management of occupational health risks during refinery turnarounds

Prepared for CONCAWE's Health Management Group by STF-24

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ABSTRACT

This report addresses the occupational health issues which are an intrinsic part of refinery turnaround activities. It recognises the underlying importance of an effective management system and is intended to assist planners, managers and specialists to achieve a high standard in controlling health risks. Health is viewed within the framework of a generic management system that can be applied to the various phases of turnarounds, from planning to close-out. The report focuses on health risk management, prevention of risk, health surveillance, the employment of contractors and skill requirements.

Hazards to health in the various phases of a turnaround are identified, the risks listed according to severity and control strategies suggested. General guidance is also given on monitoring, health surveillance and the reporting of results.

While it is appreciated that safety and environmental issues are also encountered in turnarounds, the report focuses primarily on the occupational health risks.

KEYWORDS

Health, refinery, turnaround, risk, management, control strategy, monitoring, surveillance, contractors, standards.

CONTENTS

1. INTRODUCTION

The purpose of this report is to identify the key occupational health issues which need to be considered during the planning, execution and completion of a refinery turnaround and to give guidance on the steps which can be taken during the various phases of the turnaround in order to achieve effective control of risks to health.

The effective operation of a refinery during its production cycle is dependent in part on the planning and execution of periodic turnarounds. One characteristic of major scheduled turnarounds is intensive work on maintenance and modernisation carried out by several hundred contractors employed in the same area. The turnaround work is normally undertaken according to a tight time schedule. Many occupational health hazards are likely to be encountered during such events and these may give rise to significant health risks unless appropriately managed. The large number of personnel employed during the turnaround, the many different contracted companies with their own management systems, the temporary nature of the work which may prevent adequate engineering solutions for the control of exposure to hazardous agents, the frequently required breaking of containment of systems that carry or have carried hazardous agents, the high level of manual work and use of hand-tools, and the generally intense, around-the-clock work schedule are all factors that may complicate the control of the health risks when compared with normal refinery operating practice.

The control of health risks arising from operations involving hazardous agents is recognised as an integral part of business management. Proper assessment of the health risks and planning for adequate health protection help to minimise incidents and delays, thus resulting in efficient and effective turnarounds. Refineries operated by CONCAWE Member Companies have conducted many successful turnarounds over the years and gained much valuable experience. Representatives of Member Companies have convened a Special Task Force to exchange examples of this experience and the lessons learned in order to prepare the present report for the benefit of the industry.

The report recognises the underlying importance of an effective management system and is intended to assist planners, managers and specialists to achieve a high standard in controlling health risks. Due to the very complex nature of modern refineries and the equally complex organisation of their turnarounds, it is impossible to present a comprehensive guide for the control of all health risks that may arise from turnaround work activities. The strategies described, therefore, are meant as examples only, to be applied or amended as appropriate to any one organisation or turnaround situation.

While it is appreciated that safety and environmental issues are also encountered in turnarounds and often addressed by the same personnel, the report focuses primarily on the occupational health risks.

2. PHASES OF A REFINERY TURNAROUND

This section provides a short overview of the various phases of a refinery turnaround (TA), from initial scoping through to the concluding 'wash-up' reviews. **Appendix 1** provides a description of basic refinery units, refinery streams and the chemicals employed and serves to indicate which primary hazardous agents may be encountered. **Appendix 2** briefly describes some of the typical operations that may take place during a TA and where exposure to agents hazardous to health may occur.

Turnaround activities can range from simple maintenance operations on a single unit, through modernisation/upgrading activities, to major turnarounds affecting the entire refinery and requiring multi-year planning.

A multi-year schedule for major and minor refinery turnarounds is normally maintained. It should take into account legal requirements, changes to the refinery set-up, operational and logistic constraints, essential periodic operations such as catalyst change-out and engineering changes identified during, for example, occupational hygiene surveys.

According to the schedule, the turnaround strategy would normally be initiated well ahead of the shutdown, which for a major turnaround could be up to two years in advance.

The following phases can be distinguished:

Preparation of the turnaround
Pre-turnaround work
Shutdown/oil out
Turnaround execution
Feedstock/start-up
Post-turnaround work

Health issues may be encountered in all phases of the TA and a number of them are included in **Appendix 3**. This extensive tabulation provides the manager and the occupational health specialist with key points of management and technical and health aspects for the successive phases of a turnaround project. The issues may vary during the different phases according to the nature of the TA, i.e. whether it is a major or minor TA, or unscheduled maintenance work.

3. MANAGING OCCUPATIONAL HEALTH ASPECTS OF A REFINERY TURNAROUND

3.1. OBJECTIVE

Risks to health in a refinery turnaround may arise from the presence of chemical, biological, physical, ergonomic and psychological factors. The objective of a turnaround management team is to eliminate, or to minimise to an acceptable level, these risks for those directly involved, such as employees and contractors, and for others who might be affected (e.g. adjacent workers, visitors, community), in a cost-effective way. This is usually best achieved by implementing an agreed management system. While it is recognised that any such system will be developed along locally established lines, in order to meet local needs, the guidance given in this report is categorised under a series of headings that reflect a possible management system structure.

For such a system to be successful, a number of organisational conditions need to be satisfied. At the planning and preparation stages, the health hazards need to be identified and a preliminary evaluation of the risks made in order to identify the control options necessary for the various tasks. The evaluation of the risks should take into account the lessons learned from previous TAs. It will identify the need for procedures for those activities and tasks which could otherwise result in significant exposure to health hazards.

Specific task procedures are likely to apply to activities such as the handling of catalysts, thermal treatment, high pressure blasting and cleaning, welding on alloyed steels, work with non-ferrous materials in confined spaces and radiography. Generic procedures are likely to be suitable for activities such as training and hazard/risk communication, incident reporting, emergency and first aid and confined space entry.

Major TAs often provide the opportunity to modify existing plant and work procedures that have in the past contributed to unsatisfactory health or safety performance. This might include the relocation of valves and other equipment for easier access, noise reduction, improved lighting, the installation of closed loop sampling points, and improved control room layout.

A waste handling strategy is required, supported by specific procedures for dealing with hazardous waste such as asbestos. This should cover the identification, segregation, storage, transport and disposal of the waste.

The process outlined may result in a prevention plan, developed jointly with the contractors, and should include measures to control all health risks.

As part of the planning process, consideration should be given to the management of emergency situations, such as the accidental contact with corrosive materials.

3.2. ORGANISATION AND RESPONSIBILITIES

Irrespective of the scale of a turnaround, it is good practice to manage this activity as a specific project with the following standard approach:

- define the objectives and constraints

- define the management structure, roles and responsibilities
- evaluate the necessary resources
- plan the individual activities
- identify the hazards and assess the risks
- carry out the work
- monitor performance during the work and modify if necessary
- review the results and identify opportunities for future improvement.

This approach is designed not only to ensure the reliability and availability of an installation for the next running cycle, but also to ensure the effective control of health risks that might arise during the actual TA.

For a major TA, it is essential to appoint a project leader and a TA project team. The project leader, normally reporting to the refinery manager, and the project team should be responsible for the overall planning and day to day execution of the TA.

A dedicated organisation for a TA provides the structure for leadership and responsibility in health. Health risks can be managed most effectively by a project team which has access to appropriate specialists in occupational hygiene and occupational medicine (see section 3.3.3).

The planner, manager, supervisor, operator and craftsman, within the scope of their own jobs, need to be competent in dealing with the risks to health which arise from turnarounds. This applies equally to contractors. **Appendix 4** contains suggested skill requirements for the main categories of workers directly involved in refinery turnarounds.

Health aspects need to be taken into account in the budget and resources allocated to the TA. Lessons learned from previous TA experiences can be helpful in this respect. Attention, for example, needs to be focused on the specialist resources/costs that may be necessary for:

– activities which require extensive technical and procedural controls, such as asbestos identification and removal
– exposure monitoring and health surveillance, in accordance with the findings from the appropriate health risk assessments
– hazard training for employees and/or contractors.

During a TA, delays in completing the work can result in significant costs in lost production. It is essential, therefore, to check the availability of likely additional resources, such as occupational hygiene specialists, so that they can be called upon as and when required. The nature of the work pattern, for example shift work covering 24 hours a day, should be taken into account.

The presence of large numbers of contractors on site for the duration of a TA has significant environmental health and welfare implications. Provision needs to be made for temporary office and living accommodation plus amenities for personal hygiene, protective clothing and equipment used at work. Easy access to dedicated clean areas for eating and drinking is essential.

The facilities need to take full account of relevant general health and safety requirements, such as safe access, adequate illumination and satisfactory ambient noise levels. The presence of any specific TA hazards, for example asbestos removal, may require additional personal hygiene facilities.

3.3. CONTRACTORS

Many TA tasks with potentially significant health risks are carried out by contractors.

Difficulties may arise as a consequence of a lack of awareness about the health risks, a lack of competence in health issues and a lack of adequate controls in the workplace. Therefore strict supervision may be needed to avoid health-related incidents.

3.3.1. Strategy

The strategy for involving contractors in a refinery turnaround should be defined and encompass:

- pre-selection, based on general health and safety requirements and competence, before seeking bids for the work
- selection criteria bearing in mind the specific occupational health requirements for the TA
- close co-operation in preparation for the TA, including general planning, risk prevention planning and worker training before commencing work
- evaluation of performance during execution of the work
- feedback of lessons learned after the TA.

3.3.2. Contract requirements

Contracts should state the minimum occupational health requirements against which performance can be assessed during the TA, meeting local statutory regulations and company policy. Performance and the competence of HSE staff are regarded as major selection criteria for contractors. Such information should be included in a register of approved contractors. In some countries this process is facilitated by the requirement for compliance with national and local contractor training and certification schemes.

Contracts should specify responsibilities as to who is providing and paying for specialist services, training (including trainee's time) and amenities.

For a contractor working directly under refinery supervision, the refinery will usually be responsible for the working environment, equipment and plant on site, while the contractor's employer will usually be responsible for providing any relevant health services such as health surveillance. However, in major turn-key contracts the contractor usually takes responsibility for all occupational health issues.

3.3.3. Selection

As a general rule contractors should be required to provide information and evidence about their organisation, resources and ability to provide services under the headings of:

- occupational health management system
- organisation, including health advisors
- training and competence.

