< 0.200	< 0.001	< 0.001

TABLE 6
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT CHROMIUM(+6)

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5551	WELDING OPERATION REACTOR	03	1	432	780.301	< 0.200	< 0.001	< 0.001
2450R	WELDING OPERATION OUTSIDE	30	1	296	499.506	< 0.200	< 0.001	< 0.001

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	11	1.064	0.000	0.118	0.319	0.096	0.003	21.202	0.000	0.024

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

TABLE 7
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT COPPER

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5737	WELDING OPERATION REACTOR	02	1	290	481.848	3.800	0.008	0.008
5835	WELDING (SHED/OUT-DOORS)	18	1	592	925.536	2.100	0.002	0.002
5774R	WELDING OPERATION REACTOR	30	1	300	506.256	1.500	0.003	0.003
5747R	WELDING LIFT PIPE	02	1	140	236.253	2.200	0.009	0.009

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	4	0.009	0.002	0.006	0.004	0.002	0.005	2.018	0.002	0.014

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

TABLE 8
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT IRON

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5763	WELDING OPERATION REACTOR	02	1	195	324.001	310.000	0.957	0.957
5737	WELDING OPERATION REACTOR	02	1	290	481.848	278.000	0.577	0.577
5796	WELDING OPERATION KILN	26	1	579	995.610	17.000	0.017	0.017
5795R	REACTOR PIPE REMOVAL	28	1	572	967.922	790.000	0.816	0.816
7624R	WELDING OPERATION KILN	28	1	561	949.308	120.000	0.126	0.126
5751R	WELDING LIFT PIPE	02	1	227	377.171	< 3.000	< 0.008	
5762R	WELDING LIFT PIPE	02	1	224	372.186	66.000	0.177	< 0.092
5838	WELDING OPERATION REACTOR	25	1	289	483.269	220.000	0.455	0.455
5792	REACTOR PIPE REMOVAL	28	1	555	939.155	80.000	0.085	0.085
5793	REACTOR PIPE REMOVAL	28	1	550	930.694	5.000	0.005	0.005
5867R	WELDING SEPARATOR SURGE(S/S)	22	1	547	912.427	81.000	0.089	0.089
1275R	WELDING SEPARATOR REACTOR	04	1	235	399.039	1900.000	4.761	4.761

TABLE 8
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT IRON

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5549R	WELDING OPERATION REACTOR	02	1	125	207.693	9.000	0.043	
5752R	WELDING OPERATION REACTOR	02	1	178	295.755	65.000	0.220	
5768R	WELDING OPERATION REACTOR	02	1	307	510.094	200.000	0.392	0.270
5800	REACTOR PIPE REMOVAL	28	1	559	945.923	130.000	0.137	0.137
5888	REACTOR PIPE REMOVAL	28	1	573	969.614	83.000	0.086	0.086
1271	WELDING OPERATION OUTSIDE	30	1	260	438.755	< 3.000	< 0.007	< 0.003
5855	WELDING SEPARATOR SURGE(S/S)	22	1	575	959.133	734.000	0.765	0.765
5940	WELDING SEPARATOR SURGE(S/S)	24	1	222	371.537	350.000	0.942	0.942
1270R	WELDING OPERATION OUTSIDE	29	1	273	458.013	< 3.000	< 0.007	
5860	WELDING OPERATION OUTSIDE	29	1	220	369.095	150.000	0.406	< 0.183
5759R	WELDING OPERATION REACTOR	01	1	90	152.348	870.000	5.711	5.711
5836	WELDING OPERATION	25	1	299	499.991	230.000	0.460	0.460

TABLE 8
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT - IRON

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5805	WELDING OPERATION REACTOR	26	1	576	990.451	150.000	0.151	0.151
5761R	WELDING LIFT PIPE	02	1	228	378.832	31.000	0.082	0.082
5772R	WELDING OPERATION OUTSIDE	30	1	275	464.068	570.000	1.228	1.228
5745	WELDING OPERATION OUTSIDE	03	1	406	670.255	75.000	0.112	0.112
5550R	WELDING OPERATION REACTOR	03	1	459	757.752	87.000	0.115	0.115
5542	WELDING OPERATION REACTOR	04	1	235	399.039	970.000	2.431	2.431
5787	WELDING OPERATION OUTSIDE	21	1	550	920.474	320.000	0.348	0.348
1264	WELDING (SHED/OUT-DOORS)	24	1	481	804.996	120.000	0.149	0.149
1263	WELDING OPERATION REACTOR	25	1	245	411.632	650.000	1.579	1.579
5953	WELDING SEPARATOR SURGE(S/S)	23	1	606	1013.360	580.000	0.572	0.572
5543R	WELDING OPERATION KILN	04	1	244	414.321	110.000	0.265	
5767	WELDING OPERATION KILN	04	1	244	414.321	2300.000	5.551	

TABLE 8
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT IRON

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5853	WELDING OPERATION KILN	04	1	244	414.321	57.000	0.138	1.985
5835	WELDING (SHED/OUT-DOORS)	18	1	592	925.536	174.000	0.188	0.188
5775	WELDING SEPARATOR SURGE(S/S)	21	1	550	926.939	2200.000	2.373	2.373
5907	WELDING SEPARATOR SURGE(S/S)	29	1	185	310.375	117.000	0.377	0.377
5774R	WELDING OPERATION REACTOR	30	1	300	506.256	840.000	1.659	1.659
1621	WELDING OPERATION KILN	04	1	489	830.340	440.000	0.530	
5552R	WELDING OPERATION KILN	04	1	489	830.340	360.000	0.434	0.482
5723	WELDING OPERATION OUTSIDE	30	1	393	663.195	77.400	0.117	0.117
2449R	WELDING SHOP (INSIDE)	01	1	497	841.299	31.000	0.037	0.037
5747R	WELDING LIFT PIPE	02	1	140	236.253	19.100	0.081	0.081

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	39	5.711	0.003	0.785	1.240	0.199	0.269	5.298	0.160	0.455

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

TABLE 9
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT MAGNESIUM

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5737	WELDING OPERATION REACTOR	02	1	290	481.848	< 1.000	< 0.002	< 0.001
5855	WELDING SEPARATOR SURGE(S/S)	22	1	575	959.133	32.000	0.033	0.033
5835	WELDING (SHED/OUT-DOORS)	18	1	592	925.536	15.500	0.017	0.017
5807	WELDING SEPARATOR SURGE(S/S)	29	1	185	310.375	2.300	0.007	0.007
5774R	WELDING OPERATION REACTOR	30	1	300	506.256	< 1.000	< 0.002	< 0.001
5723	WELDING OPERATION OUTSIDE	30	1	393	663.195	< 1.000	< 0.002	< 0.001
5747R	WELDING LIFT PIPE	02	1	140	236.253	< 1.000	< 0.004	< 0.002

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
N+ TOTAL	7	0.033	0.001	0.009	0.012	0.005	0.004	4.553	0.001	0.014

+ MORE THAN 50% OF THE VALUES USED TO COMPUTE THIS STATISTIC WERE BELOW THE LIMIT OF DETECTION
NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

TABLE 10
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT MANGANESE

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
1270R	WELDING OPERATION OUTSIDE	29	1	273	458.013	< 2.000	< 0.004	
5860	WELDING OPERATION OUTSIDE	29	1	220	369.095	90.000	0.244	< 0.110
5759R	WELDING OPERATION REACTOR	01	1	90	152.348	57.000	0.374	0.374
5836	WELDING OPERATION REACTOR	25	1	299	499.991	2.000	0.004	0.004
5805	WELDING OPERATION REACTOR	26	1	576	990.451	10.000	0.010	0.010
5761R	WELDING LIFT PIPE	02	1	228	378.832	18.000	0.048	0.048
5772R	WELDING OPERATION OUTSIDE	30	1	275	464.068	100.000	0.215	0.215
5787	WELDING OPERATION OUTSIDE	21	1	550	920.474	37.000	0.040	0.040
1264	WELDING (SHED/OUT-DOORS)	24	1	481	804.996	16.000	0.020	0.020
1263	WELDING OPERATION REACTOR	25	1	245	411.632	6.000	0.015	0.015
5953	WELDING SEPARATOR SURGE(S/S)	23	1	606	1013.360	63.000	0.062	0.062
5835	WELDING (SHED/OUT-DOORS)	18	1	592	925.536	30.200	0.033	0.033

TABLE 10
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT MANGANESE

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5775	WELDING SEPARATOR SURGE(S/S)	21	1	550	926.939	640.000	0.690	0.690
5807	WELDING SEPARATOR SURGE(S/S)	29	1	185	310.375	76.000	0.245	0.245
5774R	WELDING OPERATION REACTOR	30	1	300	506.256	379.000	0.749	0.749
5723	WELDING OPERATION OUTSIDE	30	1	393	663.195	< 1.000	< 0.002	< 0.001
2449R	WELDING SHOP (INSIDE)	01	1	497	841.299	5.000	0.006	0.006
5747R	WELDING LIFT PIPE	02	1	140	236.253	13.900	0.059	0.059

