

CC EOB SATTELITE FILE

221.6  
CCU**Shell Oil Company • Shell Chemical Company**  
Interoffice Memorandum

PLAINTIFF'S EXHIBIT

SH-3026

SEPTEMBER 25, 1981

FROM: INDUSTRIAL HYGIENIST

TO: MANAGER - EAST MAINTENANCE  
MANAGER - CAT CRACKER *DB*  
MANAGER - SAFETY REFINERY

SUBJECT: CAT CRACKER TURNAROUND

During the September, 1980 Cat Cracker Turnaround, a study of employee exposure potential was conducted by the Industrial Hygiene group. The attached report highlights their findings and the controls which were employed to reduce worker exposures. Their efforts were a continuation of Shell's interest in planning for and protecting worker health during all phases of operation, both routine and non-routine. The general applicability of certain controls utilized during the Cat Cracker Turnaround are still under review by the Health and Safety Department, e.g., respirator use by welders.

The results of this investigation are provided for your information and review. Please contact me if you have any questions regarding the study.

*Phil Snyder*

P.J. Snyder

PJS:md

Attachment

cc: ECB Satellite  
PJS Chron

LAM 013381

DPMC-14678

1980 DPMC CAT CRACKER SHUTDOWN

LAM 013382

DPMC-14679

## 1980 DPMC CAT CRACKER SHUTDOWN

### SUMMARY

A significant reduction in actual employee exposure from past DPMC Cat Cracker turnarounds was accomplished by the use of respirators, Industrial Hygiene workpractices and general dilution ventilation. No respiratory inhalation incidents associated with welding fume exposure were reported.

An in-depth study of ventilation rates was performed and the results compared to measured exposure levels. While minimized, exposures associated with coated electrode welding in enclosed spaces and air arc gouging continue to be potentially excessive.

Personnel dosimetry for noise exposure identified excessive exposure levels and the need to specify the use of hearing protection on future CCU turnarounds.

The continued planning for and use of health workpractices, controlled ventilation, and respiratory protection during future CCU turnarounds is recommended.

### INTRODUCTION

Since 1978, several studies of employee exposure potential during Catalytic Cracking Unit (CCU) shutdowns have been performed at various Shell manufacturing locations. These investigations have identified certain exposures which may represent an occupational health hazard including:

Air arc gouging may generate total particulates, iron oxide copper, nickel, total chromium and hexavalent chromium in excess of existing standards while cutting in vessels such as cyclones, plenum chambers, spent catalyst risers and even in larger vessels with ventilation "dead" spots.

Coated electrode welding may result in excessive levels of dusts and hexavalent chromium in enclosed spaces with poor ventilation.

Refractory removal may generate refractory and trapped catalyst dust in excess of the nuisance particulate limit.

Chipping coke deposits in the reactor may generate dust levels in excess of the TLV for particulate polycyclic aromatic hydrocarbon.

Removing asbestos containing insulation can potentially release asbestos fibers into the atmosphere and appropriate precautions must be taken.

LAM 013383

Residual sand from sandblasting may result in excessive levels of crystalline silica during subsequent maintenance operations.

Chipping, grinding, and air arc gouging may result in excessive levels of noise.

As a continuation of Shell's effort to understand the potential health hazards associated with major shutdowns, an Industrial Hygiene study was conducted during the September 1980 CCU shutdown. The objectives of this work were to:

- (1) further develop information on employee exposure potential including exposure to specific metals,
- (2) evaluate the effectiveness of general ventilation and its relationship to employee exposure, and
- (3) implement specific controls to minimize employee exposure to previously recognized hazards.

The results and findings of this study are summarized by this report.

#### EXPOSURE MONITORING

##### GENERAL

During the CCU shutdown, employee exposure monitoring was conducted in the Regenerator, Reactor, Third Stage Separator and Fractionator. Air samples were collected during air arc gouging, and manual coated electrode welding. The metal being cut or ionized varied from carbon steels to high alloy stainless steels. Other samples were collected to assess exposure potential to employees not directly involved in the above welding processes.

All personnel "breathing zone" samples were collected on the outside of any respirator or welding hood in use, therefore actual exposures were less than those reported.

All air sampling was conducted using either matched weight mixed cellulose ester filters (MCE) or polyvinyl chloride (PVC) filters. All filters were

**LAM 013384**

DPMC-14681

analyzed for total fume and for 13 selected metals. Shell's Westhollow Laboratory performed the required analysis by D. C. Plasma Emission Spectroscopy. The permissible exposure limits which were used in this study are provided as Table I.

#### REGENERATOR

Employee monitoring conducted over the entire period of time which employees were working inside the regenerator revealed total average fume concentrations of  $11.6 \text{ mg/m}^3$ , and  $9.6 \text{ mg/m}^3$  averaged over an eight-hour period. 25% of these measurements exceeded the eight-hour permissible limit of  $10 \text{ mg/m}^3$ , used in this study (Table II). Short-term personnel and area sampling revealed excessive dust and fume exposure levels during selected work activities (Table III).

In general, short-term "investigative" air sampling indicated that air arc gouging in the Regenerator appeared to contribute to higher exposure levels than welding alone. Welder assistants and other personnel working in the Regenerator bottom received a significant portion of their exposure from catalyst dust dropping from dip legs and suspended in air from arc cutting processes. Although probably minimized, this occurred in spite of previous vacuuming efforts. The lower exposure levels identified during welding of the cyclone support pads at the 9th level may be associated with a noticeable upward ventilation flow. This is supported by the measured concentration of fumes above this work area (range  $3.6 - 49.3 \text{ mg/m}^3$ ). The highest area measurements for chromium ( $3.5 \text{ mg/m}^3$ ) and manganese fume ( $1.8 \text{ mg/m}^3$ ) collected in the regenerator are also associated with this upper cyclone area, (Table IV).

Significant exposure during stick welding occurred where work was performed in enclosed spaces, e.g., inside cyclones, and the 40" riser. General dilution ventilation did, however, prevent a static accumulation of fumes.