Their ability to manage the risks to health in an effective manner should be judged on the basis of evidence provided regarding aspects such as:

- health risk assessments
- control strategies and procedures
- control of working hours
- past performance, e.g. for other clients.

3.3.4. Information on hazards to health

Prior to contractors carrying out appropriate health risk assessments for a TA it is necessary for them to receive adequate hazard information from the company. Specialist advice and technical support may be needed to ensure the adequate control of health risks associated with a specific operation.

Contractors should have their own information and understanding about hazardous agents which they bring onto site (e.g. welding materials, coatings, abrasive blast agents, insulation, isotopes) and ensure that their workers are properly informed and protected. The refinery organisation should be advised about such agents, including waste materials, that might affect company personnel and operations.

3.3.5. Contractor training

In order to achieve the effective control of health risks during a refinery TA, all contractors should be briefed and trained in the following:

- competence in specific task-related health and safety issues, e.g. chemical handling, use of breathing apparatus (BA)
- site emergency plans, occupational health and safety systems and processes
- linkage between contractor health and safety management systems and the refinery health and safety management systems.

Contractor personnel should also be included in a programme of induction training. Furthermore refinery management should provide a mechanism for ensuring the competence of contractors prior to commencement of a TA.

3.4. PLANNING THE CONTROL OF HEALTH RISKS IN THE TURNAROUND

As part of the planning process, consideration should be given to the potential need to notify the local or national authorities of work to be carried out (e.g. asbestos removal) in accordance with local regulations.

Health risk assessments are required to identify the chemical, biological and physical agents, their hazards and the potential extent of the associated exposures, and to prevent or minimise such exposures. The assessments should identify circumstances for which control measures are necessary during the various TA phases and to define the need, if any, for exposure monitoring and health surveillance. The health risk assessments should be conducted sufficiently far in advance of the actual work activities in order to allow the proper control measures to be implemented effectively. A dedicated team with a mix of expertise in TA tasks and occupational hygiene practice may be required for the risk assessments.

The results from the health risk assessments, including the actions arising, should be appropriately communicated to site supervisors, other employees and contractors to ensure an effective understanding of the recommended control strategies and any other related requirements. This communication should be systematic and may be in verbal form, e.g. during work planning meetings, in written form, e.g. as instructions to be appended to work permits, or become part of the pre-TA training curriculum.

3.5. HEALTH HAZARD IDENTIFICATION AND RISK ASSESSMENT

Appendix 5 provides examples of hazardous agents, potential health effects and control measures for the full range of TA phases to assist in the health risk assessment process. Some of the principal hazardous agents for each TA phase are summarised below:

Pre-TA work	asbestos, refractory ceramic fibres, noise, ionising radiation, manual handling
Shutdown/oil out	hazardous substances, manual handling
TA execution	hazardous substances (e.g. asphyxiant gases, dusts and fibres, welding fumes and gases), noise, UV light, ionising radiation, manual handling
Oil in/Start-up	hazardous substances, noise
Post TA work	hazardous substances, noise

A TA project normally involves an intense and sometimes unpredictable workload and may involve the extensive use of overtime. Mental stress, therefore, can represent a significant health hazard.

3.6. SELECTION OF CONTROL STRATEGIES

The strategy to prevent or minimise occupational health risks arising from hazardous substances should be based on the selection of an appropriate set of precautionary measures from the generally accepted hierarchy of measures set down below:

Elimination	– of a hazardous substance or process
Substitution	– of a hazardous substance or process with a less hazardous substance/process – or by use of the same substance in a less hazardous form, e.g. pellet instead of powder
Engineering Controls	– by containment of a substance or process, e.g. within enclosed pipework/tankage – by semi-containment, e.g. using partial enclosures, which may be coupled with a local exhaust ventilation (LEV) system – by LEV, to capture and control airborne releases of hazardous substances at or close to the point of emission – by general ventilation
Segregation	– by separating processes, e.g. dusty from non-dusty, to minimise the number of workers at risk
Procedural Controls	– by using operating procedures/standing instructions/permits-to-work which specify the precautionary measures to be taken – by reducing the number of people exposed – by reducing the period of exposure, e.g. via job rotation – by the regular inspection and maintenance of engineering measures, e.g. LEV – by the safe storage and disposal of hazardous substances
Personal Protective Equipment	– by protecting workers from the work environment when the above measures are insufficient or not reasonably practicable
Personal Hygiene	– by restricting eating, drinking and smoking to approved areas – by the provision and use of adequate washing and changing facilities

The measures should be fit for purpose, maintained in good working order and their effectiveness checked on a regular basis.

A similar strategy should be adopted for other hazardous agents (e.g. noise, manual handling).

Reasonable practicability should be taken into account; this is closely linked with the adoption of industry best practice. Although personal protective equipment has a relatively low position in the hierarchy of control measures, in practice it has a critical role in many aspects of TAs (see section 3.6.3).

3.6.1. Engineering controls

Engineering approaches are the primary means of control of risk arising from:

- product streams prior to equipment opening (i.e. closed draining systems, purging and venting to flare)
- welding fumes and gases
- noise from mobile equipment
- ionising radiation
- adverse workstation ergonomic factors.

3.6.2. Procedural controls

Exposure to the various chemical, biological, physical and adverse ergonomic factors can be minimised and in some cases virtually eliminated by a combination of technical and procedural controls. A Permit-to-Work system linked to the health protection plan is the basic procedural mechanism. This serves to specify the risk reduction measures that need to be adopted for individual TA activities.

3.6.3. Personal protective equipment (PPE)

Personal protective equipment should be used to protect workers from exposure to chemical, biological and physical agents that cannot be eliminated, or adequately controlled by other methods.

The interaction of intensive manual work, PPE that may be restrictive and a confined working area can create adverse effects on the individual, ranging from reduced working efficiency to musculoskeletal injury.

These effects can be avoided by controlling the work load, by the careful selection of separate items of PPE (to ensure compatibility), and by the introduction of mechanical means to limit dependence on manual handling.

During TAs there is normally a high level of reliance on the wearing of personal protective equipment because of the amount of containment that is broken, for example to control risks from:

- process gases and vapours in non-drained systems
- abrasive, hydro-blasting aerosols
- catalysts and other dusty materials
- asbestos and other insulating materials
- noise from fixed installations and equipment
- ultraviolet radiation.

Good PPE selection, which is job and risk dependent, is critical. Where skin contact may occur, or where work clothes can be contaminated by dust or fibres, there is a particular need for a high standard of personal hygiene. Accessible and suitable washing and changing facilities should be provided.

The selection of PPE is just one of several aspects of a PPE programme, which itself is regarded as an essential part of the TA management system. The PPE programme incorporates the correct selection and specification of equipment and also addresses the issue, use, maintenance, storage, training and evaluation of performance.

3.6.4. Confined spaces

Some TA tasks are carried out in confined spaces. This magnifies the potential risks and creates practical management problems. Multiskilled work in furnaces, towers and vessels, for example, can result in high exposure to noise, vapours, dust and welding fumes. This necessitates special attention with respect to health risks when issuing Permits to Work, including a Confined Space Entry Permit. Where possible,

isolation of the primary source of risk can be used to minimise the number of workers at risk.

Where there are very high noise levels, such as within vessels when pneumatic tools are used, normal hearing protection may not be capable of reducing the exposure sufficiently. The use of double hearing protection (earplugs & muffs) and/or reduced daily exposure time should be considered.

An adequate combination of local exhaust ventilation and general ventilation is required for most confined space activities and should be specified in detail on the Permit to Work. A requirement to monitor oxygen levels and, where appropriate, the concentration of hazardous substances in the confined space is also necessary. Useful guidance is provided by the American Industrial Hygiene Association (Harris et al, 1996).

3.6.5. Thermal stress

Where air temperatures exceed normal ambient levels, consideration will need to be given to the possibility of heat stress. Environmental or personal cooling can be used to avoid or delay the onset of stress, otherwise an appropriate work-rest regime, for example as specified by the American Conference of Governmental Industrial Hygienists (ACGIH, 1999), will need to be implemented.

Where low temperatures are encountered, consideration will need to be given to maintaining the body core temperature, for example by measures such as the provision of heat, by the use of thermal clothing and by a careful consideration of work schedules. Wind chill factors and wet conditions are critical in determining the effectiveness of precautionary measures.

3.6.6. Precautions in specific activities

Appendix 5 refers to hazardous agents which can be expected to be encountered during turnarounds and unscheduled maintenance work on refineries.

Eleven tasks are identified in **Appendix 6** involving one or more hazardous agents which can give rise to the following potential health effects: irritation, chemical burns, cancer, damage to lungs, genetic effects, systemic toxicity, noise-induced hearing loss (NIHL) and hyperthermia. The information given can be used as inputs to health risk assessments.

Several of the tasks necessitate entry into vessels and pipe-work or work on furnaces, whilst others involve abrasive blasting, radiographic examination, non-destructive testing and transformer fluid replacement.

A wide range of hazardous agents can be encountered, including pyrophoric ferric sulphide, nickel, vanadium, acids, dust, hydrogen fluoride, benzene, furfural, polycyclic aromatic compounds (PCAs), polychlorinated biphenyls (PCBs), fibrous dusts, hydrocarbon residues, noise and ionising radiation, and may be present together with safety hazards, such as steam and air under high pressure.

Examples of relevant control measures for the eleven tasks are also shown in **Appendix 6**.

3.7. IMPLEMENTING HEALTH RISK CONTROL

Normally, a number of strategic issues need to be addressed during the consecutive phases of the TA and the main associated occupational health considerations are outlined below. Further detail is provided in **Appendix 3**.

3.7.1. General issues

Occupational health considerations need to be taken into account in:

- risk management guidance, for major and minor scheduled TAs and unscheduled maintenance work, recognising major differences in work content, manpower and duration
- contract requirements, for general and specialised third party work responsible for supervision, for occupational hygiene follow-up and for general work
- contractor prequalification, concerning health services and competence, performance monitoring and the provision of PPE, compliance with company policies and procedures, requirements for training and certification, and precautionary measures.