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	28	0.749	0.001	0.105	0.194	0.037	0.027	5.893	0.014	0.054

+ MORE THAN 50% OF THE VALUES USED TO COMPUTE THIS STATISTIC WERE BELOW THE LIMIT OF DETECTION
NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

TABLE 11
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT MOLYBDENUM

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5737	WELDING OPERATION REACTOR	02	1	290	481.848	1.400	0.003	0.003
5855	WELDING SEPARATOR SURGE(S/S)	22	1	575	959.133	6.400	0.007	0.007
5835	WELDING (SHED/OUT-DOORS)	18	1	592	925.536	51.900	0.056	0.056
5807	WELDING SEPARATOR SURGE(S/S)	29	1	185	310.375	< 1.000	< 0.003	< 0.002
5774R	WELDING OPERATION REACTOR	30	1	300	506.256	< 1.000	< 0.002	< 0.001
5723	WELDING OPERATION OUTSIDE	30	1	393	663.195	< 1.000	< 0.002	< 0.001
5747R	WELDING LIFT PIPE	02	1	140	236.253	< 1.000	< 0.004	< 0.002

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
+ TOTAL	7	0.056	0.001	0.010	0.020	0.008	0.003	4.322	0.001	0.012

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

TABLE 12
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT SODIUM

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5737	WELDING OPERATION REACTOR	02	1	290	481.848	16.500	0.034	0.034
5855	WELDING SEPARATOR SURGE(S/S)	22	1	575	959.133	173.100	0.018	0.018
5835	WELDING (SHED/OUT-DOORS)	18	1	592	925.536	23.800	0.026	0.026
5807	WELDING SEPARATOR SURGE(S/S)	29	1	185	310.375	56.400	0.182	0.182
5774R	WELDING OPERATION REACTOR	30	1	300	506.256	5.100	0.010	0.010
5723	WELDING OPERATION OUTSIDE	30	1	393	663.195	< 1.000	< 0.002	< 0.001
5747R	WELDING LIFT PIPE	02	1	140	236.253	24.400	0.103	0.103

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	7	0.182	0.001	0.077	0.079	0.030	0.030	7.022	0.005	0.183

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

TABLE 13
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT NICKEL

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5737	WELDING OPERATION REACTOR	02	1	290	481.848	14.200	0.029	0.029
5795R	REACTOR PIPE REMOVAL	28	1	572	967.922	< 3.000	<0.003	< 0.002
5792	REACTOR PIPE REMOVAL	28	1	555	939.155	< 3.000	<0.003	<0.002
5793	REACTOR PIPE REMOVAL	28	1	550	930.694	< 3.000	<0.003	<0.002
5800	REACTOR PIPE REMOVAL	28	1	559	945.923	< 3.000	< 0.003	<0.002
5888	REACTOR PIPE REMOVAL	28	1	573	969.614	< 3.000	< 0.003	<0.002
5855	WELDING SEPARATOR SURGE(S/S)	22	1	575	959.133	6.700	0.007	0.007
5543R	WELDING OPERATION KILN	04	1	244	414.321	< 3.000	< 0.007	
5767	WELDING OPERATION KILN	04	1	244	414.321	200.000	0.483	
5853	WELDING OPERATION KILN	04	1	244	414.321	< 3.000	< 0.007	< 0.163
5835	WELDING (SHED/OUT-DOORS)	18	1	592	925.536	9.500	0.010	0.010

TABLE 13
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT NICKEL

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5807	WELDING SEPARATOR SURGE(S/S)	29	1	185	310.375	20.800	0.067	0.067
5774R	WELDING OPERATION REACTOR	30	1	300	506.256	< 1.000	< 0.002	< 0.001
5723	WELDING OPERATION OUTSIDE	30	1	393	663.195	< 1.000	< 0.002	< 0.001
5747R	WELDING LIFT PIPE	02	1	140	236.253	5.000	0.024	0.024

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
+ TOTAL	7	0.163	0.001	0.024	0.046	0.013	0.005	5.912	0.002	0.016

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

TABLE 14
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT PHOSPHORUS

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5737	WELDING OPERATION REACTOR	02	1	290	481.848	< 1.000	< 0.002	< 0.001
5855	WELDING SEPARATOR SURGE(S/S)	22	1	575	959.133	56.600	0.059	0.059
5835	WELDING (SHED/OUT-DOORS)	18	1	592	925.536	1.600	0.002	0.002
5807	WELDING SEPARATOR SURGE(S/S)	29	1	185	310.375	1.600	0.005	0.005
5774R	WELDING OPERATION REACTOR	30	1	300	506.256	1.500	0.003	0.003
5723	WELDING OPERATION OUTSIDE	30	1	393	663.195	< 1.000	< 0.002	< 0.001
5747R	WELDING LIFT PIPE	02	1	140	236.253	< 1.000	< 0.004	< 0.002

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	7	0.059	0.001	0.010	0.021	0.008	0.003	4.265	0.001	0.012

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

TABLE 15
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT LEAD

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5737	WELDING OPERATION REACTOR	02	1	290	481.848	< 1.000	< 0.002	< 0.001
5855	WELDING SEPARATOR SURGE(S/S)	22	1	575	959.133	5.100	0.005	0.005
5835	WELDING (SHED/OUT-DOORS)	18	1	592	925.536	3.300	0.004	0.004
5807	WELDING SEPARATOR SURGE(S/S)	29	1	185	310.375	< 1.000	< 0.003	< 0.002
5774R	WELDING OPERATION REACTOR	30	1	300	506.256	1.100	0.002	0.002
5723	WELDING OPERATION OUTSIDE	30	1	393	663.195	1.200	0.002	0.002
5747R	WELDING LIFT PIPE	02	1	140	236.253	< 1.000	< 0.004	< 0.002

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	7	0.005	0.001	0.003	0.001	0.001	0.002	1.706	0.001	0.004

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

TABLE 16
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT SAMPLE #	RESPIRABLE JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5795R	REACTOR PIPE REMOVAL	28	1	572	967.922	7340.000	7.583	7.583
7624R	WELDING OPERATION KILN	28	1	561	949.308	3400.000	3.582	3.582
5751R	WELDING LIFT PIPE	02	1	227	377.171	20.000	0.053	
5762R	WELDING LIFT PIPE	02	1	224	372.186	640.000	1.720	0.881
5867R	WELDING SEPARATOR SURGE(S/S)	22	1	547	912.427	780.000	0.855	0.855
1275R	WELDING OPERATION REACTOR	04	1	235	399.039	3970.000	9.949	9.949
5549R	WELDING OPERATION REACTOR	02	1	125	207.693	70.000	0.337	
5752R	WELDING OPERATION REACTOR	02	1	178	295.755	460.000	1.555	
5768R	WELDING OPERATION REACTOR	02	1	307	510.094	1040.000	2.039	0.549
1270R	WELDING OPERATION OUTSIDE	29	1	273	458.013	30.000	0.066	0.066
5759R	WELDING OPERATION REACTOR	01	1	90	152.348	1750.000	11.487	11.487
5761R	WELDING LIFT PIPE	02	1	228	378.832	310.000	0.818	0.818

TABLE 16
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT SAMPLE #	RESPIRABLE JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5772R	WELDING OPERATION OUTSIDE	30	1	275	464.068	3010.000	6.486	6.486
5550R	WELDING OPERATION REACTOR	03	1	459	757.752	1150.000	1.518	1.518
5543R	WELDING OPERATION KILN	04	1	244	414.321	390.000	0.941	
5853	WELDING OPERATION KILN	04	1	244	414.321	810.000	1.955	0.448
5774R	WELDING OPERATION REACTOR	30	1	300	506.256	1264.000	2.497	2.497
5552R	WELDING OPERATION KILN	04	1	489	830.340	1550.000	1.867	1.867
2449R	WELDING SHOP (INSIDE)	01	1	497	841.299	100.00	0.119	0.119
5747R	WELDING LIFT PIPE	02	1	140	236.253	209.000	0.885	0.885

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	16	11.487	0.066	3.224	3.619	0.905	1.569	4.211	0.730	3.376