#### REACTOR

Full shift employee monitoring conducted inside the reactor revealed a total average fume concentration of  $3.2 \text{ mg/m}^3$ , and  $2.3 \text{ mg/m}^3$  averaged over an eight-hour period (Table II). While none of these personnel measurements exceeded

LAM 013385

DPMC-14682

the eight-hour permissible limit of  $10 \text{ mg/m}^3$ , all employee monitoring conducted during the air arc gouging approached this permissible limit. Air arc cutting also resulted in excessive exposure potential to total metals (35 - 287% of permissible limit)\*. General dilution ventilation did not satisfactorily reduce potential employee exposure which may be associated with arc gouging, or fume contaminant levels above welding processes.

Ventilation in the reactor generally exceeded that found in the Regenerator 37 - 49 air changes/hour versus 17 - 22 air changes/hour. This combined with the presence of less catalyst dust may have contributed to the lower exposure levels measured during reactor work.

#### THIRD STAGE SEPARATOR

Personnel monitoring revealed excessive exposure levels to total fume on 100% of the samples collected during arc gouging, ranging  $33 - 41 \text{ mg/m}^3$ , (Table II). Short-term exposures were measured to be as high as  $183 \text{ mg/m}^3$ . An employee monitored for 236 minutes was determined to have an excessive peak exposure to copper fumes, ( $.32 \text{ mg/m}^3$ ). Total chrome air concentration on this specific air sample was determined to be equivalent to the permissible limit ( $.5 \text{ mg/m}^3$ ). Welding resulted in relatively lower measured exposure levels, ranging  $2.3 - 9.3 \text{ mg/m}^3$ . Exposure to total fume and total metals were within permissible limits during welding. While the Third Stage Separator had the highest general ventilation rate, 65 - 72 air changes/hour, it alone does not appear satisfactory to reduce exposure to employees performing air arc cutting. The potential eye hazard condition created by arc cutting and high ventilation rates were protected against by the mandatory use of full-facepiece respiratory protection.

#### FRACTIONATOR

Although limited in scope, all personnel sampling conducted in the Fractionator were within permissible limits for both total welding fume and total metal exposure (Table IV). The highest air concentrations found were above the welding zone.

\*As a rough index of exposure, combined metal exposures exceeding a PEL of 100% are viewed as potentially exceeding the permissible limit for individual metals.

LAM 013386

DPMC-14683

### NOISE EXPOSURE

Approximately 60% of all personnel eight-hour monitoring exceeded the 90 dB(a) permissible limit (Table V). Area sound level measurements further identified work area sound levels as potentially excessive. For example:

- . All work areas on the Reactor exceeded 85 dB(a); most areas above the 7th level exceeded 90 dB(a).
- . Sound levels inside manway access "penthouses" ranged from 98 dB(a) to 115 dB(a). Air driven Coppus blowers are associated with the higher sound levels.
- . Sound levels in the proximity of arc welding machines (ground level) were 95 - 96 dB(a).
- . The rest area at the Regenerator 10th level was 95 dB(a). All levels on the 6th and 11th levels exceeded 90 dB(a).

Sources of noise exposure included air arc cutting, grinding, chipping, ventilators and welding machines.

The need to use hearing protection should be better communicated to contract employees on future CCU turnarounds. Beginning with the first day and weekly thereafter sound level surveys need to be conducted and high noise level areas (floors) posted with temporary signs.

Specific tasks inside vessels such as air arc cutting should be continued to be identified as mandatory hearing protection jobs.

### HEALTH AND SAFETY CONSIDERATIONS: WORKPRACTICES

#### PRE-SHUTDOWN PLANNING

Input to the CCU shutdown health workpractices was received from a Head Office team representing Health and Safety - Operations, Maintenance Support - Manufacturing and Engineering Services - Products. Experiences acquired at prior CCU shutdowns at other locations were reviewed and recommendations discussed with the DPMC shutdown team. Prior to the shutdown, health and safety requirements were outlined for maintenance in written form (Attachment I).

LAM 013387

DPMC-14684

### RESPIRATORY PROTECTION

To protect against fume and dust exposure in the Third Stage Separator, Reactor and Regenerator, air-purifying respirators were required to be worn by all personnel upon entry. Based on the incidence of eye injury during earlier CCU turnarounds, full-face masks or half-face with goggles were required.

Air-supplied respirators were specified for all welding work in all vessels. Welders were afforded an opportunity to select between the MSA full-face, constant flow mask with lens adapter and the MSA half-face, constant flow welders mask. Breathing quality air was supplied by a leased Sullair compressor and Deltech air purification unit purchased specifically for the CCU shutdown. This option was selected over purchasing air based on economic considerations. A single trailer containing breathing air was used as a backup system, however, it was not used. Air was piped to the various vessel levels where work was planned. In total, 56 respirator connections were available, many of these being located at the manway entrances.

The primary contractor was responsible for cleaning, inspecting and issuing respirators on each of the two shifts. For control purposes each mask was numbered and a record made of its use. The average number of respirators issued each day (2 shifts) were:

|                   |     |
|-------------------|-----|
| Full-face Airline | 5   |
| Half-face Airline | 60  |
| Full-face Filter  | 100 |
| Half-face Filter  | 42  |

Respirator filter cartridges were initially replaced daily and later on a weekly basis. Respirators were returned to Shell at the completion of the shutdown. Assuring that contractor workers and Shell Staff, e.g., Inspectors followed the above requirements and used respirators at all times required extensive auditing by Industrial Hygiene personnel. Among the considerations which impacted on respirator acceptability was the periodic fogging of air-purifying full-facepiece respirators. This was minimized by the use of a defogging agent.

**LAM 013388**

In general, less problems were encountered with welders who found the MSA half-facepiece welder's mask an acceptable protective device. Welders reported that although they were somewhat inconvenienced, they could work for longer periods of time and more comfortably.

#### VENTILATION

General ventilation levels which were achieved were determined to be significantly improved over past DPMC CCU shutdowns. Both air driven portable ventilators and electrically driven air movers were used. Electrically driven air movers were determined to be quieter and capable of a higher cfm. Placement of ventilators was made according to pre-shutdown planning. Several "access penthouses" were constructed and placed at manways so as to allow vessel entry without removing the ventilator.