3.7.2. Preparation phase

When preparing for a specific TA:

- Liaise with workers' representatives and relevant authorities and apply for consents and permits, as appropriate.
- Review lessons learned from previous TAs.
- Review health hazard inventories for the process units involved in the TA.
- Review the TA tasks to be undertaken and carry out health risk assessments.
- Establish occupational hygiene procedures that address the key health hazards and risks.
- Review the work procedures (including input by occupational hygiene specialists).
- Incorporate occupational hygiene procedures into TA job lists.
- Include health aspects in contracts and bid specifications, such as scope, responsibilities for follow-up of performance and the consequences of non-compliance.
- Select contractors in line with the health and other prequalification requirements.
- Liaise with HSE staff of major contractors (specialised/turn-key contractors) and ensure that the health performance requirements for contractors and employees are aligned.
- Establish occupational health training and certification programmes for contractors commensurate with the TA risks.
- Establish the occupational health training programmes for refinery personnel commensurate with the TA risks.

- Formulate occupational hygiene monitoring and health surveillance programmes based on the findings from the health risk assessments.
- Allocate sufficient resources for the health training, monitoring and surveillance.

3.7.3. Pre-TA work

While the unit is still in operation:

- Verify that the occupational hygiene procedures are relevant for:
  - hydrocarbon and hydrogen sulphide emissions
  - chemical cleaning/stripping
  - welding
  - insulation removal/handling
  - manual handling (e.g. scaffolding)
  - radiography
- Conduct the planned occupational health training.
- Ensure that work permit procedures, including the use of PPE and Respiratory Protective Equipment (RPE), are enforced.
- Carry out the planned exposure monitoring and medical surveillance.
- Undertake field inspections and ensure that incident reports and ad-hoc issues are addressed.

3.7.4. Shut-down/Oil out phase

When clearing equipment and preparing for inspections and mechanical work:

- Verify that the occupational hygiene procedures are relevant for:
  - blinding
  - draining
  - purging and venting
  - hydrocarbon and hydrogen sulphide emissions
  - gas testing/confined space entry
- Conduct the planned occupational health training.
- Ensure that the work permit requirements, including the use of PPE and respiratory protective equipment (RPE), are implemented.
- Undertake the planned exposure monitoring and health surveillance.
- Validate the health risk assessments and the associated findings.
- Carry out field inspections and address any ad-hoc issues.

3.7.5. TA execution

When executing planned inspections and mechanical work:

- Verify that the occupational hygiene procedures are implemented effectively for:
  - gas testing
  - confined space entry (including the ventilation requirements)
  - catalyst handling
  - asbestos, refractory ceramic fibres and insulation handling
  - welding
  - abrasive blasting, cutting, grinding
  - hydroblasting
  - chemical cleaning/stripping
  - application of protective coatings
  - manual handling
  - radiography
  - waste handling
- Ensure that the work permit requirements, including the use of PPE/RPE, are implemented.
- Conduct the planned exposure monitoring and medical surveillance.
- Validate the appropriateness of the health risk assessments and the associated findings.
- Carry out field inspections at regular intervals and address any ad-hoc issues.

3.7.6. Start-up phase

When testing and preparing for “oil in”:

- Ensure that the job safety analysis/work permit procedures, including PPE/RPE use, are implemented.
- Verify that the occupational hygiene procedures are implemented effectively where there is potential for exposure to:
  - hydrocarbons, including benzene
  - hydrogen sulphide
  - hydrogen fluoride
  - noise
- Conduct the planned exposure monitoring and medical surveillance.
- Carry out field inspections and address any ad-hoc issues.

3.7.7. Post TA work

When finalising work with the unit operating:

- Ensure that the job safety analysis/work permit procedures, including PPE/RPE use, are implemented.
- Verify that the occupational hygiene procedures are implemented effectively for:
  - insulation handling
  - painting (e.g. with regard to solvents)
  - manual handling
- Conduct the planned exposure monitoring and health surveillance.
- Validate the appropriateness of the health risk assessments and the associated findings.
- Carry out field inspections and address any ad-hoc issues.

3.7.8. Close out phase

At the end of the TA, use the debriefing meeting to highlight the lessons learned and to identify any additional health issues which need to be incorporated into future TAs regarding the occupational health considerations at the various stages.

The following should be included:

- the lessons learned
- planning, budget, preparation
- organisation, logistics, co-ordination
- procedures, information, PPE selection and use
- management of changes in contractors and work schedules
- contractor performance

As a result:

- Develop a health action plan as input to future TA planning.
- Forward a statement of the positive and negative occupational health points of the completed turnaround to company personnel and contractors for input to toolbox meetings.
- Inform company personnel and contractors about the relevant strengths and weaknesses in the implementation of the completed turnaround, for input to future toolbox meetings.
- Update the hazard inventories, as appropriate, assess any new health risks, and review the existing health risk assessments.

3.8. PERFORMANCE MONITORING

Ongoing monitoring of the health protection performance is important and can be achieved during all phases from pre-TA to post-TA activities by regular inspections and scheduled audits, accompanied with prompt feedback to line management. Scheduled and unscheduled audits and inspections should be undertaken for assurance purposes and appropriate action taken to rectify any shortcomings identified. Suitable checklists for use during the inspections in the various phases of the TA may be derived from the content of the preceding sections.

The formal incident investigation system, its reporting and follow-up should include all occupational health incidents, including exposure limit exceedences, significant worker complaints, exposures to unidentified/unexpected hazards, inappropriate personal protective equipment, as well as actual occupational health accidents, such as respiratory problems, skin burns and dermatitis.

The nature and extent of the exposure monitoring and health surveillance is determined to some extent by the requirements of national regulations as well as by the findings of the health risk assessments. The collection of occupational health data and the evaluation of health protection performance are discussed in more detail in the following sections.

3.8.1. Exposure monitoring

General guidance on the evaluation of exposure to hazardous agents is given in CONCAWE Report 87/57. Hazard specific exposure monitoring may be appropriate for:

- asbestos, refractory ceramic fibres, and other insulating materials
- lead and other metals
- benzene, toluene, xylene and other aromatic hydrocarbons
- aliphatic hydrocarbons, e.g. n-hexane
- furfural
- oil mist and vapour
- hydrogen sulphide
- amines and derivatives
- catalyst dust
- welding gases and fumes
- inorganic acids
- noise
- thermal environment (hot and cold)
- lighting.

An evaluation of the thermal environment may be required for indoor situations, such as temporary offices and living accommodation. An assessment of the lighting in operational areas may also be necessary.

Where exposure control relies upon local exhaust ventilation (as for welding fume), dilution ventilation (as for work in vessels with volatile chemicals) or other engineering controls, the performance of such systems should be evaluated on a routine basis for assurance purposes. A rapid feedback of the findings is essential and urgent action necessary where any shortcomings are identified.

3.8.2. Health surveillance

Health surveillance may be introduced:

- to evaluate individuals' health
- to confirm continuing fitness for work
- to confirm the effectiveness of control measures, with reference to occupational exposure limits
- to detect occupational diseases.

The general guidance given in CONCAWE Report 96/54 on health surveillance applies to TAs. Any pre-placement medical examination should normally address psychiatric disease, neurological disorders, cardiovascular conditions, diabetes mellitus, vision and hearing. Fitness to use breathing apparatus, where this may be required, should also be determined.

Hazard specific health surveillance, including biological monitoring and/or biological or biochemical effect monitoring, may be appropriate where there is potential for exposure to:

- benzene and other aromatic hydrocarbons
- polycyclic aromatic hydrocarbons
- other hydrocarbons
- furfural
- phenolic substances
- lead and other metals
- noise
- extremes of temperature.

3.8.3. Evaluation and reporting

The results from any exposure monitoring and health surveillance need to be collected, recorded, validated and analysed. Specialist interpretation is necessary in order to obtain reliable conclusions and to make meaningful recommendations.

Exposure data should be recorded in accordance with company procedures or, for example, CONCAWE Report 7/83.

Standardized reporting is necessary to link exposure measurements and health risk assessments, biological monitoring and health surveillance with medical records.

For biological monitoring, two types of report are required:

- overall collective reports for management, summarising the results, but without the names of individuals being identified
- medical reports for each individual worker concerned, with a guarantee of confidentiality for the information contained.

The collective reports are intended for inclusion in the discussion on health risks with management and the workforce, and contractors where appropriate, e.g. in the close-out phase of the TA.

The nature of many TA activities is such that there will be a need for the rapid analysis of monitoring samples, as the results may affect the way in which the work should be conducted and the speed at which it is progressed.

3.9. REVIEW OF EFFECTIVENESS

The procedures established and the actions taken on the basis of a well-structured health risk assessment may not avoid or minimise all the possible health risks.

Accordingly, a programme of continuous care is necessary, including some or all of exposure and effect monitoring, supervision of work method, equipment inspection, checks on the use of technical controls and personal protective equipment, to ensure that effective health protection is achieved as necessary.

The effective management of occupational health risks cannot be achieved without taking into account the people directly involved. Their perception of risk influences the way they work, their use of PPE, their respect of procedures, motivation for preparation, monitoring, and analysing and improving tasks. Information on the potential hazards and risks should be given to all the people directly involved and training provided regarding the necessary procedures.

4. STANDARDS AND NORMS FOR GOOD PRACTICE

These are summarised in **Appendix 7**.

Standards and norms which apply generally to refineries also apply to TAs. Standards of good practice, based on operational and technical experience are published for the industry by CONCAWE. These standards address, for specific hazards, hazard identification, exposure evaluation, health management, health surveillance, and emergency and first-aid procedures.

Some ISO and CEN standards are applicable to personal protection, waste disposal and specific hazards, including asbestos and noise.

Exposures to hazardous agents should comply with national and company standards. Where these are not available, reference can be made to limit values from other sources, such as the Threshold Limit Values (TLVs) promulgated by the American Conference of Governmental Industrial Hygienists (ACGIH) and to the associated documentation which defines the basis for the recommended exposure limits.