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

TABLE 17
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT SAMPLE #	TOTAL JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5763	WELDING OPERATION REACTOR	02	1	195	324.001	770.000	2.377	2.377
5737	WELDING OPERATION REACTOR	02	1	290	481.848	3700.000	7.679	7.679
5796	WELDING OPERATION KILN	26	1	579	995.610	230.000	0.231	0.231
5838	WELDING OPERATION REACTOR	25	1	289	483.269	17090.000	35.363	35.363
5792	REACTOR PIPE REMOVAL	28	1	555	939.155	1020.000	1.086	1.086
5793	REACTOR PIPE REMOVAL	28	1	550	930.694	90.000	0.097	0.097
5800	REACTOR PIPE REMOVAL	28	1	559	945.923	1180.000	1.247	1.247
5888	REACTOR PIPE REMOVAL	28	1	573	969.614	1280.000	1.320	1.320
1271	WELDING OPERATION OUTSIDE	30	1	260	438.755	20.000	0.046	0.046
5855	WELDING SEPARATOR SURGE(S/S)	22	1	575	959.133	3047.500	3.177	3.177
5940	WELDING SEPARATOR SURGE(S/S)	24	1	222	371.537	1640.000	4.414	4.414

TABLE 17
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT SAMPLE #	TOTAL JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5814	WELDING SEPARATOR SURGE(S/S)	29	1	310	520.088	380.000	0.731	0.731
5860	WELDING OPERATION OUTSIDE	29	1	220	369.095	1970.000	5.337	5.337
5836	WELDING OPERATION REACTOR	25	1	299	499.991	31700.000	63.401	63.401
5805	WELDING OPERATION REACTOR	26	1	576	990.451	3180.000	3.211	3.211
5745	WELDING OPERATION OUTSIDE	03	1	406	670.255	700.000	1.044	1.044
5542	WELDING OPERATION REACTOR	04	1	235	399.039	3820.000	9.573	9.573
5787	WELDING OPERATION OUTSIDE	21	1	550	920.474	1390.000	1.510	1.510
1264	WELDING (SHED/OUT-DOORS)	24	1	481	804.996	650.000	0.807	0.807
1263	WELDING OPERATION REACTOR	25	1	245	411.632	56700.000	137.744	137.744
5953	WELDING SEPARATOR SURGE(S/S)	23	1	606	1013.360	2460.000	2.428	2.428
5767	WELDING OPERATION KILN	04	1	244	414.321	5780.000	13.951	13.951

TABLE 17
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT SAMPLE #	TOTAL JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5835	WELDING (SHED/OUT-DOORS)	18	1	592	925.536	486.400	0.526	0.526
5775	WELDING SEPARATOR SURGE(S/S)	21	1	550	926.939	6460.000	6.969	6.969
1258	WELDING SEPARATOR SURGE(S/S)	24	1	153	256.059	5640.000	22.026	22.026
5807	WELDING SEPARATOR SURGE(S/S)	29	1	185	310.375	440.100	1.418	1.418
7617	WELDING OPERATION KILN	29	1	525	880.795	2360.000	2.679	2.679
1621	WELDING OPERATION KILN	04	1	489	830.340	1650.000	1.987	1.987
5723	WELDING OPERATION OUTSIDE	30	1	393	663.195	86.000	0.130	0.130

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	29	137.744	0.046	11.466	27.654	5.135	2.352	6.340	1.165	4.747

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

TABLE 18
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT TITANIUM

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5737	WELDING OPERATION REACTOR	02	1	290	481.848	4.900	0.010	0.010
5855	WELDING SEPARATOR SURGE(S/S)	22	1	575	959.133	12.900	0.013	0.013
5835	WELDING (SHED/OUT-DOORS)	18	1	592	925.536	15.800	0.017	0.017
5807	WELDING SEPARATOR SURGE(S/S)	29	1	185	310.375	24.100	0.078	0.078
5774R	WELDING SEPARATOR REACTOR	30	1	300	506.256	22.100	0.044	0.044
5723	WELDING OPERATION OUTSIDE	30	1	393	663.195	<1.000	<0.002	<0.001
5747R	WELDING LIFT PIPE	02	1	140	236,253	2.100	0.009	0.009

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	7	0.078	0.001	0.025	0.027	0.010	0.013	4.369	0.003	0.050

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

TABLE 19
FUME EXPOSURE LEVELS AT WELDING OPERATIONS
DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT ZINC

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5737	WELDING OPERATION REACTOR	02	1	290	481.848	< 1.000	< 0.002	< 0.001
5855	WELDING SEPARATOR SURGE(S/S)	22	1	575	959.133	10.000	0.010	0.010
5835	WELDING (SHED/OUT-DOORS)	18	1	592	925.536	2.200	0.002	0.002
5807	WELDING SEPARATOR SURGE(S/S)	29	1	185	310.375	5.300	0.017	0.017
5774R	WELDING OPERATION REACTOR	30	1	300	506.256	< 1.000	< 0.002	< 0.001
5723	WELDING OPERATION OUTSIDE	30	1	393	663.195	< 1.000	< 0.002	< 0.001
5747R	WELDING LIFT PIPE	02	1	140	236.253	< 1.000	< 0.004	< 0.002

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
+ TOTAL	7	0.017	0.001	0.005	0.006	0.002	0.003	3.364	0.001	0.008

+ MORE THAN 50% OF THE VALUES USED TO COMPUTE THIS STATISTIC WERE BELOW THE LIMIT OF DETECTION
NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

Table 20
WORKER EXPOSURE TO METAL CONTAINING DUST DURING REACTOR CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT ALUMINUM

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5843	REACTOR CLEANING OPERATION	24	1	572	957.293	< 4.000	< 0.004	< 0.002
5786	REACTOR CLEANING OPERATION	21	1	570	960.646	3100.000	3.227	3.227
5863	REACTOR CLEANING OPERATION	22	1	583	972.477	3200.000	3.291	3.291
5857	REACTOR CLEANING OPERATION	23	1	275	459.858	580.000	1.261	1.261
5854	REACTOR CLEANING OPERATION	24	1	552	923.821	120.000	0.130	0.130
5798	REACTOR CLEANING OPERATION	22	1	582	970.809	21000.000	21.631	21.631
5941	REACTOR CLEANING OPERATION	23	1	590	986.604	34.000	0.034	0.034

Table 20
WORKER EXPOSURE TO METAL CONTAINING DUST DURING REACTOR CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT ALUMINUM

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5859	REACTOR CLEANING OPERATION	24	1	578	967.334	370.000	0.382	0.382
5881R	REACTOR CLEANING OPERATION	23	1	584	976.571	< 4.000	< 0.004	< 0.002
5849	REACTOR CLEANING OPERATION	22	1	581	969.141	190.000	0.196	0.196
5938	REACTOR CLEANING OPERATION	23	1	615	725.936	340.000	0.468	0.468
5875	REACTOR CLEANING OPERATION	24	1	552	923.821	52.000	0.056	
5861	REACTOR CLEANING OPERATION	23	1	587	981.588	25.000	0.025	0.025
5847	REACTOR CLEANING OPERATION	23	1	541	638.588	6600.000	10.335	10.335
5956	REACTOR CLEANING OPERATION	23	1	517	864.533	< 15.000	< 0.017	< 0.009
5819R	REACTOR CLEANING OPERATION	29	1	575	964.680	23.000	0.024	0.024

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95 LCL	95% UCL
TOTAL	16	21.631	0.004	2.567	5.730	1.433	0.188	15.210	0.044	0.801

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

Table 21
WORKER EXPOSURE TO METAL CONTAINING DUST DURING REACTOR CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT: BARIUM

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5843	REACTOR CLEANING OPERATION	24	1	572	957.293	< 15.000	< 0.016	< 0.008
5786	REACTOR CLEANING OPERATION	21	1	570	960.646	540.000	0.562	0.562
5863	REACTOR CLEANING OPERATION	22	1	583	972.477	320.000	0.329	0.329
5857	REACTOR CLEANING OPERATION	23	1	275	459.858	110.000	0.239	0.239
5854	REACTOR CLEANING OPERATION	24	1	552	923.821	89.000	0.096	0.096
5798	REACTOR CLEANING OPERATION	22	1	582	970.809	110.000	0.113	0.113
5941	REACTOR CLEANING OPERATION	23	1	590	986.604	< 15.000	< 0.015	< 0.008
5859	REACTOR CLEANING OPERATION	24	1	578	967.334	75.000	0.078	0.078
5881R	REACTOR CLEANING OPERATION	23	1	584	976.571	< 15.000	< 0.015	< 0.008

Table 21
WORKER EXPOSURE TO METAL CONTAINING DUST DURING REACTOR CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT: BARIUM

SAMPLE #	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5881R	REACTOR CLEANING OPERATION	23	1	584	976.571	< 15.000	< 0.015	< 0.008
5849	REACTOR CLEANING OPERATION	22	1	581	969.141	160.000	0.165	0.165
5938	REACTOR CLEANING OPERATION	23	1	615	725.936	94.000	0.129	0.129
5875	REACTOR CLEANING OPERATION	24	1	552	923.821	28.000	0.030	0.030
5861	REACTOR CLEANING OPERATION	23	1	587	981.588	< 15.000	< 0.015	< 0.008
5847	REACTOR CLEANING OPERATION	23	1	541	638.588	59.000	0.092	0.092
5956	REACTOR CLEANING OPERATION	23	1	517	864.533	<15.000	< 0.017	< 0.009
5819R	REACTOR CLEANING OPERATION	29	1	575	964.680	9.000	0.009	0.009