A thorough study of airflow was completed during the shutdown and showed the maximum air changes per hour to be greatest for the Third Stage Separator (65 - 72 changes/hour). The Reactor was found to have 37 - 49 changes/hour and the Regenerator 17 - 22 changes/hour. The ventilation study conducted did not include the Fractionator. Maximum ventilation rates obtained were comparable to initial target levels. The use of general ventilation contributed to overall lower welding fume air concentrations. Directed airflow created by general ventilation reduced static accumulations of fume and assisted in lowering welder exposure where fumes moved away from the breathing zone, e.g., when the welder was in a vertical position. However, personnel working in other areas of vessels could be exposed to such fumes although in a somewhat lower concentration. Given the same number and location of ventilators it is unlikely that general ventilation alone is sufficient to meet current permissible exposure limits for total welding fume and total metals.

The practicality of using portable local exhaust ventilators should be reviewed.

A more thorough discussion of the ventilation study conducted is included in a separate report, "1980 Cat Cracker Shutdown - Ventilation Study".

**LAM 013389**

DPMC-14686

### WASH FACILITIES AND PROTECTIVE CLOTHING

Protective clothing (including slicker suits and boots) and showering at the end of the shift was specified for personnel who had anticipated exposure potential to polycyclic aromatic (PCA) containing materials, e.g., slurry oil and coke deposits. Outer street clothing was not permitted to be worn under slicker suits. Typically 140 cloth coveralls were issued and laundered each day by the contractor. A single 34' x 10' shower trailer with 12 shower heads was rented at a cost of \$700.00 a month. Disposable towels were provided by the contractor on each shift. Daily, an average of 15 employees showered indicating less than 100% participation. A separate outside wash facility supplied with soap and hot and cold water was made available to all shutdown workers.

### POLYCYCLIC AROMATIC HYDROCARBONS "PCAs"

Anticipated exposure potential to "carcinogenic" PCA containing material was protected against by protective clothing and washing. To determine what concentrations of residual PCA that may be encountered during a CCU shutdown, selected bulk samples were collected on 9-16-80 and analyzed by liquid chromatography.

| Specific PCA<br>Analyzed For | Pitch Off Top of Reactor<br>Vent at 9th Floor | Reactor<br>Floor Sludge | Sludge From Fractionator<br>After Hydroblasting Tray #10 |
|------------------------------|-----------------------------------------------|-------------------------|----------------------------------------------------------|
| Phenanthrene                 | .10%                                          | <.01%                   | <.01%                                                    |
| Anthracene                   | <.01%                                         | <.01%                   | <.01%                                                    |
| Pyrene                       | 1.00%                                         | <.01%                   | .10%                                                     |
| Chrysene                     | .05%                                          | <.01%                   | .02%                                                     |
| Benz (a) Pyrene              | <.01%                                         | <.01%                   | <.01%                                                    |

The analyses presented above indicate relatively low levels of PCAs in the samples collected and reflect the decontamination procedures used.

### PARTICULATE CONTROL

The contractor was required to use vacuum trucks to clean off internal vessel horizontal surfaces on a daily basis. The purpose of this was to minimize re-entrainment of particulate matter into the work air. This practice was useful in all areas except the lower vessel areas. It should be noted that vacuum lines left in manways interfered with the use of ventilation access houses. Future access penthouses should be designed to better accommodate this need.

LAM 013390

SANDBLASTING - SILICA HAZARD

The Complex policy of using an alternate material for silica sand was followed.

ASBESTOS

Personnel involved in asbestos refractory removal followed the Complex policy of using dust masks, disposable clothing and dust suppression using water. No monitoring was done for asbestos exposure.

SAFETY RECORD - HEALTH RELATED INCIDENTS

The primary contractor reported a generally favorable safety record during the 49-day shutdown. Foreign eye injuries accounted for 30% of all first aid cases, with the majority of these being associated with foreign bodies. No first aid cases were attributed to fume or dust exposure. This satisfactory performance can be associated with improved ventilation and wider use of respiratory protection. A single doctor case which was reported is associated with a finger amputation during rigging in the Regenerator.

SIDE-BY-SIDE FUME SAMPLING

Table VI highlights the results of parallel side-by-side area sampling using PVC and "matched weight" MCE type filter cassettes. The results of this limited comparison indicated that under the conditions of use, the PVC cassettes showed results which were greater on 78% of the samples. Generally, the MCE filter results were 50% of the PVC. This variation may be associated with analytical and/or sampling variables. A more detailed study of field sampling reproducibility using different filter types should be conducted to better understand this observation.

