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ABRASIVE BLASTING PROCEDURE

AGREEMENT NO. : 09-5578-E-4

**PROJECT NAME : Ruwais Refinery Expansion Project
EPC-4: Tankage & Associated
Interconnecting Piping**



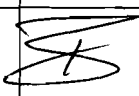
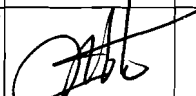
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PMC : Mott MacDonald Ltd.

CONTRACTOR : Daewoo Engineering & Construction Co., Ltd.

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	EPC-4 TANKAGE AND ASSOCIATED INTERCONNECTING PIPING		
	AGREEMENT No. 09-5578-E-4		
PROJECT No. 5578	Doc. No. 5578-E4-HSE-HU-00022	Rev. 0	Page 2 / 14

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NOTES:

- (a) Revisions are denoted by a vertical line placed in the right-hand margin against the revised text.
- (b) PREP = Prepared by, CHKD = Checked by, REVD = Reviewed by, APP'D = Approved by.
- (c) In case of conflict between any requirements stipulated in this document with the contractual requirements, the contractual requirements shall prevail.

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1. INTRODUCTION

1.1 Purpose

The purpose of this procedure is to establish guidelines for the use, modification and repair of sandblast equipment during the Ruwais Refinery Expansion Project, as well as safety when carrying out related activities.

1.2 Scope

This procedure shall be applied to all Abrasive Blasting activities on the Ruwais Refinery Expansion Project premises. The equipment includes small sandblast machines (1/2 to 10 sack), as well as trailer-mounted five and seven-ton mobile units. In some locations, there may also be a stationary 30-ton or larger sandblast unit; applicable sections of this procedure will cover these units as well.

1.3 Objectives

The objective of the Abrasive Blasting Procedure to ensure that all personnel are familiar with the mandatory safety requirements that is to be in place when conducting this type of activity.

2. DEFINITIONS

- Abrasive Valve

Pneumatically operated valve used to control the amount of sand metered into the blasting system. It contains a tungsten carbide covered piston, which can be moved in to partially obstruct the flow of abrasive from the sand tank.

- Air Valve

Air Valve is a pneumatically operated valve controlling the air supply to the sandblast hose when the system is turned on.

- Breathing Air Filter

Filter connected to air compressor, which is designed to remove water, oil mist, and particulate from the breathing air.

- Bull Hose

A large diameter hose used to connect the compressor air supply with the sandpot air inlet.

- Choke Valve

Valve used to control the flow of air into the sandblast hose. Choke valves are used to fine-tune the sand/air mix, as well as the "Choke Out" obstructions in the hoses.

- Control Valve

A two-way valve, either pneumatic or electric, that allows air to flow into the control hoses which operate the air and abrasive valves, or allows it to bleed to atmosphere, shutting the system down.

- Deadman's Switch

This is an electrical device, (limit switch) which triggers the abrasive delivery system of a sandblast machine. A switch that is automatically operated in case the human operator becomes incapacitated.

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- Deadman Valve

A pneumatic device (valve) which triggers the abrasive delivery system of a sandblast machine. Deadman switches/valves shut off the flow of abrasive and air when they are released, giving rise to the use of the word "deadman".

- Dump Valve

Ball valve used- to dump air from the sandpot prior to refilling or making repairs.

- Inlet Valve

Ball valve used to control the flow of air from the compressor to the sandpot.

- Pressure Vessel

Any vessel over 150 mm in diameter designed to contain more than one atmosphere gauge pressure (14.7 psig).

- Sandblaster Hood

A respirator designed to use compressed air which consists of a helmet that covers the entire head, plus a cape that covers the shoulders and an apron that hangs from the bottom of the cape to the crotch.

- Sandblast Nozzle

A venturi-type device designed to increase the velocity of the abrasive and to spread it to a pattern, which allows rapid removal of coatings and corrosion. Sandblast nozzles are made of aluminum or cast urethane plastic with a tungsten carbide liner secured by sintering or with adhesive.