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	16	0.562	0.008	0.118	0.151	0.038	0.047	4.704	0.021	0.108

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

Table 22
WORKER EXPOSURE TO METAL CONTAINING DUST DURING REACTOR CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15–OCTOBER 5, 1981

REAGENT	CHROMIUM (TOTAL)							
SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5843	REACTOR CLEANING OPERATION	24	1	572	957.293	< 3.000	< 0.003	< 0.002
5786	REACTOR CLEANING OPERATION	21	1	570	960.646	22.000	0.023	0.023
5863	REACTOR CLEANING OPERATION	22	1	583	972.477	28.000	0.029	0.029
5857	REACTOR CLEANING OPERATION	23	1	275	459.858	6.000	0.013	0.013
5854	REACTOR CLEANING OPERATION	24	1	552	923.821	4.000	0.004	0.004
5798	REACTOR CLEANING OPERATION	22	1	582	970.809	230.000	0.237	0.237
5941	REACTOR CLEANING OPERATION	23	1	590	986.604	< 3.000	< 0.003	< 0.002
5859	REACTOR CLEANING OPERATION	24	1	578	967.334	4.000	0.004	0.004
5881R	REACTOR CLEANING OPERATION	23	1	584	976.571	< 3.000	< 0.003	< 0.002

Table 22

WORKER EXPOSURE TO METAL CONTAINING DUST DURING REACTOR CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT CHROMIUM (TOTAL)

SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5849	REACTOR CLEANING OPERATION	22	1	581	969.141	3.000	0.003	0.003
5938	REACTOR CLEANING OPERATION	23	1	615	725.936	4.000	0.006	0.006
5875	REACTOR CLEANING OPERATION	24	1	552	923.821	< 3.000	< 0.003	< 0.002
5861	REACTOR CLEANING OPERATION	23	1	587	981.588	< 3.000	< 0.003	< 0.002
5847	REACTOR CLEANING OPERATION	23	1	541	638.588	37.000	0.058	0.058
5956	REACTOR CLEANING OPERATION	23	1	517	864.533	< 3.000	< 0.003	< 0.003
5819R	REACTOR CLEANING OPERATION	29	1	575	964.680	4.000	0.004	0.004

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	16	0.237	0.002	0.024	0.059	0.015	0.006	4.607	0.003	0.013

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

Table 23

WORKER EXPOSURE TO METAL CONTAINING DUST DURING REACTOR CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT SAMPLE	IRON JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5843	REACTOR CLEANING OPERATION	24	1	572	957.293	8.000	0.008	0.008
5786	REACTOR CLEANING OPERATION	21	1	570	960.646	360.000	0.375	0.375
5863	REACTOR CLEANING OPERATION	22	1	583	972.477	450.000	0.463	0.463
5857	REACTOR CLEANING OPERATION	23	1	275	459.858	670.000	1.457	1.457
5854	REACTOR CLEANING OPERATION	24	1	552	923.821	55.000	0.060	0.060
5798	REACTOR CLEANING OPERATION	22	1	582	970.809	5300.000	5.459	5.459
5941	REACTOR CLEANING OPERATION	23	1	590	986.604	55.000	0.056	0.056
5859	REACTOR CLEANING OPERATION	24	1	578	967.334	500.000	0.517	0.517
5881R	REACTOR CLEANING OPERATION	23	1	584	976.571	< 3.000	< 0.003	< 0.003

Table 23
WORKER EXPOSURE TO METAL CONTAINING DUST DURING REACTOR CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT IRON

SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5849	REACTOR CLEANING OPERATION	22	1	581	969.141	69.000	0.071	0.071
5938	REACTOR CLEANING OPERATION	23	1	615	725.936	630.000	0.868	0.868
5875	REACTOR CLEANING OPERATION	24	1	552	923.821	24.000	0.026	0.026
5861	REACTOR CLEANING OPERATION	23	1	587	981.588	44.000	0.045	0.045
5847	REACTOR CLEANING OPERATION	23	1	541	638.588	11000.000	17.226	17.226
5956	REACTOR CLEANING OPERATION	23	1	517	864.533	6.000	0.007	0.007
5819R	REACTOR CLEANING OPERATION	29	1	575	964.680	120.000	0.124	0.124

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	16	17.226	0.002	1.673	4.361	1.090	0.144	12.062	0.038	0.541

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

Table 24

WORKER EXPOSURE TO METAL CONTAINING DUST DURING REACTOR CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT NICKEL

SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5843	REACTOR CLEANING OPERATION	24	1	572	957.293	< 3.000	< 0.003	< 0.002
5786	REACTOR CLEANING OPERATION	21	1	570	960.646	16.000	0.017	0.017
5863	REACTOR CLEANING OPERATION	22	1	583	972.477	18.000	0.019	0.019
5857	REACTOR CLEANING OPERATION	23	1	275	459.858	4.000	0.009	0.009
5854	REACTOR CLEANING OPERATION	24	1	552	923.821	< 3.000	< 0.003	< 0.002
5798	REACTOR CLEANING OPERATION	22	1	582	970.809	55.000	0.057	0.057
5941	REACTOR CLEANING OPERATION	23	1	590	986.604	< 3.000	< 0.003	< 0.002
5859	REACTOR CLEANING OPERATION	24	1	578	967.334	4.000	0.004	0.004
5881R	REACTOR CLEANING OPERATION	23	1	584	976.571	< 3.000	< 0.003	< 0.002

Table 24

WORKER EXPOSURE TO METAL CONTAINING DUST DURING REACTOR CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT NICKEL

SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5849	REACTOR CLEANING OPERATION	22	1	581	969.141	< 3.000	< 0.003	< 0.002
5938	REACTOR CLEANING OPERATION	23	1	615	725.936	< 3.000	< 0.004	< 0.002
5875	REACTOR CLEANING OPERATION	24	1	552	923.821	< 3.000	< 0.003	< 0.002
5861	REACTOR CLEANING OPERATION	23	1	587	981.588	< 3.000	< 0.003	< 0.002
5847	REACTOR CLEANING OPERATION	23	1	541	638.588	10.000	0.016	0.016
5956	REACTOR CLEANING OPERATION	23	1	517	864.533	< 3.000	< 0.003	< 0.002
5819R	REACTOR CLEANING OPERATION	29	1	575	964.680	< 3.000	< 0.003	< 0.002

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	16	0.057	0.002	0.009	0.014	0.004	0.004	3.356	0.002	0.007

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

Table 25
WORKER EXPOSURE TO METAL CONTAINING DUST DURING REACTOR CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT SAMPLE	TOTAL JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5843	REACTOR CLEANING OPERATION	24	1	572	957.293	260.000	0.272	0.272
5786	REACTOR CLEANING OPERATION	21	1	570	960.646	44910.000	46.750	46.750
5863	REACTOR CLEANING OPERATION	22	1	583	972.477	46570.000	47.888	47.888
5857	REACTOR CLEANING OPERATION	23	1	275	459.858	6900.000	15.005	15.005
5854	REACTOR CLEANING OPERATION	24	1	552	923.821	1900.000	2.057	2.057
5798	REACTOR CLEANING OPERATION	22	1	582	970.809	326070	335.874	335.874
5941	REACTOR CLEANING OPERATION	23	1	590	986.604	730.000	0.740	0.740
5859	REACTOR CLEANING OPERATION	24	1	578	967.334	4910.000	5.076	5.076
5849	REACTOR CLEANING OPERATION	22	1	581	969.141	4290.000	4.427	4.427

Table 25
WORKER EXPOSURE TO METAL CONTAINING DUST DURING REACTOR CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT SAMPLE	TOTAL JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5938	REACTOR CLEANING OPERATION	23	1	615	725.936	6350.000	8.747	8.474
5875	REACTOR CLEANING OPERATION	24	1	552	923.821	990.000	1.072	1.702
5861	REACTOR CLEANING OPERATION	23	1	587	981.588	370.000	0.377	0.377
5847	REACTOR CLEANING OPERATION	23	1	541	638.588	147180	230.477	230.477
5956	REACTOR CLEANING OPERATION	23	1	517	864.533	130.000	0.150	0.150

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	14	335.874	0.150	49.922	102.234	27.323	5.273	11.625	1.279	21.729

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

Table 26
WORKER EXPOSURE TO METAL CONTAINING DUST DURING KILN CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT ALUMINUM

SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5779	KILN CLEANING OPERATION	21	1	576	970.758	5300.000	5.460	5.460
1268	KILN BRICK REMOVAL	25	1	430	382.477	17.000	0.044	0.044
5830	KILN CLEANING OPERATION	26	1	553	950.902	75.000	0.079	0.079
2942	KILN CLEANING OPERATION	23	1	317	530.091	25.000	0.047	0.047
5946	KILN CLEANING OPERATION	24	1	579	969.008	1000.000	1.032	1.032
1614R	KILN CLEANING OPERATION	25	1	583	979.516	< 10.000	< 0.010	< 0.005
1612	KILN RATTLING OPERATION	25	1	566	950.954	< 10.000	< 0.011	< 0.005
5784	KILN CLEANING OPERATION	19	1	631	1039.414	810.000	0.779	0.779

Table 26
WORKER EXPOSURE TO METAL CONTAINING DUST DURING KILN CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT	ALUMINUM							
SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
1259R	KILN CLEANING OPERATION	25	1	576	967.755	< 10.000	< 0.010	< 0.005
5893	KILN CLEANING OPERATION	28	1	568	961.153	280.000	0.291	0.291
5902	KILN CLEANING OPERATION	19	1	605	996.585	5700.000	5.720	5.720
5880	KILN CLEANING OPERATION	21	1	576	970.758	15000.000	15.452	15.452
5886R	KILN CLEANING OPERATION	19	1	623	1026.236	4300.000	4.190	4.190
7623	KILN CLEANING OPERATION	23	1	572	964.016	4100.000	4.253	4.253
5773	KILN CLEANING OPERATION	30	1	611	1031.074	550.000	0.533	0.533
1265	KILN CLEANING OPERATION	25	1	225	189.015	84.000	0.444	0.444

Table 26

WORKER EXPOSURE TO METAL CONTAINING DUST DURING KILN CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT ALUMINUM

SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
1269	KILN CLEANING OPERATION	26	1	372	639.666	3700.000	5.784	5.784
1618	KILN BRICK REMOVAL	25	1	505	848.466	11.000	0.013	0.013
5832	KILN CLEANING OPERATION	19	1	445	733.026	1100.000	1.501	1.501
5839	KILN CLEANING OPERATION	26	1	569	978.414	12.000	0.012	0.012

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	20	15.452	0.005	2.283	3.774	0.844	0.288	14.988	0.081	1.021

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

Table 27
WORKER EXPOSURE TO METAL CONTAINING DUST DURING KILN CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT BARIUM

SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5779	KILN CLEANING OPERATION	21	1	576	970.758	900.000	0.927	0.927
5830	KILN CLEANING OPERATION	26	1	553	950.902	10.000	0.011	0.011
2942	KILN CLEANING OPERATION	23	1	317	530.091	< 15.000	0.028	< 0.014
5946	KILN CLEANING OPERATION	24	1	579	969.008	180.000	0.186	0.186
1614R	KILN CLEANING OPERATION	25	1	583	979.516	< 3.000	< 0.003	< 0.002
1612	KILN CLEANING OPERAION	25	1	566	950.954	< 3.000	< 0.003	< 0.002
1259R	KILN CLEANING OPERATION	25	1	576	967.755	< 3.000	< 0.003	< 0.002
5893	KILN CLEANING OPERATION	28	1	568	961.153	75.000	0.078	0.078
5902	KILN CLEANING OPERATION	19	1	605	996.585	830.000	0.833	0.833

Table 27
WORKER EXPOSURE TO METAL CONTAINING DUST DURING KILN CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT: BARIUM

SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5880	KILN CLEANING OPERATION	21	1	576	970.758	420.000	0.433	0.433
5886R	KILN CLEANING OPERATION	19	1	623	1026.236	570.000	0.555	0.555
7623	KILN CLEANING OPERATION	23	1	572	964.016	530.000	0.550	0.550
5773	KILN CLEANING OPERATION	30	1	611	1031.074	84.000	0.081	0.081
1265	KILN CLEANING OPERATION	25	1	225	189.015	39.000	0.206	0.026
1269	KILN CLEANING OPERATION	26	1	372	639.666	100.000	0.156	0.156
1618	KILN BRICK REMOVAL	25	1	505	848.466	< 3.000	< 0.004	< 0.002
5832	KILN CLEANING OPERATION	19	1	445	733.026	180.000	0.246	0.246
5839	KILN CLEANING OPERATION	26	1	569	978.414	< 3.000	< 0.003	< 0.003

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	18	0.927	0.002	0.238	0.298	0.070	0.047	11.875	0.014	0.162

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

Table 28
WORKER EXPOSURE TO METAL CONTAINING DUST DURING KILN CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT	CHROMIUM (TOTAL)							
SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5779	KILN CLEANING OPERATION	21	1	576	970.758	47.000	0.048	0.048
1268	KILN BRICK REMOVAL	25	1	430	382.477	< 3.000	< 0.008	< 0.004
5830	KILN CLEANING OPERATION	26	1	553	950.902	< 3.000	< 0.003	< 0.002
2942	KILN CLEANING OPERATION	23	1	317	530.091	< 3.000	< 0.006	< 0.003
5946	KILN CLEANING OPERATION	24	1	579	969.008	11.000	0.011	0.011
1614R	KILN CLEANING OPERATION	25	1	583	979.516	< 3.000	< 0.003	< 0.002
1612	KILN RATTLING OPERATION	25	1	566	950.954	< 3.000	< 0.003	< 0.002
5784	KILN CLEANING OPERATION	19	1	631	1039.414	15.000	0.014	0.014

Table 28
WORKER EXPOSURE TO METAL CONTAINING DUST DURING KILN CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT	CHROMIUM (TOTAL)							
SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
1259R	KILN CLEANING OPERATION	25	1	576	967.755	< 3.000	< 0.003	< 0.002
5893	KILN CLEANING OPERATION	28	1	568	961.153	4.000	0.004	0.004
5902	KILN CLEANING OPERATION	19	1	605	996.585	82.000	0.082	0.082
5880	KILN CLEANING OPERATION	21	1	576	970.758	82.000	0.084	0.084
5886R	KILN CLEANING OPERATION	19	1	623	1026.236	57.000	0.056	0.056
7623	KILN CLEANING OPERATION	23	1	572	964.016	29.000	0.030	0.030
5773	KILN CLEANING OPERATION	30	1	611	1031.074	11.000	0.011	0.011
1265	KILN CLEANING OPERATION	25	1	225	189.015	< 3.000	< 0.016	< 0.008

Table 28
WORKER EXPOSURE TO METAL CONTAINING DUST DURING KILN CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT CHROMIUM (TOTAL)

SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
1269	KILN CLEANING OPERATION	26	1	372	639.666	7.000	0.011	0.011
1618	KILN BRICK REMOVAL	25	1	505	848.466	< 3.000	< 0.004	< 0.002
5832	KILN CLEANING OPERATION	19	1	445	733.026	18.000	0.025	0.025
5839	KILN CLEANING OPERATION	26	1	569	978.414	< 3.000	< 0.003	< 0.002

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	20	0.084	0.002	0.020	0.027	0.006	0.008	4.218	0.004	0.016

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

Table 29
WORKER EXPOSURE TO METAL CONTAINING DUST DURING KILN CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT: IRON

SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5779	KILN CLEANING OPERATION	21	1	576	970.758	1200.000	1.236	1.236
1268	KILN BRICK REMOVAL	25	1	430	387.787	40.000	0.103	0.103
5830	KILN CLEANING OPERATION	26	1	553	950.902	150.000	0.158	0.158
2942	KILN CLEANING OPERATION	23	1	317	530.091	43.000	0.081	0.081
5946	KILN CLEANING OPERATION	24	1	579	969.008	1700.000	1.754	1.754
1614R	KILN CLEANING OPERATION	25	1	583	979.516	5.000	0.005	0.005
1612	KILN RATTLING OPERATION	25	1	566	950.954	16.000	0.017	0.017
5784	KILN CLEANING OPERATION	19	1	631	1039.414	580.000	0.558	0.558
1259R	KILN CLEANING OPERATION	25	1	576	967.755	3.000	0.003	0.003

Table 29
WORKER EXPOSURE TO METAL CONTAINING DUST DURING KILN CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT IRON

SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5893	KILN CLEANING OPERATION	28	1	568	961.153	340.000	0.354	0.354
5902	KILN CLEANING OPERATION	19	1	605	996.585	2000.000	2.007	2.007
5880	KILN CLEANING OPERATION	21	1	576	970.758	2900.000	2.987	2.987
5886R	KILN CLEANING OPERATION	19	1	623	1026.236	1500.000	1.462	1.462
7623	KILN CLEANING OPERATION	23	1	572	964.016	710.000	0.737	0.737
5773	KILN CLEANING OPERATION	30	1	611	1031.074	1700.000	1.649	1.649
1265	KILN CLEANING OPERATION	25	1	225	189.015	17.000	0.090	0.090
1269	KILN CLEANING OPERATION	26	1	372	639.666	510.000	0.797	0.797