5. REFERENCES

ACGIH (1999) 1999 TLVs® and BEIs® threshold limit values for chemical substances and physical agents – biological exposure indices. Cincinnati OH: American Conference of Governmental Industrial Hygienists

CONCAWE (1983) Guidelines for recording industrial hygiene data. Report No. 7/83. Brussels: CONCAWE

CONCAWE (1987) Review of strategies for the evaluation of employee exposures to substances hazardous to health. Report No. 87/57. Brussels: CONCAWE

CONCAWE (1996) Development of a health surveillance programme for workers in the downstream petroleum industry. Report No. 96/54. Brussels: CONCAWE

Harris, M.K. et al (1996) Field guidelines for temporary ventilation of confined spaces with an emphasis on hotwork. Fairfax VA: American Industrial Hygiene Association

GLOSSARY

ACGIH	American Conference of Governmental Industrial Hygienists
Biological monitoring	Evaluation of intake of, or the effect of, a harmful agent in a specified job type or task
BA	Breathing apparatus
Competence	Demonstrated ability to undertake a specified range of tasks
Control hierarchy	List of precautionary measures in decreasing order of effectiveness. The preferred approach involves eliminating a health risk, whilst the least favoured option is reliance upon the use of personal protective equipment to protect a worker from the work environment
Control strategy	Selection and application of one or more precautionary measures from the control hierarchy
Environmental health and welfare	Aspects of health which might be affected by surroundings, domestic facilities and sanitary arrangements
Exposure assessment	Evaluation of exposure to any harmful agent in a specified job type or task compared with an exposure limit value
Exposure monitoring	Measurement of exposure to an agent to check compliance with an exposure limit value
Hazard	An inherent property of a substance, agent or ergonomic situation indicating the potential to cause harm
Hazard information	Physical, chemical, environmental and health data on any harmful agent
Hazardous agent	Any chemical, physical, biological, ergonomic or psychological factor to which exposure may occur that is known to have a potentially harmful effect on health
Health hazard inventory	A list of hazardous agents, harmful effects and associated data on jobs and tasks for input to health risk assessments
Health performance	Measurements of the effectiveness of controls and harmful effects compared with pre-set standards
Health risk assessment	Formal evaluation of the risk to health in specified jobs and tasks
LEV system	Local exhaust ventilation system
Medical surveillance	Regular evaluation of state of health to check compliance with medical criteria

Method statement / prevention plan	Scheme identifying hazardous agents, severity of risk and control strategies in the planning stage
Musculoskeletal injury	Harm to any part of the skeleton, joints and muscles
NIHL	Noise-induced hearing loss
Occupational health	Any aspect of health in the workforce which may be affected by workplace activities
Occupational health standard	A reference value against which measured performance can be evaluated
Occupational hygiene	Recognition, evaluation and control of exposure to harmful agents arising from workplace activities
Occupational medicine	Surveillance, prevention and treatment of harmful effects in employees, arising from workplace activities
PCA	Polycyclic aromatic compound
PCB	Polychlorinated biphenyl
Personal medical record	A confidential record in the custody of a physician on a named individual
Personal protective equipment (PPE)	Any item of clothing or equipment which is worn as part of a control strategy, for example respiratory protective equipment (see below)
PPE programme	Management system to ensure that PPE is selected, evaluated, maintained and properly used to control exposure
Prevention plan / method statement	Scheme identifying hazardous agents, severity of risk and control strategies in the planning stage
Procedural control	Method of work to prevent or minimise exposure to hazardous agents
Qualitative risk rating	Judgement of the likelihood of a harmful effect occurring based on practical experience
Respiratory protective equipment (RPE)	Any item of equipment, such as a filtering face mask or breathing apparatus, to protect from harmful airborne chemical or biological agents
Risk	Likelihood of a harmful effect occurring as a result of exposure arising from a workplace activity
TA	Turnaround
TLV	Threshold limit value

APPENDIX 1

BASIC REFINERY UNITS, ASSOCIATED REFINERY STREAMS AND PROCESS CHEMICALS

Crude oil refining makes use of a large number of complementary processes designed to meet both the product demand volumes and the specified quality of the finished products. Although every refinery has its specific configuration, there are a few generic schemes that help to understand how the processes interact:

Hydroskimming refineries consist of primary distillation, distillate hydrotreating and naphtha reforming. They do not have the ability to change the basic yield pattern of the crude oil they process.

Complex refineries incorporate at least one conversion process. The most common configuration includes a fluid catalytic cracker (FCC) and associated plants and often a visbreaker to further upgrade the residue. The alternatives are either hydrocrackers or cokers. Some refineries have both FCC and hydrocracker.

Individual processes are briefly described below.

1. Crude Distillation (CDU or Topping)

   The CDU physically separates the crude oil into fractions of specific boiling ranges by distillation and steam stripping, e.g. gas, LPG, naphtha, kerosine, gasoil, atmospheric residue. These fractions then usually undergo further separation and/or treatment. Small quantities of chemicals such as neutralising amines or ammonia are used for neutralising chlorides released in the overhead section. Anti-corrosion or filming amines are also used. A desalter usually precedes the crude distiller where the crude oil is washed with fresh water to remove the bulk of the mineral salts. A demulsifying chemical is used to help separate oil and water. Small amounts of caustic soda (either fresh or spent in the form of sodium carbonate) is often injected into the crude oil after the desalter to neutralise the non-hydrolysable salts and limit the production of chlorides in the column.

2. (High) Vacuum distillation (HVU)

   The atmospheric residue is further distilled under vacuum to separate a small gasoil fraction, a large vacuum distillate fraction to be further used in cracking units and a vacuum residue. Chemicals are used as in the CDU.

3. Hydrotreating of distillates

   Hydrotreating is applied to most distillates from naphtha to gasoil primarily to remove sulphur. Nitrogen-containing compounds are also partially converted. The reaction occurs at moderate to high temperatures and pressures in the presence of hydrogen over an alumina catalyst impregnated with metal sulphides (cobalt, molybdenum, nickel). A small amount of cracking occurs leading to the production of small amounts of light fractions while sulphur and nitrogen are converted to hydrogen sulphide and ammonia. The sour off-gases are commonly treated with an organic amine to remove these components which are then routed to the sulphur recovery unit.

Hydrotreating is also applied to heavier fractions such as FCC feedstocks or luboil fractions. Higher pressures are used for such applications and such units are often designed for partial conversion of the feed, becoming in effect mild hydrocrackers.

4. Catalytic Reformer

Paraffins and cycloparaffins (or naphthenes) are converted into aromatics by de-hydrogenation and cyclisation over an alumina catalyst impregnated with platinum and one or several other metals (such as rhenium or tin). The reformate is used either as a major high-octane gasoline blending component or as a source of light aromatic hydrocarbons (benzene, toluene, xylenes) for the petrochemical industry. Small amounts of a chloriding agent (e.g. DMDS) are used to maintain the catalyst's acidic function.

5. Isomerisation

The isomerisation process converts C_5/C_6 normal paraffins into their respective branched paraffins which have a higher octane number. The feedstock, mixed with hydrogen at moderate temperature is passed on a solid alumina catalyst promoted with chlorides. The very acidic off-gases need to be neutralised by caustic and small amounts of spend caustic are produced.

6. Gas Plants

Gas streams (C_4 minus hydrocarbons) from various refinery processes are processed in gas plants to remove heavier hydrocarbons and then to isolate various fractions such as liquefied petroleum gases (C_3/C_4 mixtures or LPG). The lighter gases (C_2 minus) are used as refinery fuel. Before fractionation the gas streams need to be amine and/or caustic treated to remove hydrogen sulphide and mercaptans. Gas plants do not normally use auxiliary chemicals.

7. Fluid Catalytic Cracking (FCC)

"Fluid" Catalytic Cracking is the mainstay of refining, converting vacuum distillates and light atmospheric residues into a variety of lighter products mainly gasoline and olefinic C_3/C_4. The term "fluid" applies to the catalyst, a very fine alumina-based powder, transported from the reactor to the regenerator and back in a fluidised form. As the process does not involve hydrogen, the products are largely unsaturated and also contain notable amounts of sulphur. They therefore need further treatment to be used in final blends. In the regenerator the coke deposited on the spent catalyst is burned with air. Control of emissions of catalyst particulates, carbon monoxide and sulphur dioxide is a major issue for FCCs. Distillate FCCs are usually heat-balanced i.e. the heat required for the cracking reaction is supplied by burning of the coke deposited on the catalyst. The introduction of residual feeds results in a sharp increase in coke formation so that residue-FCCs are net heat producers. Anti-corrosion and neutralising chemicals are commonly used in the fractionation section.

The general principle of the FCC is used in a number of commercial processes aiming at converting heavy residues.

8. Alkylation

The alkylation process uses a very strong acid catalyst (sulphuric or, more often hydrofluoric acid) to react isobutane with C_3 or C_4 olefins usually originating from the FCC. The alkylate product is valuable high-octane component for gasoline blending. By-products are acid, organic sulphates and sulphonates, or organic fluorides.

9. Hydrocracking

The hydrocracking process employs a principle similar to hydrotreating but at higher temperature and pressure, allowing vacuum distillates and heavy gasoils to be cracked and hydrogenated. The process is very flexible and can be designed to produce a range of yield structures from mainly naphtha to mainly middle distillates with conversion ranging from about 30% to nearly 100%. In the process sulphur and nitrogen are essentially quantitatively removed. Hydrocracked products are therefore of high quality and do not normally require further treatment. The sour off-gases are commonly treated with an organic amine to remove hydrogen sulphide and ammonia, which are then routed to the sulphur recovery unit. The catalysts consist of an alumina base impregnated with various metals (nickel and molybdenum mainly). Significant quantities of wash water are used and the sour water contains large amounts of corrosive ammonium salts.

The hydrocracking principle is also applied to the conversion of heavy residues. This requires even higher pressures and temperatures as well as special catalyst systems to deal with a/o heavy metals (vanadium and nickel).

10. Thermal cracking

Thermal cracking is the simplest and oldest of all cracking processes, simply consisting in heating the feedstock and letting the heavy molecules thermally decompose into smaller ones.

Visbreaking is the mild thermal cracking of vacuum residues. Conversion to lighter products is very limited and the main objective is to reduce the viscosity of the residue (hence the name).

Thermal cracking can also be applied to atmospheric residues and vacuum distillates. Severity is higher than in visbreaking as the objective is to produce light distillates.

Coking is the ultimate thermal cracking process where the vacuum residue feed is submitted to high temperatures for an extended time resulting in the production of a full range of distillates and leaving a solid residue known as petroleum coke. There are two major variants of the process namely “delayed” coking where the residue is “cooked” in a drum and “fluidcoking ®” where the feed is passed across a fluidised bed of coke re-circulated coke particles. Delayed coking produces bulk coke whereas fluidcoking produces coke in a finely divided powder. The latter is usually directly fed to a gasifier (“flexicoking ®”) to produce “syngas”(carbon monoxide and hydrogen).