- SandPot

A pressure vessel designed to contain sandblasting abrasive and to deliver this abrasive through a flexible hose to a sandblast nozzle.

- Whip Hose

A sandblast hose of smaller diameter and sometimes lighter gauge to which the nozzle is attached. Sandblast rigs equipped with hoses are easier to handle.

3. RESPONSIBILITIES

3.1 Project Manager

- Has the final responsibility to ensuring that abrasive blasting work on the project is done without endangering health and safety in accordance with the local legislation, client's requirements and stipulations laid down in the HSE management system document.
- Ensures that all abrasive materials and equipment are in compliance with HSE requirements.

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3.2 HSE Manager

- Shall coordinate with the Section Managers to ensure that suitable arrangements, including subcontractors, are in place to conduct the abrasive work safely.
- Shall assign HSE personnel to monitor, inspect and advise employees during preparation and execution of abrasive blasting activity.
- Obtain safety information from the manufacturer regarding the abrasive blasting materials.

3.3 Section Manager

- Ensure that abrasive blasting is carried out without endangering health and safety in accordance with the HSE Plan and procedures.
- Give his staff members job-related information and instructions on the subject of health and safety and repeats such information and instructions as needed.
- Conducts inspections on plant and equipment prior to commencement of work.
- Ensures that all employees receive PPE and sees to it that the PPE is used and maintained correctly.
- Makes inventory of potential hazards, takes corrective and preventive actions.
- Ensures that the PTW (Permit to Work) is validated daily.

3.4 Supervisor

- To ensure that all personnel are adequately trained for the relevant task, that they are using the correct equipment and personal protective equipment, that all relevant hazards have been identified and that the respective permit to work formalities has been correctly addressed, where required.
- Must conduct a tool box meeting with his crews about the abrasive blasting work, related hazards and control measures to prevent any kind of injury and the instruction laid down in the MSDS before starting the job.
- Has a responsibility of providing the required PPE to his crew for the job.
- Housekeeping is done at the end of the abrasive blasting activity and the waste to be disposed of as per project waste disposal procedure.

3.5 Employee

All Personnel carrying out the tasks covered by this procedure are responsible for operating the relevant equipment and performing the activities in a safe and proper manner and in accordance with this procedure. They shall also ensure that they are fully aware of all the hazards involved in the specific and carry out all the appropriate safety precautions and should:

- Get involved in abrasive blasting machine hazard assessments.
- Obtain safety information from the manufacturer.
- Obtain assistance from experts in the field of concern.
- Attend the necessary training.

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4. PROCEDURES FOR ABRASIVE BLASTING

4.1 Inspection

Every component of sandblasting setup must be checked and its proper function assured before being put into service.

- The sandblast machine must be in operable condition. Units that lack essential parts, such as valve handles or adjustment knobs must not be placed in service. Units exhibiting visible damage (dents in the sand tank, cracked valve bodies, etc.) must be removed from service and repaired before being used.
- Hoses must be in good condition. Hoses with soft spots, broken couplings, and damaged outer casings must not be used.
- Dead man lines must be in good condition. Electric deadman lines must not have cracked insulation or ban splices; pneumatic deadman lines must be crack free and must not have abraded outer castings. Deadman switches /valves must operate freely and without obstruction. Switches/valves must not lack essential parts.
- Sandblast hoods must be complete with helmet, suspension, "sock", cape, apron, and belt with needle valve for controlling air flow. The helmet must have a faceplate. All the necessary personal protective clothing shall be correctly worn. Appropriate respiratory protective equipment shall be available and clearly specified as suitable for use by the persons operating the equipment.
- The abrasive material used for shot blasting / grit blasting should be synthetic grit, a ground slag, ground carborundum, iron or steel shot.