Table 29
WORKER EXPOSURE TO METAL CONTAINING DUST DURING KILN CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT IRON

SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
1618	KILN BRICK REMOVAL	25	1	505	848.466	13.000	0.015	0.015
5832	KILN CLEANING OPERATION	19	1	445	733.026	490.000	0.668	0.668
5839	KILN CLEANING	26	1	569	978.414	6.000	0.006	0.006

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	20	2.987	0.003	0.734	0.850	0.190	0.196	9.153	0.070	0.553

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

Table 30
WORKER EXPOSURE TO METAL CONTAINING DUST DURING KILN CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT	NICKEL							
SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5779	KILN CLEANING OPERATION	21	1	576	970.758	39.000	0.040	0.040
5830	KILN CLEANING OPERATION	26	1	553	950.902	< 3.000	< 0.003	< 0.002
2942	KILN CLEANING OPERATION	23	1	317	530.091	< 3.000	< 0.006	< 0.003
5946	KILN CLEANING OPERATION	24	1	579	969.008	8.000	0.008	0.008
1614R	KILN CLEANING OPERATION	25	1	583	979.516	< 3.000	< 0.003	< 0.002
1612	KILN RATTLING OPERATION	25	1	566	950.954	< 3.000	< 0.003	< 0.002
5784	KILN CLEANING OPERATION	19	1	631	1039.414	8.000	0.008	0.008
1259R	KILN OPERATION OPERATION	25	1	576	967.755	< 3.000	< 0.003	< 0.002
5893	KILN CLEANING OPERATION	28	1	568	961.153	< 3.000	< 0.003	< 0.002
5902	KILN CLEANING OPERATION	19	1	605	996.585	40.000	0.040	0.040

Table 30
WORKER EXPOSURE TO METAL CONTAINING DUST DURING KILN CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT NICKEL

SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5880	KILN CLEANING OPERATION	21	1	576	970.758	82.000	0.084	0.084
5886R	KILN CLEANING OPERATION	19	1	623	1026.236	30.000	0.029	0.029
7623	KILN CLEANING OPERATION	23	1	572	964.016	28.000	0.29	0.29
5773	KILN CLEANING OPERATION	30	1	611	1031.074	< 3.000	< 0.003	< 0.001
1265	KILN CLEANING OPERATION	25	1	225	189.015	< 3.000	< 0.016	< 0.008
1269	KILN CLEANING OPERATION	26	1	372	639.666	5.000	0.008	0.008
1618	KILN BRICK REMOVAL	25	1	505	848.466	< 3.000	< 0.004	< 0.002
5832	KILN CLEANING OPERATION	19	1	445	733.026	9.000	0.012	0.012
5839	KILN CLEANING OPERATION	26	1	569	978.414	< 3.000	< 0.003	< 0.002

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	19	0.084	0.001	0.015	0.021	0.005	0.006	4.037	0.003	0.012

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER
+ MORE THAN 50 OF THE VALUES USED TO COMPUTE THIS STATISTIC WERE BELOW THE LIMIT OF DETECTION

Table 31
WORKER EXPOSURE TO METAL CONTAINING DUST DURING KILN CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT SAMPLE	TOTAL JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5779	KILN CLEANING OPERATION	21	1	576	970.758	50040.000	51.547	51.547
1268	KILN BRICK REMOVAL	25	1	430	382.477	330.000	0.863	0.863
5830	KILN CLEANING OPERATION	26	1	553	950.902	6790.000	7.141	7.141
2942	KILN CLEANING OPERATION	23	1	317	530.091	530.000	1.000	1.000
5946	KILN CLEANING OPERATION	24	1	579	969.008	13620.000	14.056	14.056
1612	KILN RATTLING OPERATION	25	1	566	950.954	290.000	0.305	0.305
5784	KILN CLEANING OPERATION	19	1	631	1039.414	9560.000	9.197	9.197
5893	KILN CLEANING OPERATION	28	1	568	961.153	5240.000	5.452	5.452
5902	KILN CLEANING OPERATION	19	1	605	996.585	59680.000	59.884	59.884
5880	KILN CLEANING OPERATION	21	1	576	970.758	130750	134.689	134.689

Table 31

WORKER EXPOSURE TO METAL CONTAINING DUST DURING KILN CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5773	KILN CLEANING OPERATION	30	1	611	1031.074	10660.000	10.339	10.339
1265	KILN CLEANING OPERATION	25	1	225	189.015	5000.000	26.453	26.453
1269	KILN CLEANING OPERATION	26	1	372	639.666	40970.000	64.049	64.049
1618	KILN BRICK REMOVAL	25	1	505	848.466	140.000	0.165	0.165
5832	KILN CLEANING OPERATION	19	1	445	733.026	11540.000	15.743	15.743
5839	KILN CLEANING OPERATION	26	1	569	978.414	130.000	0.133	0.133

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	16	134.689	0.133	25.063	36.382	9.096	6.062	9.060	1.874	19.613

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

Table 32
WORKER EXPOSURE TO METAL CONTAINING DUST DURING KILN CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT	VANADIUM							
SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5779	KILN CLEANING OPERATION	21	1	576	970.758	23.000	0.024	0.024
1268	KILN BRICK REMOVAL	25	1	430	382.477	< 20.000	< 0.052	< 0.026
5830	KILN CLEANING OPERATION	26	1	553	950.902	< 10.000	< 0.011	< 0.005
2942	KILN CLEANING OPERATION	23	1	317	530.091	< 20.000	< 0.038	< 0.019
5946	KILN CLEANING OPERATION	24	1	579	969.008	< 20.000	< 0.021	< 0.010
1614R	KILN CLEANING OPERATION	25	1	583	979.516	< 10.000	< 0.010	< 0.005
1612	KILN RATLING OPERATION	25	1	566	950.954	< 10.000	< 0.011	< 0.005
5784	KILN CLEANING OPERATION	19	1	631	1039.414	< 20.000	< 0.019	< 0.010
1259R	KILN CLEANING OPERATION	25	1	576	967.75	< 10.000	< 0.010	< 0.005
5893	KILN CLEANING OPERATION	28	1	568	961.153	< 10.000	< 0.010	< 0.005
5902	KILN CLEANING OPERATION	19	1	605	996.585	32.000	0.032	0.032

Table 32
WORKER EXPOSURE TO METAL CONTAINING DUST DURING KILN CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT VANADIUM

SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5880	KILN CLEANING OPERATION	21	1	576	970.758	75.000	0.077	0.077
5886R	KILN CLEANING OPERATION	19	1	623	1026.236	26.000	0.025	0.025
7623	KILN CLEANING OPERATION	23	1	572	964.016	26.000	0.027	0.027
5773	KILN CLEANING OPERATION	30	1	611	1031.074	< 10.000	< 0.010	< 0.005
1265	KILN CLEANING OPERATION	25	1	225	189.015	< 10.000	< 0.053	< 0.026
1269	KILN CLEANING OPERATION	26	1	372	639.666	10.000	0.016	0.016
1618	KILN BRICK REMOVAL	25	1	505	848.466	< 10.000	< 0.012	< 0.006
5832	KILN CLEANING OPERATION	19	1	445	733.026	< 20.000	< 0.027	< 0.014
5839	KILN CLEANING OPERATION	26	1	569	978.414	< 10.000	< 0.010	< 0.005

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
+TOTAL	20	0.077	0.005	0.017	0.017	0.004	0.012	2.305	0.008	0.018

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER
+ MORE THAN 50 OF THE VALUES USED TO COMPUTE THIS STATISTIC WERE BELOW THE LIMIT OF DETECTION

Table 33
WORKER EXPOSURE TO CATALYST CONTAINING DUST DURING
CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT	ALUMINUM							
SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5834	CATALYST CLEAN-UP S/S	17	1	123	208.784	88.000	0.421	0.421
1613	CATALYST CLEAN-UP S/S	29	1	310	520.088	10.000	0.019	0.019
5826	SHAKER OPERATION (CATALYST CLEANING)	18	1	634	991.199	4800.000	4.843	4.843
5895R	SHAKER OPERATION (CATALYST CLEANING)	19	1	625	1029.530	450.000	0.437	0.437
5846R	CATALYST CLEAN-UP S/S	29	1	624	1046.888	66.000	0.063	0.063
1274R	SHAKER OPERATION (CATALYST-CLEANING)	30	1	616	1039.511	38.000	0.037	0.037
5827	CATALYST CLEAN-UP S/S	17	1	173	278.578	1700.000	6.102	6.102
5801R	SHAKER OPERATION (CATALYST CLEANING)	18	1	361	564.389	470.000	0.833	0.833
5788	SHAKER OPERATION (CATALYST CLEANING)	18	1	635	992.762	1400.000	1.410	1.410
5894	SHAKER OPERATION (CATALYST CLEANING)	19	1	630	1037.766	1600.000	1.542	1.542