LAM 013391

DPMC-14688

TABLE I

LAM 013392

DPMC-14689

TABLE I  
PERMISSIBLE EXPOSURE LEVELS

|                                         | <u>OSHA<br/>Standard</u>                                          | <u>1981 ACGIH<br/>Recommendation</u> | <u>Criteria Used<br/>For This Study</u> |                            |
|-----------------------------------------|-------------------------------------------------------------------|--------------------------------------|-----------------------------------------|----------------------------|
| Nuisance Dust (Total)                   | 15.00 mg/m <sup>3</sup>                                           | 10.00 mg/m <sup>3</sup>              | 15.00 mg/m <sup>3</sup>                 |                            |
| Welding Fume                            | -                                                                 | 5.00 inside hood                     | -                                       |                            |
|                                         | -                                                                 | -                                    | 10.00 Outside Hood*                     |                            |
| Zinc Oxide Fume                         | 5.00                                                              | 5.00                                 | 5.00 mg/m <sup>3</sup>                  | or 5,000 ug/m <sup>3</sup> |
| Cadmium Oxide Fume                      | .10                                                               | .05 ceiling                          | .10                                     | 100                        |
| Magnesium Oxide Fume (as Mg)            | 15.00                                                             | 10.00                                | 10.00                                   | 10,000                     |
| Manganese Fume (as Mn)                  | 5.0 ceiling                                                       | 1.00                                 | 1.00                                    | 1,000                      |
| Nickel Metal (as Ni)                    | 1.00 (.015 mg/m <sup>3</sup><br>NIOSH proposed)                   | 1.00                                 | 1.00                                    | 1,000                      |
| Molybdenum, Insol                       | 15.00                                                             | 10.00                                | 10.00                                   | 10,000                     |
| Copper Fume (as Cu)                     | .10                                                               | .20                                  | .10                                     | 100                        |
| Copper Dust (as Cu)                     | 1.00                                                              | 1.00                                 | -                                       | -                          |
| Titanium                                | 15.00                                                             | -                                    | 15.00                                   | 15,000                     |
| Iron Oxide Fume (as Fe)                 | 10.00                                                             | 5.00                                 | 5.00                                    | 5,000                      |
| Vanadium (as V)                         | .05 ceiling                                                       | .05 ceiling                          | .05                                     | 50                         |
| Aluminum Dust                           | 15.00                                                             | 10.00                                | -                                       | -                          |
| Aluminum Fumes                          | -                                                                 | 5.00                                 | 5.00                                    | 5,000                      |
| Inorganic Lead Dust<br>and Fume (as Pb) | .05                                                               | .15                                  | .05                                     | 50                         |
| Total Chromium (as Cr)                  | 1.00 (.001 mg/m <sup>3</sup><br>NIOSH pro-<br>posed for<br>CR VI) | .50 CR III<br>.05 CR VI              | .50 CR III<br>.05 CR VI                 | 500<br>50                  |

\*10 mg/m<sup>3</sup> accepted as the permissible exposure limit for total welding fume where breathing zone samples are collected outside welding hoods; assumes that a reduction of 50% is provided by welding hoods. Equivalent criteria used during the 1978 DPMC CCU Shutdown.

LAM 013393

DPMC-14690

TABLE II

LAM 013394

DPMC-14691

TABLE III

LAM 013395

DPMC-14692

TABLE III  
MEASURED TOTAL FUME CONCENTRATIONS FOR SELECTED WORK ACTIVITIES

REGENERATOR

1. Welder arc gouging out dip legs at 6th level

|           |                                      |
|-----------|--------------------------------------|
| Personnel | Number Samples: 3                    |
|           | Range mg/m <sup>3</sup> : 5.3 - 15.3 |
|           | Mean Avg. Conc: 8.9                  |

|      |                                      |
|------|--------------------------------------|
| Area | Number Samples: 7                    |
|      | Range mg/m <sup>3</sup> : 1.6 - 10.6 |
|      | Mean Avg. Conc: 4.3                  |

2. Welder helper in regenerator bottom during arc gouging

|           |                                      |
|-----------|--------------------------------------|
| Personnel | Number Samples: 2                    |
|           | Range mg/m <sup>3</sup> : 7.5 - 11.0 |
|           | Mean Avg. Conc: 9.2                  |

|                  |                                     |
|------------------|-------------------------------------|
| Area<br>(at 15') | Number Samples: 2                   |
|                  | Range mg/m <sup>3</sup> : 1.8 - 9.7 |
|                  | Mean Avg. Conc.: 5.7                |

3. Welding stainless steel support pads on cyclones at 9th level

|           |                                      |
|-----------|--------------------------------------|
| Personnel | Number Samples: 4                    |
|           | Range mg/m <sup>3</sup> : <1.3 - 7.1 |
|           | Mean Avg. Conc: 2.7                  |

|                         |                                    |
|-------------------------|------------------------------------|
| Area<br>(at work level) | Number Samples: 5                  |
|                         | Range mg/m <sup>3</sup> : <.6 - 13 |
|                         | Mean Avg. Conc: 3.8                |

|                            |                                      |
|----------------------------|--------------------------------------|
| Area<br>(above work level) | Number Samples: 9                    |
|                            | Range mg/m <sup>3</sup> : 3.6 - 49.3 |
|                            | Mean Avg. Conc: 19.0                 |

4. Welding and cutting inside regenerator cyclones

|           |                             |
|-----------|-----------------------------|
| Personnel | Number Samples: 1           |
|           | Range mg/m <sup>3</sup> : - |
|           | Mean Avg. Conc: 11.7        |

|      |                                      |
|------|--------------------------------------|
| Area | Number Samples: 3                    |
|      | Range mg/m <sup>3</sup> : 4.1 - 27.1 |
|      | Mean Avg. Conc: 14.2                 |

5. Welder working inside 40" riser at regenerator bottom

|           |                                   |
|-----------|-----------------------------------|
| Personnel | Number Samples: 2                 |
|           | Range mg/m <sup>3</sup> : 15 - 18 |
|           | Mean Avg. Conc: 16.5              |

6. Welder cutting out air ring support at regenerator bottom

|           |                             |
|-----------|-----------------------------|
| Personnel | Number Samples: 1           |
|           | Range mg/m <sup>3</sup> : - |
|           | Mean Avg. Conc: 13.8        |

LAM 013396

\*Each sample reported may be a composite of several measurements taken on the same employee or in the same area.

# MEASURED TOTAL FUME CONCENTRATIONS FOR SELECTED WORK ACTIVITIES

## REGENERATOR

7. Welder helpers assisting in regenerator bottom during rigging, grinding, some welding

|                                                           |                                      |
|-----------------------------------------------------------|--------------------------------------|
| Personnel<br>(one 70 mg/m <sup>3</sup><br>result omitted) | Number Samples: 5                    |
|                                                           | Range mg/m <sup>3</sup> : 2.1 - 12.0 |
|                                                           | Mean Avg. Conc: 6.0                  |

8. Welding dip leg braces 2nd level, 6th floor of regenerator

|           |                             |
|-----------|-----------------------------|
| Personnel | Number Samples: 1           |
|           | Range mg/m <sup>3</sup> : - |
|           | Mean Avg. Conc: 3.6         |

9. Area measurements collected during various work phases in the general work area in the regenerator lower levels

|      |                                    |
|------|------------------------------------|
| Area | Number Samples: 24                 |
|      | Range mg/m <sup>3</sup> : .99 - 38 |
|      | Mean Avg. Conc: 5.4                |