Thermally cracked products are highly unsaturated and contain sulphur. They require extensive further treatment.

Anti-corrosion and neutralising chemicals are commonly used in the fractionation sections.

11. Residue gasification

This process consists in the partial oxidation of residual streams in the presence of steam to produce “syngas” (carbon monoxide and hydrogen with some carbon dioxide). The syngas can then be used either as such as a fuel or further processed into hydrogen (see section 12). In any case hydrogen sulphide removal is required. The main advantage of this process compared to direct combustion for e.g. electricity generation is the relative ease with which contaminants can be removed and the possibility of using clean syngas to power efficient gas turbines.

12. Hydrogen Manufacturing Unit (HMU)

Modern refineries require large amounts of hydrogen to treat and upgrade many streams. This hydrogen is commonly produced by steam reforming of methane (natural gas). The so-called “syngas”, a mixture of mainly hydrogen and carbon monoxide is produced by passing a mixture or methane and steam at high temperature over a nickel-containing solid catalyst. The carbon monoxide is further reacted with more steam under different conditions and over an iron-containing solid catalyst to produce carbon dioxide and hydrogen (shift reaction). Carbon dioxide is separated in an organic amine absorber. The hydrogen is purified with an appropriate process (mostly pressure swing absorption units).

13. Solvent Deasphalting

This process, usually part of a luboil complex, is applied to vacuum residues to recover a heavy “distillate” known as deasphalted oil (DAO) from the remaining extra heavy residue known as asphalt. DAOs are further used for the preparation of specific lube base oil grades. Propane is the usual solvent although butane or even pentane have been used. The solvent is circulated and there is very little net consumption.

14. Solvent Extraction

Solvent extraction is used in luboil complexes as well as for the production of light aromatics. In the former case, certain vacuum distillate cuts are contacted with a solvent to remove aromatic components and thereby improve their quality as luboil component. In the latter case reformate are treated to remove non-aromatic components. A large number of solvents are used mainly furfural for luboil manufacture and sulfolane for aromatics production. The solvent is continuously circulated and there is only a small net consumption.

15. Solvent Dewaxing

Highly paraffinic heavy distillates contain very long chain paraffins (waxes) that need to be removed before the distillate can be used as a lube base oil because of their high solidification temperature. A solvent is used for this purpose (usually methyl-ethyl-ketone). The process also involves cooling for which a propane or ammonia cycle is commonly used. The solvent is recovered from the oil by distillation and steam stripping and recycled.

16. Caustic treatment

This process is applied to gases, naphtha and kerosines, either with liquid caustic to remove small amounts of hydrogen sulphide or on impregnated solid catalysts to turn corrosive mercaptans into harmless disulphides. The latter can be extracted if desired to reduce the sulphur content of the stream. Spent caustic is produced.

17. Amine treatment

Sour gases produced in various refinery processes need to be treated to remove hydrogen sulphide. This is done by washing such gases with an organic amine. The amine is regenerated to recover the hydrogen sulphide-rich gas, which is then sent to the sulphur recovery unit.

18. Sour water stripping

Modern refineries use significant amounts of process water that need to be stripped of its contaminants before being reused or further treated before rejection. Steam stripping of sour water removes the bulk of hydrogen sulphide and ammonia. The off-gases are sent to the sulphur recovery unit.

19. Sulphur Recovery

Off-gases from amine treaters and sour water strippers consist mainly of hydrogen sulphide with smaller amounts of ammonia and COS. The Claus process is overwhelmingly used to oxidise hydrogen sulphide into elemental sulphur while ammonia is turned to nitrogen and COS to CO_2 and sulphur. The process can achieve up to about 95% sulphur recovery and is nowadays associated to a variety of “tailgas” treatment processes that can increase sulphur recovery up to 99.9%.

APPENDIX 2

SHORT DESCRIPTION OF SOME TYPICAL OPERATIONS CARRIED OUT DURING A REFINERY TURNAROUND

1. Breaking containment of process lines or vessels

   Many items of process equipment that contain substances hazardous to health during normal service have to be opened during a turnaround, e.g. to replace valves, filters, exhausted catalyst, or to be cleaned out. General health and safety procedures require process isolation, e.g. by flushing or venting, prior to breaking containment, and this would normally help to reduce the potential for exposure to hazardous substances, such as refinery streams, catalyst materials and process chemicals; however a residual amount often remains in the system.

2. Entry of confined spaces

   Entry into confined areas such as tanks and process vessels may be required and is often scheduled to occur during turnaround, e.g. for inspection or clean-out purposes. Most companies maintain standard procedures, which should take account of fire and explosion hazards, as well as of occupational exposure limits for the hazardous substances that were present in the vessels and for substances, such as welding fumes, that may be generated during the work in the confined space.

3. Change out of catalyst materials

   Most catalyst materials, often fine solids, require periodic change-out and this will typically be scheduled during a refinery or plant turnaround. The exhausted material may have undergone chemical and physical changes during its time in the process, and may contain trace levels of hazardous process substances. Fresh catalyst material may cause dust exposures. Temporary enclosures may have to be built to prevent interference from moisture. CONCAWE report 95/57 provides further guidance.

4. Installation of new process equipment / removal of redundant equipment

   Construction and demolition activities during a turnaround may involve welding, cutting and grinding. Activities sometimes take place in congested areas, with little ventilation, and may actually interfere with each other, especially when taking places on different levels, one above the other.

   Other construction work during a turnaround may be on furnaces inside process units. Due to the high temperatures required for processing physical furnace materials may have undergone changes and present a greater health hazard than the original material.

   Construction and demolition work may be associated with high noise levels.

5. Insulation installation and removal

Insulation materials, such as asbestos lagging, refractory ceramic fibres etc. may have deteriorated during usage, due to heat, frost or humidity, and as a consequence present a greater potential for airborne dusts than the virgin material.

6. Surface stripping and coating

Surface stripping may utilise means such as abrasive blasting or handtool applications such as needle gunning. Modern coatings are often complex systems with reactive compounds that present relatively high health hazards, such as sensitisation.

7. Utilities maintenance

Turnaround work on utilities systems may involve many of the above mentioned activities, and in addition may involve potential contact with utility chemicals, some of which are corrosive. Because refinery utilities may be out of service as part of the turnaround, there is often a requirement for temporary facilities such as diesel powered electricity generators. A large number of generators in a relatively small area, in combination with low wind speeds, may give rise to a build-up of diesel fumes and excessive noise.

APPENDIX 3

EXAMPLES OF STRATEGIC ISSUES TO BE CONSIDERED DURING THE IMPLEMENTATION PHASES OF THE TURNAROUND

1. Preparation

ISSUES	MANAGEMENT TASK	SPECIFIC DETAILS
Communication (internal)	Inform all persons who will be involved with the TA.	
Create Task Force	Set up a Special Task Force under the control of the project leader.	
Task Force activities	Ensure that a detailed plan is drawn up by the Special Task Force (STF), under control of the project leader.	The task force takes overall charge of the project. On the basis of the defined activities, the task force will identify the need for additional resources at the different stages of the project, (internal and/or external). The HSE department should be involved from the start of the project. The plan should outline the main phases of the preparation for the shutdown and describe the tasks to be undertaken by each department: • operations • maintenance • inspection • HSE • supply and storage of spare parts. The plan must take into account the local regulations and laws concerning: • work organisation and duration • health.
Feedback on progress	Arrange regular meetings.	The success of the turnaround will depend upon compliance with the plan. Progress will be monitored by a regular monthly progress report to the STF.
Non destructive testing (inspection) in the running phase	Ensure that optimal use is made of non-destructive testing.	Undertake the maximum of non destructive tests in the running phase, about one month ahead of the shutdown, to limit the additional work that will be needed during the turnaround.
Initial list of planned activities	Prepare an initial detailed list of planned activities and their associated costs.	Ensure that there is one single list including all requests. Ensure that the list is available to everyone involved in the project.
Long delivery items	Ensure that orders are placed for items requiring long delivery times.	Place the orders for long delivery items.

ISSUES	MANAGEMENT TASK	SPECIFIC DETAILS
Global TA planning	Prepare a single overall turnaround plan covering all phases.	The plan should include: • activities before unit shutdown • shutdown • turnaround activities • tests before start-up • start-up • activities after start-up. Analyse in detail : • the interface between operations and maintenance (this should be described in an agreement protocol) • possible conflicts between the TA and other operational units • activities authorised before the shutdown and after the start-up • incompatible activities during the turnaround.
Safety isolation procedures	Ensure that written isolation procedures are available.	Draw up safety isolation procedures for: • piping in battery unit • internal equipment • electrical installations • radioactive sources. Consider the utilities needed to test different equipment.
Procedures for preventing risks from residual products	Ensure that procedures are documented for the prevention of risks from residual products remaining in the plant after shutdown.	Carry out risk analysis and document the special procedures required to prevent risk from residual products, in particular: • towers and drums containing residual pyrophoric products (consider packing) • removal of catalyst from reactors or drums • cleaning residual deposits from equipment.
Special procedures for critical tasks	Ensure that procedures are documented for critical jobs.	Carry out task analysis of the critical jobs and prepare written procedures e.g. for: • scaffolding erection and dismantling in areas of potential exposure to health hazardous agents • asbestos insulation removal • opening and closing of confined spaces • entry and observation of staff working inside confined spaces (consider steps before and after cleaning) • management of process isolations and breaking of containment • high pressure cleaning • management of permits for working in hot environments • management of lifting operations, especially with cranes.
Finalise the work inventory	Prepare the final complete list of work to be done.	Completely describe and assess each task.
Update the technical files	Make sure that all the technical files have been updated.	Collate and update complete technical files, including information on the legal and internal requirements. Define the cleaning requirements for equipment, using photographs if necessary.