Table 33
WORKER EXPOSURE TO CATALYST CONTAINING DUST DURING
CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT ALUMINUM

SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5789	CATALYST CLEAN-UP S/S	26	1	594	1021.403	550.000	0.538	0.538
1276R	SHAKER OPERATION (CATALYST CLEANING)	30	1	611	1031.074	< 10.000	< 0.010	< 0.005
5852	CATALYST CLEAN-UP S/S	26	1	594	1021.403	320.000	0.313	0.313
5851	CATALYST CLEAN-UP S/S	23	1	522	872.894	49.000	0.056	0.056
5781	CATALYST CLEAN-UP S/S	18	1	205	320.498	12000.000	37.442	37.442

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	15	37.442	0.005	3.604	9.538	2.463	0.391	10.922	0.014	1.468

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

Table 34

WORKER EXPOSURE TO CATALYST CONTAINING DUST DURING CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT SAMPLE	BARIUM JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5834	CATALYST CLEAN-UP S/S	17	1	123	208.784	< 15.000	< 0.072	< 0.036
1613	CATALYST CLEAN-UP S/S	29	1	310	520.088	< 3.000	< 0.006	< 0.003
5826	SHAKER OPERATION (CATALYST CLEANING)	18	1	634	991.199	390.000	0.393	0.393
5895R	SHAKER OPERATION (CATALYST CLEANING)	19	1	625	1029.530	73.000	0.071	0.071
1274R	SHAKER OPERATION (CATALYST CLEANING)	30	1	616	1039.511	5.000	0.005	0.005
5827	CATALYST CLEAN-UP S/S	17	1	173	278.578	200.000	0.718	0.718
5801R	SHAKER OPERATION (CATALYST CLEANING)	18	1	361	564.389	43.000	0.076	0.076
5788	SHAKER OPERATION (CATALYST CLEANING)	18	1	635	992.762	130.000	0.131	0.131
5789	CATALYST CLEAN-UP S/S	26	1	594	1021.403	100.000	0.098	0.098
1276R	SHAKER OPERATION (CATALYST CLEANING)	30	1	611	1031.074	< 3.000	< 0.003	< 0.001

Table 34
WORKER EXPOSURE TO CATALYST CONTAINING DUST DURING
CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT BARIUM

SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5852	CATALYST CLEAN-UP S/S	26	1	594	1021.403	38.000	0.037	0.037
5851	CATALYST CLEAN-UP S/S	23	1	522	872.894	4.000	0.005	0.005
5781	CATALYST CLEAN-UP S/S	18	1	205	320.498	770.000	2.403	2.403

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	13	2.403	0.001	0.306	0.662	0.184	0.047	9.361	0.012	0.182

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

Table 35
WORKER EXPOSURE TO CATALYST CONTAINING DUST DURING
CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT SAMPLE	CHROMIUM (TOTAL) JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5834	CATALYST CLEAN-UP S/S	17	1	123	208.784	< 3.000	< 0.014	< 0.007
1613	CATALYST CLEAN-UP S/S	29	1	310	520.088	< 3.000	< 0.006	< 0.003
5826	SHAKER OPERATION (CATALYST CLEANING)	18	1	634	991.199	27.000	0.027	0.027
5895R	SHAKER OPERATION (CATALYST CLEANING)	19	1	625	1029.530	5.000	0.005	0.005
5846R	CATALYST CLEAN-UP S/S	29	1	624	1046.888	< 3.000	< 0.003	< 0.001
1274R	SHAKER OPERATION (CATALYST CLEANING)	30	1	616	1039.511	< 3.000	< 0.003	< 0.001
5827	CATALYST CLEAN-UP S/S	17	1	173	178.578	13.000	0.047	0.047
5801R	SHAKER OPERATION (CATALYST CLEANING)	18	1	361	564.389	< 3.000	< 0.005	< 0.003
5788	SHAKER OPERATION (CATALYST CLEANING)	18	1	635	992.762	8.000	0.008	0.008
5894	SHAKER OPERATION (CATALYST CLEANING)	19	1	630	1037.766	23.000	0.022	0.022

Table 35
WORKER EXPOSURE TO CATALYST CONTAINING DUST DURING
CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT (CHROMIUM (TOTAL)

SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5789	CATALYST CLEAN-UP S/S	26	1	594	1021.403	5.000	0.005	0.005
1276R	SHAKER OPERATION (CATALYST CLEANING)	30	1	611	1031.074	3.000	0.003	0.003
5852	CATALYST CLEAN-UP S/S	26	1	594	1021.403	3.000	0.003	0.003
5851	CATALYST CLEAN-UP S/S	23	1	522	872.894	4.000	0.005	0.005
5781	CATALYST CLEAN-UP S/S	18	1	205	320.498	52.000	0.162	0.162

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	15	0.162	0.001	0.020	0.041	0.011	0.007	3.843	0.003	0.015

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

Table 36
WORKER EXPOSURE TO CATALYST CONTAINING DUST DURING
CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT IRON

SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5834	CATALYST CLEAN-UP S/S	17	1	123	208.784	11.000	0.053	0.053
1613	CATALYST CLEAN-UP S/S	29	1	310	520.088	10.000	0.019	0.019
5826	SHAKER OPERATION (CATALYST CLEANING)	18	1	634	991.199	940.000	0.948	0.948
5895R	SHAKER OPERATION (CATALYST CLEANING)	19	1	625	1029.530	200.000	0.194	0.194
5846R	CATALYST CLEAN-UP S/S	29	1	624	1046.888	300.000	0.287	0.287
1274R	SHAKER OPERATION (CATALYST CLEANING)	30	1	616	1039.511	230.000	0.221	0.221
5827	CATALYST CLEAN-UP S/S	17	1	173	278.578	160.000	0.574	0.574
5801R	SHAKER OPERATION (CATALYST CLEANING)	18	1	361	564.389	71.000	0.126	0.126
5788	SHAKER OPERATION (CATALYST CLEANING)	18	1	635	992.762	180.000	0.181	0.181
5894	SHAKER OPERATION (CATALYST CLEANING)	19	1	630	1037.766	< 1.000	< 1.889	< 0.944

Table 36
WORKER EXPOSURE TO CATALYST CONTAINING DUST DURING
CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT IRON

SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5789	CATALYST CLEAN-UP S/S	26	1	594	1021.403	1500.000	1.469	1.469
5852	CATALYST CLEAN-UP S/S	26	1	594	1021.403	54.000	0.053	0.053
5851	CATALYST CLEAN-UP S/S	23	1	522	872.894	310.000	0.355	0.355
5781	CATALYST CLEAN-UP S/S	18	1	205	320.498	1900.000	5.928	5.928

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	14	5.928	0.019	0.811	1.533	0.410	0.286	4.494	0.120	0.680

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

Table 37
WORKER EXPOSURE TO CATALYST CONTAINING DUST DURING
CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT SAMPLE	NICKEL JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5789	CATALYST CLEAN-UP S/S	26	1	594	1021.403	15.000	0.015	0.015
1613	CATALYST CLEAN-UP S/S	29	1	310	520.000	< 3.000	< 0.006	< 0.003
5826	SHAKER OPERATION (CATALYST CLEANING)	18	1	634	991.199	17.000	0.017	0.017
5895R	SHAKER OPERATION (CATALYST CLEANING)	19	1	625	1029.530	3.000	0.003	0.003
5846R	CATALYST CLEAN-UP S/S	29	1	624	1046.888	< 3.000	< 0.003	< 0.001
1274R	SHAKER OPERATION (CATALYST CLEANING)	30	1	616	1039.511	< 3.000	< 0.039	0.039
5827	CATALYST CLEAN-UP S/S	17	1	173	278.578	11.000	0.039	0.039
5801R	SHAKER OPERATION (CATALYST CLEANING)	18	1	361	564.389	< 3.000	< 0.005	< 0.003
5788	SHAKER OPERATION (CATALYST CLEANING)	18	1	635	922.762	4.000	0.004	0.004
5894	SHAKER OPERATION (CATALYST CLEANING)	19	1	630	1037.766	18.000	0.017	0.017

Table 37
WORKER EXPOSURE TO CATALYST CONTAINING DUST DURING
CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT NICKEL

SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5789	CATALYST CLEAN-UP S/S	26	1	594	1021.403	4.000	0.004	0.004
1276R	SHAKER OPERATION (CATALYST CLEANING)	30	1	611	1031.074	< 3.000	< 0.003	< 0.001
5852	CATALYST CLEAN-UP S/S	26	1	594	1021.403	< 3.000	< 0.003	< 0.001
5851	CATALYST CLEAN-UP S/S	23	1	522	872.894	< 3.000	< 0.003	< 0.002
5781	CATALYST CLEAN-UP S/S	18	1	205	320.498	34.000	0.106	0.106