## THIRD STAGE SEPARATOR

10. Arc gouging swirl vanes out of separator

|           |                                     |      |                                     |
|-----------|-------------------------------------|------|-------------------------------------|
| Personnel | Number Samples: 2                   | Area | Number Samples: 2                   |
|           | Range mg/m <sup>3</sup> : 33.7-41.2 |      | Range mg/m <sup>3</sup> : 20.6-23.2 |
|           | Mean Avg. Conc: 37.5                |      | Mean Avg. Conc: 21.9                |

11. Welding new swirl vanes into separator

|           |                                   |
|-----------|-----------------------------------|
| Personnel | Number Samples: 2                 |
|           | Range mg/m <sup>3</sup> : 2.3-9.3 |
|           | Mean Avg. Conc: 5.8               |

## FRACTIONATOR

LAM 013397

12. Monel liner welding inside fractionator column

|           |                                   |      |                                   |
|-----------|-----------------------------------|------|-----------------------------------|
| Personnel | Number Samples: 3                 | Area | Number samples: 11                |
|           | Range mg/m <sup>3</sup> : <.8-2.5 |      | Range mg/m <sup>3</sup> : .8-12.7 |
|           | Mean Avg. Conc: 1.4               |      | Mean Avg. Conc: 4.6               |

\*Each sample reported may be a composite of several measurements taken on same employee or in the same area.

DPMC-14694

MEASURED TOTAL FUME CONCENTRATIONS FOR SELECTED WORK ACTIVITIES

REACTOR

13. Welding on new 4th level reactor wall

|           |                                   |                           |                             |
|-----------|-----------------------------------|---------------------------|-----------------------------|
| Personnel | Number Samples: 2                 | Area<br>(above work area) | Number Samples: 1           |
|           | Range mg/m <sup>3</sup> : 1.4-2.4 |                           | Range mg/m <sup>3</sup> : - |
|           | Mean Avg. Conc: 1.9               |                           | Mean Avg. Conc: 3.3         |

14. Assisting welders working on new reactor wall

|           |                                   |
|-----------|-----------------------------------|
| Personnel | Number Samples: 2                 |
|           | Range mg/m <sup>3</sup> : .82-.84 |
|           | Mean Avg. Conc: .83               |

15. Assisting welders arc cut out dust hoppers

|           |                             |
|-----------|-----------------------------|
| Personnel | Number Samples: 1           |
|           | Range mg/m <sup>3</sup> : - |
|           | Mean Avg. Conc: 3.9         |

16. Arc gouging out dust hoppers/distrib. head in reactor bottom

|           |                                    |                               |                                    |
|-----------|------------------------------------|-------------------------------|------------------------------------|
| Personnel | Number Samples: 6                  | Area<br>(8-20ft from welders) | Number Samples: 6                  |
|           | Range mg/m <sup>3</sup> : 2.3-13.3 |                               | Range mg/m <sup>3</sup> : 1.3-15.4 |
|           | Mean Avg. Conc: 6.5                |                               | Mean Avg. Conc: 7.8                |

  

|                           |                                    |
|---------------------------|------------------------------------|
| Area<br>(above work area) | Number Samples: 4                  |
|                           | Range mg/m <sup>3</sup> : 5.5-12.3 |
|                           | Mean Avg. Conc: 8.4                |

17. Chipping inside reactor cyclones

|                           |                                    |
|---------------------------|------------------------------------|
| Area<br>(above work area) | Number Samples: 4                  |
|                           | Range mg/m <sup>3</sup> : 2.5-33.4 |
|                           | Mean Avg. Conc: 19.4               |

\*Each sample reported may be a composite of several measurements taken on the same employee or in the same area.

LAM 013398

DPMC-14695

TABLE IV

LAM 013399

DPMC-14696

TABLE

## MAXIMUM FUME/DUST CONCENTRATION MEASURED AND ASSOCIATED WORK

## FRACTIONATOR

(Results Reported as ug/m3)

|                      | Personnel | Sampling Time (Min.) | Area                                                 | Sampling Time (Min.) |     |
|----------------------|-----------|----------------------|------------------------------------------------------|----------------------|-----|
| Zinc Oxide Fume      | <10       | 93                   | Welding on Monel liner in Fractionator, 190 rod used | <10                  | 75  |
| Cadmium Oxide Fume   | <10       | 93                   | Welding on Monel liner in Fractionator, 190 rod used | <10                  | 75  |
| Magnesium Oxide Fume | 10.00     | 93                   | Welding on Monel liner in Fractionator, 190 rod used | 150                  | 181 |
| Manganese Fume       | 31.00     | 165                  | Welding on Monel liner in Fractionator, 190 rod used | 350                  | 181 |
| Nickel Metal         | 51.00     | 165                  | Welding on Monel liner in Fractionator, 190 rod used | 480                  | 181 |
| Molybdenum, Insol    | -         | -                    | -                                                    | -                    | -   |
| Copper Fume/Dust     | 130.00*   | 165                  | Welding on Monel liner in Fractionator, 190 rod used | 1,000                | 181 |
| Titanium             | 22.00     | 165                  | Welding on Monel liner in Fractionator, 190 rod used | 190                  | 75  |
| Iron Oxide Fume      | 790.00    | 93                   | Welding on Monel liner in Fractionator, 190 rod used | 3,100                | 75  |
| Vanadium             | -         | -                    | -                                                    | -                    | -   |

\*Measured concentrations determined to be in excess of permissible exposure limits - See Table I for limits.