ISSUES	MANAGEMENT TASK	SPECIFIC DETAILS
Refinery organisation during TA	Define the organisation necessary for the plant turnaround.	The organisation should consider: • management of potential accidents • work permits. Operate a work permit management system with : • a clear written document giving the risk analysis and the associated preventative measures for each phase of a task • a clear process of authorised signing before giving the go-ahead for any work. Taking account of the particular state of units, the rules applied in the turnaround may be less onerous, but need to be as clearly stated as in the running phase. It is important to have a "materials and services purchase general conditions notice", signed by the refinery manager which clearly describes: • the responsibilities shared between the refinery and the (sub)contractors • the insurance conditions and requirements • the notice also has to be accepted and signed by the (sub)contractor.
Environment notice		Prepare a special environment notice, including: • procedures for safe handling of hazardous waste
General HSE notice		Write a general HSE notice for the turnaround, including: • general safety rules • safety capabilities and habilitation for staff • procedures in the case of an accident • accident/incident reports and follow-up • procedure in case of disaster • organisation of emergency services • entry to and exit from the refinery • traffic and parking • works authorisation • communication.
(Sub) contractors evaluation of HSE awareness	Assess the present level of HSE awareness by the (sub)contractors.	Prepare an HSE questionnaire to check on the current level of awareness of HSE issues by the pre-selected (sub)contractors or ask (sub)contractors to submit a safety plan to assess their awareness
(Sub)contractors evaluation	Evaluate (sub)contractors during the TA.	Prepare a statement for (sub)contractor evaluation during the turnaround. This notice has to specify : • the quality and HSE criteria • the measurement method used to evaluate deficient HSE management. Prepare a plan for HSE audits and set up an internal audit scheme.
Qualifications requirements for (sub)contractor staff	Assess qualifications of (sub)contractor staff.	Where necessary because of work complexity, define qualifications required for each special activity (scaffolding, assembling, welding, instrumentation, electricity, mechanics,...) and compare to those of the selected (sub)contractors.

ISSUES	MANAGEMENT TASK	SPECIFIC DETAILS
Finalise the requirements for contracted work activity		Complete the requirements for each contracted activity, including : • the "materials and services purchase general conditions notice" • the complete technical files • the (sub)contractors staff qualification requirements • the global turnaround plan • the general HSE notice • the environment notice • the safety isolation procedures • the special procedures for residual products risks • the special procedures for management of critical works • the HSE (sub)contractor selection evaluation • the (sub)contractors evaluation during turnaround.
(Sub)contractors strategy	Define a strategy for consultation with and preselection of (sub)contractors (this should take into account, the predicted special activities and capabilities of the (sub)contractors).	To ensure efficient management of the TA, all foreseen work should be covered in the consultation with (sub)contractors.
(Sub)contractors consultation **9 to 15 months before TA for major turnarounds**	Consult the preselected (sub)contractors.	Obtain from the (sub)contractors the: • turnaround plan organisation • qualifications of training and supervisory staff • estimated number of worked hours • HSE management programme and quality management program, in general and for the expected turnaround.
Comparison and analysis of offers		Make a detailed and thorough analysis of the (sub)contractors offers and • check that their critical paths are correct and compatible with the global turnaround plan • make comparisons of the offers. Confirm ability to manage simultaneous tasks and interferences.
Offers negotiation	Negotiate the offers with the acceptable (sub)contractors.	
Special TA approbation meeting	Convene a meeting to approve the: • definitive lists of planned work • definitive agreed credits • organisation of the turnaround.	

ISSUES	MANAGEMENT TASK	SPECIFIC DETAILS
Selection of (sub)contractors	Select the (sub)contractors, in agreement with the results of negotiation.	A (sub)contractor is acceptable if its offer is technically acceptable and its present HSE performance level satisfies the TA organisation's requirements.
Orders to (sub)contractors **6 to 12 months before TA for major turnarounds**	Place the orders for the selected (sub)contractors.	
Definitive lists of work	To ensure complete overall awareness, send to all the internal participants the agreed definitive lists of planned work.	
Bring the TA organisation up to date	Update the organisation and confirm the requirements for necessary external resources.	
Orders for external supervision	Place the orders for external services of inspection and works co-ordination and supervision. Clearly define the expected services, with a complete description of each function.	
Co-ordinators and supervisors files		Prepare the complete files for the inspection and maintenance co-ordinators and supervisors, including all the technical and HSE information.
Daily or continuous monitoring during TA		List all the topics requiring daily or continuous recording and monitoring during the turnaround. Prepare the associated registers.
Logistics preparation	Prepare all the logistical arrangements.	Arrangements need to be made for the following: • traffic and parking • "turnaround village" with mobile homes • hygiene installations for manpower • medical facilities (if necessary) • additional lighting of the unit • need for air compressors and electricity generators • waste storage and disposal • communication and information tools. Make specific plans for the turnaround phase : • a general plan with indication of the roadways, the parking points, all HSE information • a specific plot-plan showing the turnaround village and the related installations.

ISSUES	MANAGEMENT TASK	SPECIFIC DETAILS
General planning of the TA	Establish a general plan for the TA	Prepare a general plan including all the work, control and inspection phases and clearly showing the critical paths. • This plan has to be **made with the (sub)contractors and fully agreed by them**, because it will be the basis for the daily progress report during the operational turnaround. • It is very important to obtain active and practical support for the plan.
Record of phases by plant equipment (for management of the interfaces during TA)		Plot the major chronological phases for each section of plant, requiring clearance from the person in charge at the end of each phase. This is essential to manage the interfaces between operations, technical, inspection, safety, maintenance and (sub)contractors. (including instrumentation and piping)
Information/ communication of general TA organisation	Circulate a general TA organisation note which covers all the organisational, logistical and HSE themes and associated information.	
Information from the (sub)contractors	Obtain information from the (sub)contractors which is necessary for a risk analysis and the preparation of a prevention plan or package of method statements.	Each (sub)contractor has to give : • general information about its company • its internal organisation, with the names and qualifications of the persons in charge • the plan for its tasks, compatible with the general planning • a detailed analysis of its tasks and operating methods and of the risks generated by them.
Preliminary visits to the installations	Acquaint (sub)contractors with the work site.	Carry out preliminary visits to the installations with (sub)contractors' representatives.
Studies on difficult tasks	Confirmwith the (sub)contractors their plans on difficult tasks and the proposed measures to limit the problems faced by the workforce.	Check for any specific health aspects.
Analysis of task interferences	Analyse possible influence of TA work on activities in adjoining areas.	Arrange meetings with the (sub)contractors on operating methods and interference analysis, especially for critical tasks. It is necessary to run some meetings with a reasonable number of participants (less than 15).
Synthesis of the interference analysis		Use the results of the analysis meetings, review the interferences between the tasks, the equipment and the installations, and the associated health and safety measures. This review will be an essential part of the turnaround prevention plan.

ISSUES	MANAGEMENT TASK	SPECIFIC DETAILS
TA prevention plan / method statements	Circulate the TA prevention plan/ method statements.	The TA plan should give: • a clear statement of the responsibilities between the (sub)contractors and the refinery • the actions planned to control all the identified risks. The global document should be sent to all the (sub)contractors and they should be asked to give the complete information to their workforce.
Work preparation progress by the (sub)contractors **1 month before TA**	Check regularly that the work preparation progress by the (sub)contractors is on schedule.	
Logistics installation	Put in place all the logistic installations.	
Welcome and formation of the external co-ordinators and supervisors	Welcome the external co-ordinators and supervisors and give them the complete plan for their jobs. Do not underestimate the time for preparation.	
Work permits		Prepare all the works permits with the associated plant plans. This has to be a joint effort by operations and maintenance staff.
HSE information for all the workers		Circulate HSE information to all those working on the turnaround and arrange for the delivery of the entry cards at the same time. It is useful to distribute a short note outlining the main practical information.
Special safety meeting for the persons in charge of the (sub)contractors	Hold a special meeting with the (sub)contractors, to remind them of the safety measures in the TA prevention plan / method statements. • Training and information of workers as basic elements for safety. • Appointment of a responsible person employed by the (sub)contractor in charge of HSE management during the turnaround.	

2. Work before shutdown

ISSUES	MANAGEMENT TASK	SPECIFIC DETAILS
Work before shutdown **Management of the shutdown**	Set up a small team to manage the works before shutdown.	
Preliminary work		Carry out the work before unit shutdown, which is generally limited to : • Erection of scaffolding • insulation removal (with special precautions) • logistic equipment installations • delineate areas with signs. For safety during the shutdown phase, it is very important to respect the constraints agreed during the preparation phase.

3. Shutdown/oil out

ISSUES	MANAGEMENT TASK	SPECIFIC DETAILS
Scheduling needs		Define all the scheduling needs (e.g. special feedstocks, rising products, slops) for the shutdown. NB There should be no (sub) contractor work during this phase.
Environment and wastes strategy	Define the specific TA management strategy.	
Reinforced organisation of operation shifts	Define any special reinforced organisational changes and responsibilities of the operation shifts.	
Special operations and checking before shutdown		Carry out operations and checks before the shutdown (cleaning of drains and sewers, test of seldom- used valves etc.).
Preparation of tools and equipment		Prepare all the tools and equipment (hoses, individual protections, screens, gaskets, ...) that are required for the TA.
Shutdown operations		Shutdown, emptying and gas removal operations, should follow written procedures: • developed by task-forces including operations staff • giving clear intermediate stable states • made with check-lists of actions to be ticked off • giving precise criteria to check product and gas removal from the installations. These operations need to be done with great care to protect the operational turnaround phase from any risk coming from residual products in the equipment.
Screens installation		Install the required screens using a clearly defined management system.
Turnaround organisation		Set up the organisation for the operational turnaround.

4. Turnaround

ISSUES	MANAGEMENT TASK	SPECIFIC DETAILS
Give the go-ahead	Authorise the TA work after checking that all the shutdown operations are ended and that all the safety isolation procedures have been applied.	
Communication		Use intrinsically safe equipment to ensure effective and real-time communication between the main parties of the TA, including HSE persons in charge of the largest (sub)contractors.
Permits delivery		Deliver the permits to the (sub)contractors foremen, with the final signature by the person in charge (who is generally the senior operator of the units). It is necessary to have adequate resources to administer permits for work during the first 2 days (peak period).
Good housekeeping practices		Keep good housekeeping practices throughout the turnaround and be very demanding right from the start.
Prevention plan review	Review the preventative action plan for introduction of each new task or a new (sub)contractor in the TA.	
HSE audits		Carry out planned HSE audits and issue the reports promptly. In case of anomaly, check that the corrective actions are timely and that they effectively solve the problem. Look especially at: • the prevention measures of the permits • scaffolding • lift operations • all objects that may fall • housekeeping.
Daily co-ordination meetings	Run a general daily meeting to co-ordinate the work. HSE aspects should be addressed at the beginning of the meeting when information on any incidents/accidents should be communicated. Run other specific meetings as required by the turnaround.	