4.2 Preparation

- Shot-blasting / grit-blasting activities shall not be commenced until the Permit to Work system has been correctly implemented (See procedure). All the stipulated precautions must be rigidly observed by personnel performing the tasks.
- Verify all equipment.
- Personnel not connected with the operation from the area must be restricted in abrasive blasting area.
- The working area should be clearly roped off by barriers and warning notices posted. No other work is to be undertaken within the boundaries of this area.
- Ensure that any abrasive cleaning in the vicinity of equipment / building air intakes is only carried out when the equipment is shut down and/or protected from dust contamination.
- Remove all loose material from the vicinity of the work. Pipelines, vehicles, cables and plant in close proximity to the work must be protected.

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4.3 General Safety Precautions:

- In restricted areas, blast cleaning shall be conducted in accordance with Work Permit System. Abrasive blast cleaning is considered HOT WORK and accordingly where flammables could be present, gas tests shall be carried out prior to commencing abrasive blast cleaning operations.
- Where abrasive blast cleaning is to be carried out in a confined space, confined space entry procedures must be followed.
- Noise Control, shall be controlled as per the allowable noise levels and exposure times for workers. When noise levels exceed 85 dB (A), hearing protection shall be provided to all workers in the affected area.
- All operators of abrasive blast cleaners shall be instructed and trained in the correct use and hazards associated with abrasive blast cleaning equipment and abrasive materials.
- Surfaces other than those receiving preparation should be protected from damage due to abrasive blast cleaning operations.
- An abrasive blast cleaning gun must never be pointed at any person or part of the body; such action can result in serious injury.
- Abrasive blast cleaning equipment may only be operated with all protective guards and controls in place and working properly, in accordance with manufacturer's recommendations.
- Areas where abrasive blast cleaning is in progress shall be suitably barricaded to keep unauthorized personnel out of the hazardous area, or otherwise protected. Warning signs shall be posted in hazardous areas with suitable warnings of the potential dangers (i.e., "No Entry Abrasive Blast Cleaning in Progress").
- Combustible abrasives (i.e. nut shells, etc.) capable of forming explosive mixtures with air, shall not be used.
- Before abrasive blast cleaning any in-service pressure containing equipment (piping, tanks, vessels etc.), ensure that non-destructive testing has been carried out or other methods used to determine that the wall thickness is adequate for abrasive blast cleaning.
- Utilize approved safety harness and fall protection.

4.4 PPE requirements:

Abrasive blast cleaners shall wear an air supplied hood, type "CE" supplied-air respirator, approved for abrasive blast cleaning by the National Institute for Occupational Health (NIOSH) of the United States Department of Health and Human Services, and the Mine Safety and Health Administration (MSHA) of the U.S. Department of Labor, or an equivalent organization as determined by the Loss Prevention Department. Other workers in or around the work area must wear a high efficiency dust-filter respirator approved (NIOSH/MSHA or an equivalent organization) for the airborne contaminants likely to occur from abrasive blast cleaning.

Abrasive blast cleaners shall also wear personal protective equipment that includes safety goggles, leather gloves, leather apron, hearing protection, safety shoes and coveralls. Abrasive blast cleaning assistants may require all of the above personal protective equipment, dependent on their proximity to the abrasive

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blast cleaning operator. Other personal protective equipment may be required depending on the work being carried out and the location.

4.5 Safety Procedures

Setup Procedures

- Position air compressor up wind of sandblasting area when possible.
- Position sandblast machine as close to work area as practical.
- Lay out hoses, couple together, and wire or otherwise secure couplings to prevent them from being twisted apart.
- Couple bull hose to both compressor and sand pot, wire couplings, and secure both ends with a Safety cable (Whip-Check).
- All hose connection must have wipe check attached
- Couple sand blast hose to sand pot and wire couplings.

Deadman Lines

- Electric deadman lines should be plugged into the terminal on the junction box at the front of the sandpot.
- Pneumatic deadman lines should be connected to the couplings at the rear of the pot.

WARNING: It is possible to connect these lines in reverse if the couplings are the same (either two male snap couplings or two threaded fittings) and in this case, the hoses and their respective couplings must be color coded to prevent mix-up. The result of connecting the lines in reverse is that the system will turn on when the trigger is pressed, but will not shut off when it is released.