DPMC-14697

LAM 013400

TABLE

## MAXIMUM FUME/DUST CONCENTRATION MEASURED AND ASSOCIATED WORK

## FRACTIONATOR

(Results Reported as ug/m3)

|                              | Personnel | Sampling Time (Min.) | Area                                                 | Sampling Time (Min.)                                  |
|------------------------------|-----------|----------------------|------------------------------------------------------|-------------------------------------------------------|
| Aluminum Fume/Dust           | 120.00    | 165                  | 1,400                                                | 181                                                   |
|                              |           |                      | Welding on Monel liner in Fractionator, 190 rod used | 5' above welder working on liner in Fractionator      |
| Inorganic Lead Dust and Fume | -         | -                    | -                                                    | -                                                     |
| Chromium                     | 80.00     | 78                   | 430                                                  | 75                                                    |
|                              |           |                      | Welding on Monel liner in Fractionator, 190 rod used | Area in 12-13th tray welding on liner in Fractionator |

## REACTOR

(Results Reported as ug/m3)

|                      |         |    |                                                        |                                               |
|----------------------|---------|----|--------------------------------------------------------|-----------------------------------------------|
| Zinc Oxide Fume      | 70.00   | 55 | 110                                                    | 45                                            |
|                      |         |    | Welding on Reactor wall using E-7018 rod               | Above cyclones, chipping being done inside    |
| Cadmium Oxide Fume   | -       | -  | 20                                                     |                                               |
|                      |         |    | Air arc gouging in Reactor bottom                      | Above cyclones, chipping being done inside    |
| Magnesium Oxide Fume | 30.00   | 29 | 360                                                    | 33                                            |
|                      |         |    | Air arc gouging on 7th floor on downcomers             | Air arc gouging on 7th floor on downcomers    |
| Manganese Fume       | 230.00  | 43 | 180                                                    | 36                                            |
|                      |         |    | Air arc gouging in Reactor bottom on wall              | 8' from welders arc gouging Reactor walls     |
| Nickel Metal         | 1000.00 | 43 | 570                                                    | 36                                            |
|                      |         |    | Air arc gouging in Reactor bottom on wall              | 8' from welders arc gouging Reactor walls     |
| Molybdenum, Insol    | 10.00   | 43 | 20                                                     | 30                                            |
|                      |         |    | Pipefitter holding lines as welder cut dust hopper out | Above cyclones 3', chipping being done inside |

\*Measured concentrations determined to be in excess of permissible exposure limits - see Table I for limits.

TABLE

## MAXIMUM FUME/DUST CONCENTRATION MEASURED AND ASSOCIATED WORK

| REACTOR                      |                      |      |                                                           |                                                      |
|------------------------------|----------------------|------|-----------------------------------------------------------|------------------------------------------------------|
| (Results Reported as ug/m3)  |                      |      |                                                           |                                                      |
| Personnel                    | Sampling Time (Min.) | Area | Sampling Time (Min.)                                      |                                                      |
| Copper Fume/Dust             | 70.00                | 74   | Air arc gouging down-comers 5th level                     | 170* 50                                              |
| Titanium                     | 40.00                | 55   | Air arc gouging Reactor wall, Rod E-7018                  | 210 30                                               |
| Iron Oxide Fumes             | 10,000.00            | 43   | Air arc gouging down-comers 5th level                     | 7,600* 45                                            |
| Vanadium                     | -                    | -    | -                                                         | <20 30                                               |
| Aluminum Fume/Dust           | 400.00               | 74   | Removed equipment from Reactor bottom, arc gouged 15 min. | 6,300* 30                                            |
| Inorganic Lead Dust and Fume | -                    | -    | -                                                         | <20 30                                               |
| Chromium                     | 1,200.00*            | 43   | Air arc gouging Reactor wall                              | 840* 36                                              |
|                              |                      |      |                                                           | 20' from welders arc gouging bracing of distributor  |
|                              |                      |      |                                                           | 3' above cyclones, chipping being done inside        |
|                              |                      |      |                                                           | 20' from welders arc gouging bracing of distribution |
|                              |                      |      |                                                           | 3' above cyclones, chipping being done inside        |
|                              |                      |      |                                                           | 3' above cyclones, chipping being done inside        |
|                              |                      |      |                                                           | 8' from welders arc gouging Reactor walls            |

| REGENERATOR                 |       |    |                                   |                                                                  |
|-----------------------------|-------|----|-----------------------------------|------------------------------------------------------------------|
| (Results Reported as ug/m3) |       |    |                                   |                                                                  |
|                             |       |    |                                   |                                                                  |
| Zinc Oxide Fume             | 50.00 | 60 | Arc gouging at Regenerator bottom | 80 40                                                            |
| Cadmium Oxide Fume          | 30.00 | 20 | Arc gouging at Regenerator bottom | 10 70                                                            |
|                             |       |    |                                   | 6th floor above arc gouging of dip legs                          |
|                             |       |    |                                   | Regenerator bottom on air ring support. Welding on ring 15' away |

\*Measured concentrations determined to be in excess of permissible exposure limits - see Table 1 for limits.

TABLE I  
MAXIMUM FUME/DUST CONCENTRATION MEASURED AND ASSOCIATED WORK

|                      | <u>REGENERATOR</u> |                             |                                                                       |             |
|----------------------|--------------------|-----------------------------|-----------------------------------------------------------------------|-------------|
|                      | <u>Personnel</u>   | <u>Sampling Time (Min.)</u> | <u>(Results Reported as ug/m3)</u>                                    | <u>Area</u> |
| Magnesium Oxide Fume | 640.00             | 73                          | Rigged beams to be welded, did grinding in Regenerator bottom         | 310         |
|                      |                    |                             |                                                                       | 37          |
| Manganese Fume       | 600.00             | 55                          | Stick welding on chrome in line at Regenerator bottom                 | 1,800*      |
|                      |                    |                             |                                                                       | 33          |
| Nickel Metal         | 730.00             | 24                          | Assisting welder. Arc gouging at Regenerator bottom                   | 420         |
|                      |                    |                             |                                                                       | 33          |
| Molybdenum, Insol    | 70.00              | 73                          | Rigging beams to be welded, did grinding in Regenerator bottom        | 60          |
|                      |                    |                             |                                                                       | 40          |
| Copper Fume/Dust     | 90.00              | 20                          | Assisting welders arc gouging at Regenerator bottom. (44 min. sample) | 53          |
|                      |                    |                             |                                                                       | 125         |
| Titanium             | 1,600.00           | 73                          | Rigged beams to be welded, did grinding at Regenerator bottom         | 2,200       |
|                      |                    |                             |                                                                       | 33          |
| Iron Oxide Fume      | 10,000.00          | 73                          | Rigged beams to be welded, did grinding at Regenerator bottom         | 5,300       |
|                      |                    |                             |                                                                       | 108         |

6th floor above arc gouging and grinding

3' above welder working on cyclones

3' above welder working on cyclones

In cyclone, welders working below and in area

In cyclone, welders working below and in area

3' above welder working on cyclone

3' above welder working on cyclone

\*Measured concentrations determined to be in excess of permissible exposure limits - see Table I for limits.