ISSUES	MANAGEMENT TASK	SPECIFIC DETAILS
Daily progress report	Prepare daily progress reports of the works to avoid delay in schedule. There must be total commitment by all the co-ordinators and persons in charge of the (sub)contractors.	
Inspection organisation		Organise inspections to cover additional works as soon as possible in the first days of the turnaround.
Photographic report		Complete a photographic report during the turnaround.
New materials quality certificate		Check that all the new materials have the required quality certificate and statistically monitor alloy composition.
Welding operations control		Check that the welding operations are carried out by nominated welders and according to an agreed, registered welding method. These points have to be checked by a welding specialised firm and agreed by the local responsible person.
Accident reporting and follow-up		Issue a special report with complete analysis and corrective measures to follow up any serious accident or near-miss.
First-aid accidents reporting		Promptly report and analyse the first-aid accidents. To make real HSE improvement, it is very important to get all the workers to declare any injury.
Special HSE meeting in case of sensitive delay		Hold a meeting with all the HSE persons in charge of the (sub)contractors as soon as a noticeable delay occurs. In case of general delay on a HSE subject (e.g. housekeeping), it may be necessary to stop the turnaround and to convene a special meeting to draw site-wide attention to the problem.
Control report of completed work		Obtain from the (sub)contractors a signed quality control report of their completed work. This has to be part of a global quality management plan of the (sub)contractor.

ISSUES	MANAGEMENT TASK	SPECIFIC DETAILS
Respect of legal requirements		Check that all the legal requirements are satisfied and that the associated files are complete (legal requirements will vary nationally). This is generally the responsibility of a specialist from the Inspection service.
Formation of operations shifts	Give the shift operators a complete description of all the modifications that had been made and any new equipment installed.	
Documentation elaboration		Prepare documentation for all the modifications and new equipment (at least operational procedures, schemes and emergency strategies).
Quality control report by speciality		Obtain a global quality control report for each special activity. This should include all the quality control reports by the (sub)contractors. Do not forget the initial thickness measures on piping (zero point).
Information of the neighbourhood	Consider the consequences of tests before start-up and for start-up operations for each plant/unit and circulate the necessary information.	
Planned tests before start-up		Carry out all the planned tests before start-up (engines, alarm and safety systems, ...).
First visit to the installations **72 hours before START-UP**		Carry out a first visit to the installations and draw up a list of anomalies, with correction delay and names of the persons in charge.
Process isolations management		Check that all the isolations are removed and that all the associated check-lists are complete and signed by the (sub)contractors foremen in charge. To avoid any leakage during the start-up phase, it is highly advisable to require from the (sub)contractors : • to have special tightening quality procedure • to fix a label close to each replaced gasket, with a mark number, the name of the (sub)contractor, the name of the worker and the day of the operation.

ISSUES	MANAGEMENT TASK	SPECIFIC DETAILS
Full cleaning operation		Ensure that cleaning of the unit has been fully completed (don't forget the drains and sewers, and the screens alongside hot equipment) and that all the (sub)contractors materials and equipment have been removed.
Final visit before start-up **24 hours before START-UP**		Make a final visit to check that all the "blocking anomalies" have been corrected, and to list all the small residual anomalies.
Start-up authorisation	Give operations personnel the start-up authorisation. This must be done with check-lists signed by the persons in charge of each service (maintenance, technical, inspection, safety and operations). **No authorisation may be given without a signed check list.**	

5. Start-up

ISSUES	MANAGEMENT TASK	SPECIFIC DETAILS
HSE rules and procedures		Cancel all the HSE rules and procedures of the TA and revert to normal Standard Operating Practice.
Scheduling needs for start-up	Define all the scheduling needs (special feedstocks, rising products, slops) for the start-up.	
Reinforced organisation	Define the specific start-up organisation and the responsibilities of the shifts.	May require “commissioning team” to be present at start-up until unit is stable.
"Aftersales service" maintenance	Keep a reduced shift of maintenance supervisors to assure the "aftersales service", as long as necessary.	
Specialists presence		Organise a continuous presence of specialists (instrumentation, piping, others if necessary), with a register of anomalies.
Start-up operations		Implement the start-up operations using written procedures : • prepared by task-forces including operations staff • giving clear intermediate stable states • made with check-lists of actions to be ticked off • giving precise criteria to check tightness and air removal of the installations • giving clear orders for special cases (eg : refractory drying, first compressor starting...) • These procedures must be up to date, taking into account all the modifications made during the turnaround. Considering the continuous work organisation, it is very important to demand from the start-up shifts : • a full report of the main events by the foreman • signing off of the terminated operations on the procedures • an indication of progress on a wall map plan.
Real test of major safety system		Run real tests of the major safety systems, especially for heaters.

6. Post TA work

ISSUES	MANAGEMENT TASK	SPECIFIC DETAILS
Employer Communication		Inform the workers of the relevant risks arising from the new situation (unit running phase). This is important as workers need to adapt to the running phase and the safe operating procedures.
Final works		Carry out the final works (scaffolding removal, etc.).
Small anomalies corrections		Check that all the small anomalies have been corrected (the big anomalies have been corrected before giving the start-up go ahead).

7. Turnaround close-out

ISSUES	MANAGEMENT TASK	SPECIFIC DETAILS
TA review meeting	Convene a meeting with all the persons in charge to collate positive and negative points. Define an action plan for prompt completion to obtain a clear record of the events.	
Full turnaround reports		Prepare full detailed reports, including lists of actions on health-related matters for the next TA, on the following themes : • organisation • logistic • technical • financial.
Complete documentation bringing up to date		Check that all the documentation associated with the unit is brought up to date.
Full HSE TA reports		Prepare detailed health reports, including lists of actions for the next turnaround. This is may be done in conjunction with safety and environment personnel.
Special procedures bringing up to date		Bring the special procedures up to date to take in account the difficulties met in their application.
Quality and HSE (sub)contractors evaluation		Evaluate the quality and HSE aspects of (sub)contractors.
Special HSE manifestation meeting	Convene a close-out meeting of all the participants of the TA and give the HSE evaluation results, accompanied by special awards for deserving (sub)contractors led by the refinery manager or senior members of the management team.	

APPENDIX 4

SKILL REQUIREMENTS

1. Planners and Managers

They should be familiar with and be able to apply:

- regulatory standards and requirements
- company health policy and objectives
- company occupational health standards
- operating unit procedures for the protection of workers' health
- industry occupational health guidelines

Skills are required to communicate effectively with employees, employee representatives, contractors, government agencies, local authorities, emergency services and the media, all of which are or can become involved in TAs.

2. Supervisors

When the TA is initiated, the supervisor should play a key role in monitoring compliance with health procedures. A good working knowledge of the following is essential:

- the results of health risk assessments
- the permit to work system and occupational health aspects of operating procedures; the permit system is an integral part of the TA process and supervisors should be well-trained so as to be aware of tasks for which a permit is necessary, e.g. confined space entry
- the correct use of control measures
- the effective implementation of a PPE programme
- first aid procedures
- emergency incident procedures
- incident investigation procedures, including health-related incidents

Effective communication skills with employees and contractors are important, including the ability to lead discussions on hazards and risks, such as 'toolbox talks'.

3. Operators and Craftsmen

The areas of principal concern to operators and craftsman are the recognition of hazardous agents, where they are to be found and the ways to prevent or control exposure. This requires information, instruction and training in:

- the recognition of hazardous agents
- the risks to health associated with key agents/tasks
- the correct use of engineering measures to control health risks

- the correct use of personal protective equipment
- first aid procedures
- emergency incident procedures
- the permit to work system

Full and effective co-operation and compliance with occupational health procedures are essential in maintaining a low risk environment.

Specific training is required for:

- entry to confined space(s)
- work with hot processes (e.g. welding)
- some specified chemical hazards (e.g. HF, benzene, corrosives)
- use of breathing apparatus

4. First Aiders

Full and part-time first aiders should receive training and be certified to relevant national levels.

5. Health Specialists

Health specialists who may be associated with the TA, including occupational hygienists, ergonomists, occupational physicians and nurses, should be trained and qualified to relevant national standards.

For occupational hygiene, the basic skills required are the ability to carry out:

- health risk assessments, including job/task exposure monitoring
- risk control planning
- compliance assurance checks, including verification activities
- training of managers, supervisors
- data collection, analysis and review
- audits of performance

For occupational medicine, the basic skills required are the ability to carry out:

- health risk evaluations
- fitness to work evaluations
- health surveillance of relevant workers
- clinical management of occupational illnesses and injuries
- training of managers, supervisors
- data collection, analysis and review
- audits of performance

Effective communication with employees and their representatives, management, contractors, government agencies, local authorities and industry and professional bodies is essential if the TA is to proceed smoothly.

6. Contractors

Contractor personnel may not have an understanding or knowledge of the refinery health hazards or procedures, including the safe systems of work which have been adopted. The specific skills necessary will depend on the nature of the task(s) being carried out and the work area in which the tasks are being conducted, e.g. welding, BA use, first aid etc.

A good working understanding of the following is required:

- risks associated with contractor activities
- risks associated with the local area/activities in the refinery
- controls required to control the health risks
- permit to work systems
- local emergency response requirements
- first aid procedures
- site specific occupational health requirements, e.g. rules on smoking and drinking
- agreed procedures for the notification of near misses, unsafe acts and conditions and accidents

The definition and clarity of the links between the refinery and contractor occupational health and safety management systems are essential in preventing confusion or misunderstandings which could lead to inadequate control of workplace occupational risks.