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
+TOTAL	15	0.016	0.001	0.014	0.027	0.007	0.005	3.822	0.002	0.010

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER
+ MORE THAN %) OF THE VALUES USED TO COMPUTE THIS STATISTIC WERE BELOW THE LIMIT OF DETECTION

Table 38
WORKER EXPOSURE TO CATALYST CONTAINING DUST DURING
CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT SAMPLE	RESPIRABLE JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
5834	CATALYST CLEAN-UP S/S	17	1	123	208.784	1050.000	5.029	5.029
5895R	SHAKER OPERATION (CATALYST CLEANING)	19	1	625	1029.530	4670.000	4.536	4.536
5846R	CATALYST CLEAN-UP S/S	29	1	624	1046.888	1970.000	1.882	1.882
1274R	SHAKER OPERATION (CATALYST CLEANING)	30	1	616	1039.511	1160.000	1.116	1.116
5801R	SHAKER OPERATION (CATALYST CLEANING)	18	1	361	564.389	3890.000	6.892	6.892
5788	SHAKER OPERATION (CATALYST CLEANING)	18	1	635	922.762	12990.000	13.085	13.085
1276R	SHAKER OPERATION (CATALYST CLEANING)	30	1	611	1031.074	240.000	0.233	0.233

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	7	13.085	0.233	4.682	4.397	1.662	2.685	3.859	0.770	9.362

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

Table 39
WORKER EXPOSURE TO CATALYST CONTAINING DUST DURING
CLEANING OPERATIONS AT THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT SAMPLE	TOTAL JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
1613	CATALYST CLEAN-UP S/S	29	1	310	520.088	140.000	0.269	0.269
5826	SHAKER OPERATION (CATALYST CLEANING)	18	1	634	991.199	44930.000	45.329	45.329
5827	CATALYST CLEAN-UP S/S	17	1	173	278.578	16840.000	60.450	60.450
5894	SHAKER OPERATION (CATALYST CLEANING)	19	1	630	1037.776	16650.000	16.044	16.044
5789	CATALYST CLEAN-UP S/S	26	1	594	1021.403	65480.000	64.108	64.108
5852	CATALYST CLEAN-UP S/S	26	1	594	1021.403	3140.000	3.074	3.074
5851	CATALYST CLEAN-UP S/S	23	1	522	872.894	1230.000	1.409	1.409
5781	CATALYST CLEAN-UP S/S	18	1	205	320.498	98750.000	308.114	308.114

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	8	308.114	0.269	62.350	102.763	36.332	13.356	10.460	1.876	95.095

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

Table 40

WORKER EXPOSURE DURING SHUTDOWN OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT CYCLOHEXANE SOL.

SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
PP5	SHUTDOWN OPERATION	16	1	470	458.983	20.000	43.575	43.575
PP9	SHUTDOWN OPERATION	17	1	629	595.804	< 20.000	< 33.568	< 16.784
PP8	SHUTDOWN OPERATION	17	1	637	603.381	20.000	33.147	33.147
PP7	SHUTDOWN OPERATION	17	1	644	610.012	< 20.000	< 32.786	< 16.393
PP6	SHUTDOWN OPERATION	16	1	465	454.100	40.000	88.086	88.086

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	5	88.086	16.393	39.597	29.443	13.167	32.272	2.023	13.458	77.388

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

Table 41
WORKER EXPOSURE AT WELDING OPERATIONS DURING
THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT CYCLOHEXANE SOL.

SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
PC10	WELDING OPERATION KILN	03	1	289	420.973	40.000	95.018	95.018
PG18	WELDING OPERATION REACTOR	26	1	563	569.469	40.000	70.241	70.241
PR10	WELDING OPERATION REACTOR	01	1	557	834.236	20.000	23.974	23.974

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	3	95.018	23.974	63.078	36.060	20.819	54.289	2.062	8.991	327.817

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

Table 42
WORKER EXPOSURE AT HYDROCARBON RESIDUAL CLEANING
OPERATIONS DURING THE TURNAROUND OF A TCCU
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15-OCTOBER 5, 1981

REAGENT CYCLOHEXANE SOL.

SAMPLE	JOB TITLE/LOCATION	DATE	SHIFT	SAMPLE TIME (MINUTES)	SAMPLE VOL (LITERS)	SAMPLE RESULT (UG/SAMPLE)	CONC (MG/CU.M.)	TWA CONC (MG/CU.M.)
PF10	FACTIONATOR ABSORBER CLEANING	01	1	85	148.116	20.000	135.029	135.029
PS10	SYN TOWER CLEANING	01	1	455	543.673	40.000	73.574	73.247
PG11	SYN TOWER CLEANING	22	1	500	490.605	120.000	244.596	244.596
PS30	SYN TOWER CLEANING	30	1	455	587.157	40.000	68.125	68.125

JOB TITLE	N	MAX	MIN	MEAN	STD DEV	STD ERROR	GEO MEAN	GEO STD DEV	95% LCL	95% UCL
TOTAL	3	244.596	68.125	131.989	97.813	56.472	111.526	1,989	20.213	615.351

NOTE: UNITS FOR THIS TABLE ARE IN: MILLIGRAMS PER CUBIC METER

TABLE 43
GENERAL HYDROCARBON LEVELS (LONG-TERM TUBES)
FOR TURNAROUND WORKERS AT DORCHESTER REFINERY COMPANY
ON SEPTEMBER 15 - OCTOBER 5, 1981

LOCATION	JOB TITLE	DATE	TOTAL TIME (MIN)	CONC. (PPM)
Syn Tower	Area/Cleaning	22 Sep 81	153	898.7
Syn Tower	General Helper/Cleaning	23 Sep 81	472	51.2
Syn Tower	General Helper/Cleaning	23 Sep 81	315	68.6
Syn Tower	General Helper/Cleaning	24 Sep 81	117	62.5
Syn Tower	General Helper/Cleaning	24 Sep 81	122	39.8
Syn Tower	General Helper/Cleaning	26 Sep 81	242	100.0
Syn Tower	Area/Cleaning	29 Sep 81	590	123.3
Syn Tower	Area/Cleaning	30 Sep 81	285	119.5
Kiln/Chicken Coop	Welder	5 Oct 81	557	128.4

TABLE 44
CARBON MONOXIDE LEVELS/LONG-TERM TUBES
FOR TURNAROUND WORKERS AT DORCHESTER REFINING COMPANY
ON SEPTEMBER 15 - OCTOBER 5, 1981

LOCATION	JOB TITLE	DATE	TOTAL TIME (MIN)	CONC. (PPM)
Separator Size	Area/Welding	21 Sep 81	130	1.9
Separator Size	Welder	24 Sep 81	228	5.5
Kiln/Chicken Coop	Welder	29 Sep 81	70	14.5
Reactor	Area/Welding	30 Sep 81	583	1.3
Reactor	Area/Welding	3 Oct 81	511	5.9
Kiln/Chicken Coop	Area/Welding	3 Oct 81	293	10.8

TABLE 45
NITROGEN DIOXIDE LEVELS/LONG-TERM TUBES
FOR TURNAROUND WORKERS AT DORCHESTER REFINING COMPANY
ON SEPTEMBER 15 - OCTOBER 5, 1981

LOCATION	JOB TITLE	DATE	TOTAL TIME (MIN)	CONC. (PPM)
Separator Surge	Welder	24 Sep 81	140	< 30.0
Welding Shed	Welder	25 Sep 81	380	> 96.2
TCCU Structure/ 1st Level	Welder	26 Sep 81	53	> 321.1
Reactor	Welder	26 Sep 81	176	> 148.3
Kiln	Area/Welding	29 Sep 81	545	23.0
Reactor	Area/Welding	30 Sep 81	578	8.4
Reactor	Welder	1 Oct 81	555	< 10.0

APPENDIX D

VENTILATION MEASUREMENTS

APPENDIX D

TABLE 1D
VENTILATION MEASUREMENTS
AT DORCHESTER REFINING COMPANY ON SEPTEMBER 15 - OCTOBER 5, 1981

LOCATION	DIAMETER/SIZE (in)	VENTILATION RATE (fpm)
Syn Tower Vent (Top)	18	1000
Syn Tower Vent (Bottom)	24	6000
Syn Tower Manway (Bottom)	24	200
Syn Tower (Lower)		20
Kiln Vent (Top)	18 X 30	300-400
Kiln (Middle)		150-300
Kiln (Lower)		150
Kiln (Upper)		400-450
Kiln (Chicken Coop)		45
Kiln Manway (Chicken Coop)	24	180-200
Reactor Vent (Middle)	24	800-1050
Reactor Vent (Top)	24	900
Reactor Manway (Bottom)	24	200
Reactor (Upper)		800
Reactor (Middle)		240