TABLE IV

## MAXIMUM FUME/DUST CONCENTRATION MEASURED AND ASSOCIATED WORK

## REGENERATOR

(Results Reported as ug/m3)

|                         | Personnel | Sampling Time (Min.) | Area                                                                  | Sampling Time (Min.) |    |
|-------------------------|-----------|----------------------|-----------------------------------------------------------------------|----------------------|----|
| Vanadium                | 60.00     | 73                   | Assisting welders, Arc gouging at Regenerator bottom                  | 10                   | 75 |
| Aluminum Fume/<br>Dust  | 34.00     | 73                   | Rigged beams to be welded. Did grinding in Regenerator bottom         | 6,500*               | 75 |
| Inorganic Lead and Fume | 40.00     | 73                   | Rigged beams to be welded. Did grinding in Regenerator bottom         | 50                   | 33 |
| Chromium                | 619.00*   | 20                   | Assisting welders arc gouging in Regenerator bottom, (44 min. sample) | 3,050*               | 33 |

15' from welders working on air rings at Regenerator bottom

6th floor above welders and people grinding

3' above welders working on cyclone support pads

3' above welders working on cyclone support pads

## THIRD STAGE SEPARATOR

(Results Reported as ug/m3)

|                      |          |    |                             |        |    |                             |
|----------------------|----------|----|-----------------------------|--------|----|-----------------------------|
| Zinc Oxide Fume      | 40.00    | 35 | Arc gouging swirl vanes out | 40.00  | 14 | Arc gouging swirl vanes out |
| Cadmium Oxide Fume   | -        | -  | -                           | <20.00 | -  | -                           |
| Magnesium Oxide Fume | 70.00    | 30 | Arc gouging swirl vanes out | <40.00 | 14 | Arc gouging swirl vanes out |
| Manganese Fume       | 1,000.00 | 10 | Tack welding swirl vanes    | 190.00 | 25 | Arc gouging swirl vanes out |

\*Measured concentrations determined to be in excess of permissible exposure limits - see Table I for limits.

DPMC-14701

LAM 013404

TABLE IV

MAXIMUM FUME/DUST CONCENTRATION MEASURED AND ASSOCIATED WORKTHIRD STAGE SEPARATOR

(Results Reported as ug/m3)

|                                 | <u>Personnel</u> | <u>Sampling<br/>Time (Min.)</u> |                             | <u>Area</u> | <u>Sampling<br/>Time (Min.)</u> |
|---------------------------------|------------------|---------------------------------|-----------------------------|-------------|---------------------------------|
| Nickel Metal                    | 1,200.00*        | 35                              | Arc gouging swirl vanes out | 50          | 22                              |
| Molybdenum,<br>Insol            | 1,300.00         | 10                              | Arc gouging swirl vanes out | 260         | 14                              |
| Copper Fume/<br>Dust            | 1,400.00*        | 10                              | Arc gouging swirl vanes out | 270*        | 20                              |
| Titanium                        | 670.00           | 35                              | Arc gouging swirl vanes out | 80          | 41                              |
| Iron Oxide Fumes                | 97,000.00*       | 10                              | Arc gouging swirl vanes out | 21,000*     | 27                              |
| Vanadium                        | -                | -                               | -                           | -           | -                               |
| Aluminum Fume/<br>Dust          | 2,500.00         | 10                              | Arc gouging swirl vanes out | 380         | 27                              |
| Inorganic Lead<br>Dust and Fume | -                | -                               | -                           | -           | -                               |
| Chromium                        | 1,100.00*        | 35                              | Arc gouging swirl vanes out | 440         | 27                              |

\*Measured concentration determined to be in excess of permissible exposure limits - see Table I for limits.

TABLE V

LAM 013406

DPMC-14703

TABLE VI

LAM 013407

DPMC-14704

TABLE,

RESULTS OF PARALLEL AREA SAMPLING  
WITH PVC AND MATCHED WT. MCE FILTERS

| Set No. | Total Weight<br>(mg/m <sup>3</sup> ) |      | % MCE/PVC | Nickel |     | Iron<br>(reported as<br>PVC) |      | Aluminum<br>ug/m <sup>3</sup> ) |      | Chrom |     |
|---------|--------------------------------------|------|-----------|--------|-----|------------------------------|------|---------------------------------|------|-------|-----|
|         | MCE                                  | PVC  |           | MCE    | PVC | MCE                          | PVC  | MCE                             | PVC  | MCE   | PVC |
| 1       | 3.9                                  | 7.6  | 51%       | 30     | 70  | 950                          | 3100 | 100                             | 300  | 150   | 430 |
| 2       | 2.8                                  | 5.1  | 55%       | 20     | 40  | 630                          | 1200 | 100                             | 100  | 130   | 220 |
| 3       | 3.9                                  | 5.9  | 66%       | <10    | 10  | 870                          | 1800 | 100                             | 200  | 50    | 90  |
| 4       | 4.1                                  | 2.2  | 186%      | <10    | <10 | 350                          | 520  | <100                            | <100 | 40    | 60  |
| 5       | 3.4                                  | .99  | 343%      | 20     | <10 | 320                          | 120  | 300                             | 100  | 40    | 20  |
| 6       | 1.4                                  | 2.8  | 50%       | -      | -   | 210                          | 310  | 100                             | 300  | 30    | 40  |
| 7       | 17.7                                 | 38.8 | 46%       | 30     | 60  | 1200                         | 2300 | 3000                            | 6500 | 100   | 160 |
| 8       | 2.2                                  | 6.7  | 33%       | 80     | 80  | 1100                         | 1400 | 400                             | 500  | 130   | 160 |
| 9       | 5.6                                  | 7.8  | 72%       | 40     | 40  | 1300                         | 1800 | 400                             | 600  | 80    | 100 |

NOTE: Above parallel air samples were collected over varying periods of time ranging from 45 to 95 minutes. All cassette pairs were strapped together and sampled in an inverted position, #1-#4 Fractionator, #5-#9 Regenerator.