APPENDIX 5

EXAMPLES OF HAZARDOUS AGENTS AND TYPICAL CONTROL MEASURES

ACTIVITIES/AGENTS	TYPICAL CONTROL MEASURES
GENERAL	
TURNAROUND ADMINISTRATION	
• Work at Display Screen Equipment	Workstation ergonomics Eye correction
• Mental work	Modify job design Effective teamworking
MANUAL HANDLING	Mechanical handling equipment Training
THERMAL ENVIRONMENT	
• Hot environment	Temperature control Work/rest regime
• Cold environment	Clothing
NOISE	Restricted time Hearing protection
VIBRATION	Tool selection Restricted time
WATERBORNE HAZARDS (e.g. LEGIONELLA)	Water treatment Maintenance
REFINERY STREAMS	
CRUDE OIL	Containment Ventilation Respiratory protection Protective clothing
• Hydrogen sulphide	Containment Restricted access Ventilation Respiratory protection Protective clothing
• Sulphur dioxide	Continuous monitoring
PETROLEUM GASES	
• Propane • 1.3-Butadiene	Ventilation Respiratory protection

ACTIVITIES/AGENTS	TYPICAL CONTROL MEASURES
NAPHTHA / GASOLINE / CONDENSATE • Hydrocarbons C4-C11 • Benzene • n-Hexane	Restricted access Ventilation Respiratory protection Protective clothing Continuous monitoring
KEROSENE / MID DISTILLATES • Hydrocarbons C9-C25 • Gasoils (cracked and unspecified)	
HEAVY BOTTOMS • Heavy fuel • Bitumen • PAH / Coke	Protective clothing Hygiene facilities
LUBRICANTS • Unrefined oils • Unrefined greases	Working practice Protective clothing
EXTRACTION SOLVENTS • Furfural • Toluene • Ketones, e.g. MEK • Chlorinated solvents • Phenol	Respiratory protection Protective clothing Skin protection
SULPHUR	Protective clothing
ADDITIVES	
PROCESS • Amines / Ammonia • Phosphates / H_2PO_5 • Caustic / KOH • Chlorides / HCl • Sulphuric acid	Containment Eye/face protection Protective clothing Respiratory protection
BOILER WATER • Hydrazine	Respiratory protection
FUEL • Oxygenates	Containment Respiratory protection Protective clothing
• TEL / TML • Octylnitrate • Mercaptans	Containment Face shield / Goggles Respiratory protection Protective clothing

ACTIVITIES/AGENTS	TYPICAL CONTROL MEASURES
SURFACE STRIPPING / COATING	
ABRASIVE BLASTING	Isolation
• Dust	Ventilation Hood / Air supply Protective clothing Hygiene facilities
• Lead	
• Noise	Hearing protection
HYDROBLASTING	
• High pressure	Isolation Face shield / Goggles
• Polluted water / aerosol	Protective clothing
• Noise	Hearing protection
APPLICATION OF PROTECTIVE COATINGS	
• Two part (reactive) coating • Solvent based coating	Ventilation Substitution Face shield / Goggles Protective clothing
CHEMICAL CLEANING	
• Corrosives	Face shield / Goggles Clothing / Gloves
• Solvents	Substitution Ventilation
WELDING & CUTTING	
FUMES	
• Lead • Metal oxides (Galvanized steel) • Stainless steel (Ni, Cu)	Restricted access Coating removal Local ventilation Respiratory protection Protective clothing
• Carbon steel • Surface coatings	Coating removal
GASES	
• Ozone • NOx • Carbon monoxide	Restricted access Local ventilation General ventilation Respiratory protection
• Ultraviolet (UV)	UV-shield Protective clothing

ACTIVITIES/AGENTS	TYPICAL CONTROL MEASURES
INSULATION REMOVAL / INSTALLATION	
MMMF • Glasswool	Vacuum removal Ventilation Protective clothing Respiratory protection Hygiene facilities
REFRACTORY CERAMIC FIBRES	Vacuum removal Restricted access Protective clothing Ventilation Respiratory protection Hygiene facilities
ASBESTOS	Vacuum removal Restricted access Protective clothing Local ventilation Respiratory protection Hygiene facilities
POLYURETHANE • Isocyanates	Local ventilation Vacuum removal Fire prevention Respiratory protection Protective clothing
CATALYST REMOVAL / LOADING / REGENERATION	
ACTIVATED ALUMINA	Ventilation Vacuum removal Respiratory protection Protective clothing
HEAVY METALS • Molybdenum • Cobalt • Platinum • Vanadium • Antimony • Nickel	Water spray on spent catalyst Ventilation Vacuum removal Restricted access Protective clothing Eye protection Respiratory protection

ACTIVITIES/AGENTS	TYPICAL CONTROL MEASURES
ORGANIC SULPHIDES • Dimethyl disulphide • Dimethyl sulphide	Containment Ventilation Respiratory protection Protective clothing
CHLORINE	Containment Restricted access Respiratory protection Eye protection Protective clothing
CHLORINATED HYDROCARBONS • Perchloroethylene	Ventilation Respiratory protection Eye protection Protective clothing
HYDROGEN FLUORIDE	See Table 3
SULPHURIC ACID	Containment Ventilation Eye protection Protective clothing Respiratory protection
UTILITIES	
NITROGEN	Restricted access Respiratory protection
HEAT TRANSFER OILS	Protective clothing
HYDRAZINE	Containment Ventilation Respiratory protection Protective clothing Eye / face protection
POLYAMINES	Eye / face protection Protective clothing
PCBs	Substitution Containment Eye / face protection Protective clothing

APPENDIX 6

EXAMPLES OF TASKS INVOLVING HAZARDOUS AGENTS AND THE TYPICAL RECOMMENDED CONTROL MEASURES

	TASK	AGENT	CONTROL MEASURES
1.	Dismantle pipework on any unit where H_2S is present	Pyrophoric ferric sulphide H_2S SO_2	Water spray, flushing and steaming. Maintain temperature less than 40°C. Use specific PPE.
2.	Clean internal surface of furnaces (including tubes and ductings)	Nickel Vanadium	Vacuum cleaner, biodegradable cleaning agent, avoiding aerosol formation. Collect in closed system, dilute before discharge. Use specific PPE.
3.	Decoke furnace tubes by steam or air injection	High pressure steam/air Noise PAH aerosol	Avoid if feasible alternative otherwise carry out in isolation. Collect solids in containers for disposal. Apply hearing conservation methods. Use specific PPE.
4.	Decoke vessels and pipelines	Acid (e.g. Citric, HCl)	Circulate in closed system. Use specific PPE. Collect spent acid, neutralise and dilute before discharge.
5.	Conduct abrasive blasting	Dust (e.g. metals/oxides) Noise High pressure air	Avoid use of silica sand. Use inert grit. Carry out in isolation, with screens. Use specific PPE. Apply hearing conservation measures. Collect residues for disposal.
6.	Replace Alkylation Plant tubed heat exchanger	HF	Carry out in isolation. Neutralise, dismantle, re-neutralise if necessary before disposal. Use specific PPE.
7.	Carry out radiographic examination of vessels and pipework	Gamma radiation	Carry out in isolation, under supervision of Radiological Protection Advisor.
8.	Drain and purge vessels and pipework	Benzene Furfural Hydrocarbon residues Polycyclic aromatic hydrocarbons (PAH)	Purge with N_2 or steam and vent to flare. Drain to closed system. Collect in tankage for recycling. Use specific PPE.
9.	Drain, replace transformer fluid	Polychlorinated biphenyl (PCB)	Discharge fluid to closed system for disposal. Use specific PPE. Replace with substitute fluid.
10.	Remove refractory ceramic fibres and or refractory brick	Noise Silica dust Fibrous dust Ceramic fibre	Carry out in isolation. Use specific PPE. Apply hearing conservation measures.
11.	Undertake very high pressure hydro cutting	Noise High pressure water	Carry out in isolation. Use specific PPE. Apply hearing conservation measures.

APPENDIX 7

STANDARDS AND NORMS OF GOOD PRACTICE

1. CONCAWE REPORTS

Guidelines for the determination of atmospheric concentrations of oil mist	1/81
Precautionary advice on the handling of motor gasolines	6/83
Guidelines for recording industrial hygiene data	7/83
Workshop on personal noise dosimetry	3/84
Review of bitumen fume exposures and guidance on measurement	6/84
Health aspects of petroleum fuels - general principles	2/85
Health aspects of lubricants	5/87
Health aspects of toluene and xylene exposures associated with motor gasoline	7/87
Emergency planning guidance note - Refinery emergency planning	6/88
Petroleum products – first aid emergency and medical advice	1/97
Health aspects of petroleum fuels - potential hazards and precautions for individual classes of fuels	85/51
The collection, disposal and regeneration of waste oils and related materials	85/53
Guidelines for hearing conservation programmes in the petroleum industry	85/58
Health aspects of worker exposures to oil mists	86/69
Guidance on legionnaires' disease and its prevention	87/51
Effects of skin contact with gasoline containing methanol	87/54
Guidelines for safe handling of marine fuels	87/55
Review of strategies for the evaluation of employee exposures to substances hazardous to health	87/57
Implementation of effective hearing conservation programmes in the European oil industry	88/61

A management guide to occupational health programmes in the oil industry	89/52
Review of the toxicity of catalytically cracked clarified oil	89/56
Guidelines for the health surveillance of workers exposed to benzene in the petroleum industry	93/59
An occupational physician's introduction to health hazards associated with working in a petroleum refinery	94/52
Catalyst handling procedures to minimize exposures	95/57
The classification and labelling of petroleum substances according to the EU dangerous substances directive	95/59
A year long study of ambient air concentrations of benzene around a service station	95/63
The role of the occupational physician in the petroleum industry – guidance for occupational physicians and managers	96/53
Development of a health surveillance programme for workers in the downstream petroleum industry	96/54
The health hazards and exposures associated with gasoline containing MTBE	97/54

2. ISO STANDARDS ON ENVIRONMENT AND HEALTH PROTECTION, SAFETY

13.030	**Solid wastes**
13.040.10	General aspects
13.040.30	Workplace atmospheres
13.040.40	Stationary source emissions
13.040.50	Transport exhaust emissions
13.060	**Water quality**
13.060.30	Sewage water disposal and treatment
13.140	**Noise with respect to human beings**
13.160	**Vibration with respect to human beings**
13.180	**Ergonomics**
13.240	**Protection against excessive pressure**
13.280	**Radiation protection**
13.340	**Protective clothing and equipment**
13.340.10	Protective clothing
13.340.20	Protective equipment

3. EN STANDARDS

Asbestos	EDir.83/477-87/217-91/382	
Dust measurement		EN 481
Respiratory protection	EDir.89/656	EN 132-147
Eye protection	EDir.89/656	EN 165-172
Noise emissions	EDir.86/188	
Use of handtools	EDir.89/655	EN 292
Welding protection		EN 175
Vibration (hand-arm and whole-body)		prEN 1033 prEN 1031