LAM 013408

DPMC-14705

ATTACHMENT I

LAM 013409

DPMC-14706

ATTACHMENT I

Shell Oil Company • Shell Chemical Company  
Interoffice Memorandum

JULY 23, 1980

FROM: INDUSTRIAL HYGIENIST  
TO: SUPERINTENDENT - MAINTENANCE - NORTH  
SUBJECT: SEPTEMBER, 1980 CCU SHUTDOWN - INDUSTRIAL HYGIENE  
REQUIREMENTS

Supplemental Safety and Industrial Hygiene requirements for personnel who will be involved in the September, 1980 Catalytic Cracker Shutdown have been outlined in the attached guideline. The precautionary measures to be required during the shutdown are based on good industrial hygiene practice and address potential problem areas which have been associated with cat cracker shutdowns. Recognized potential health hazards which have been taken into consideration include airborne catalyst dust, welding fume, noise exposure from grinding and chipping, and exposure to polycyclic aromatic containing materials such as slurry oil and residual coke deposits. Additional requirements or modifications to the prepared guideline will be specified as experience is developed in this area.

Individuals involved in the CCU Shutdown should be reminded to wear the appropriate type of respiratory protection and protective clothing. Air-supplied respirators are to be worn by personnel performing welding and arc cutting; other personnel are to use air-purifying masks as specified. Efforts should be made in so far as practical to minimize skin contact with slurry oil during the initial stages of opening lines in the fractionator slurry system. Crafts should be informed of the hazardous properties of slurry oil as covered by the attached material safety data sheet.

Vacuuming of clothing and adequate washing by personnel is recommended before eating and leaving work. Other precautionary measures not specifically included in the attached guideline which will aid in minimizing exposure potential include improved ventilation, and the periodic vacuuming of settled particulate.

Questions concerning the required precautionary measures should be directed to the Safety and Industrial Hygiene Department.

*P. J. Snyder*

P. J. Snyder

PJS/gri

LAM 013410

DPMC-14707

Cat Cracker Shutdown  
Industrial Hygiene Guideline

1. Respiratory Protection Requirements

A. Available Equipment

1. Scott full-face air-purifying mask with high efficiency dust cartridges (Part No. 652L)
2. MSA full-face constant flow airline mask with attached protective welding lens (Part No. 461-699 and Part No. 449-646)
3. MSA half-face constant flow welder's airline mask (Part No. 460-862)

| B. Contaminant or Activity                                                                                                                                                                                                    | Minimum Respiratory Protection                                                                                                                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| <u>Vessel Entry</u><br>3rd Stage Separator, Regenerator<br>Reactor at all times including<br>- cleaning<br>- preparation work<br>- inspection<br>- observation<br>Fractionator & furnace during dust<br>generating activities | Cartridge Dust Mask (No. 1 above)                                                                                                             |
| <u>Fractionator and Slurry Oil System</u><br>High boiling aromatic oils                                                                                                                                                       | A. <u>If a heavy cool liquid:</u><br>None normally required.<br>B. <u>If a solid requiring chipping:</u><br>Cartridge Dust Mask (No. 1 above) |
| <u>Sandblasting - Non-Silica Containing Grit</u>                                                                                                                                                                              | A. <u>Sandblasters:</u><br>Blaster's Air-line Hood<br>B. <u>Helpers, Transients:</u><br>Cartridge Dust Mask (No. 1 above)                     |
| <u>Cat Cracker Catalyst Dust</u>                                                                                                                                                                                              | Cartridge Dust Mask (No. 1 above)                                                                                                             |

LAM 013411

| Contaminant or Activity                                                                                                                        | Minimum Respiratory Protection                                                                                                                                                        |
|------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>Welding</u><br><br>Stainless Steel:<br>- Hex Metal (chrome)<br>- Plenum<br>- Cyclones<br>- Fluffing Lines<br>- Precipitator Clips<br>- Etc. | <u>Inside</u><br><br><u>Welders:</u><br><br>Airline Mask (No. 2 or 3 on the previous page)<br><br><u>Helpers, Transients:</u><br><br>Cartridge Dust Mask (No. 1 on the previous page) |

## 2. Use of Wash Facilities and Protective Clothing

- A. Appropriate protective clothing, to prevent skin contact as far as practical (including slicker suits) washing after incidental contact and daily showering at the end of the shift required for all personnel who have anticipated exposure potential to polycyclic aromatic containing materials:
  - All cleaning, preparation work inside vessels including fractionator, and on slurry oil system; removing or washing slurry oil and coke deposits.
- B. Appropriate protective clothing, to prevent skin contact as far as practical, washing after incidental contact, and daily showering at the end of the shift made available.
  - unflanging slurry system lines
  - slurry system pump removal and cleaning
  - ancillary fractionator personnel
  - etc.
- C. Vacuuming of dust on clothing, washing prior to eating, and leaving work required for all personnel cutting, grinding, welding or otherwise exposed to chrome containing metals.

Vacuuming of clothing by other personnel recommended but not required.

- D. Where asbestos is encountered, special precautionary measures will be implemented which are consistent with the Shell DPMC Asbestos Safety Order.

## 3. Hearing Conservation Measures

| Contaminant or Activity               | Required Protective Measures                                                                                                                   |
|---------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| Arcing, Grinding, Hammering, Chipping | Appropriate hearing protection required. By personnel directly involved in these activities and in the immediate vicinity of the noise source. |

Shutdown - CATALYTIC CRACKING  
1980 Shutdown Material  
1980 - 1981 221.6

LAM 013380

DPMC 14677.1