- Attach deadman switch/valve to whip hose near nozzle. The switch/valve maybe wired to the coupling or taped to the hose. Strapping tape should be used to secure to the hose.
- Tape the deadman lines to the whip hose and sandblast hoses down the entire length of the hose run at five-foot intervals.
- Close dump valve, choke valve, and inlet valve.
- Start air compressor.
- Sandblaster puts on hood and takes control of sandblast hose.
- (Electric controls only) - Connect lead wire to compressor battery.
- Open inlet valve; once sand pot is pressured up, open choke valve and signal sandblaster to begin.

Shutdown Procedures

- Close choke valve and inlet valve.
- Shut down air compressor.

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- Open dump valve.

CAUTION: A 3/4 inch dump valve will produce noise in excess of 130 dB when it is opened, as well as blowing sand and pieces of ice with great force. Stand clear and wear ear protection.

- (Electric control only) - Disconnect lead wire from compressor battery.

Temporary Shutdown

- Close choke valve and inlet valve.
- Shut down air compressor.

Restart

- Start air compressor.
- Sandblaster to put on hood and take control of sandblast hose.
- Open inlet valve. After sand pot has pressured up, choke valve and signal sandblaster to begin.

Refilling Sandpot (Five and Seven-Ton Mobile Units Only)

- Follow shutdown procedure.
- Uncouple bull hose and pull out of way.
- Uncouple both (if using two) sandblast hoses and both sets of deadman lines.

WARNING: When reattaching hoses to sand pot, be sure they are attached to the same couplings they were removed from. Connecting the sandblast hoses to the wrong couplings could result in one of the sandblast hoses being activated by the control mechanism on the other hose.

4.6 Precautions and Special situations

Hoses

- Hoses should be examined by feel; if a soft spot is found by flattening the hose between the hands, the hose must be taken removed from service and repaired or discarded.
- Bull hoses do not normally develop soft spots, but do develop blisters, which are visible when the hose is under pressure. If a bull hose has a blister, it must be taken out of service.
- Hose couplings are normally made of brass or bronze (aluminum couplings are available, but are not recommended due to their brittleness).
- Couplings that are noticeably worn or deformed must be removed and discarded.
- If the wiring holes in the coupling are worn through, the coupling must be discarded.
- A full complement of screws must be installed on each coupling; missing screws must be replaced before the hose may be used.

Deadman Switches/Valves

Electric Equipment

- The deadman switch must be in good condition, with no parts missing or substituted.

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- The cable from the switch to the junction box and from the junction box to the compressor battery must be in good condition; the outer insulation must be undamaged and any splices must be well made and securely taped with vinyl electrician's tape.

Pneumatic Equipment

- Pneumatic deadman valves must be clean and grit free before being used. The safety button may become stuck if the valve loads up with grit.
- The duplex hose must be in serviceable condition, with no cuts, abrasions, or cracks in the outer casing.
- Couplings or threaded fittings must be clean and free of damage.

WARNING: If similar coupling (e.g., two male snap-couplings) are used on the sandpot, one of them and the matching hose coupling must be color-coded to prevent reversing the air flow through the deadman valve. In at least one brand of equipment, this creates a very dangerous situation.

Breathing Air Filters

- Filters provided for breathing air should be used in accordance with the manufacturer's recommendation. This filter must be changed and the filter case cleaned out per manufacturers' recommendation and records kept on file. A daily visual inspection must be accomplished each day.
- An odor of hot oil or the presence of water mist in the hood air means a filter malfunction. Blasting must stop and the problem must be corrected before work resumes.
- The filter case is equipped with a petcock-type bleeder on the bottom to allow expulsion of water condensate. This petcock must be left partially open during use of the filter.

Sandblasting

- Sandblast hoods must be complete, with no parts missing or substituted. The air line must go through either a needle valve or vortex tube "air-conditioned".
- The hood's faceplate must fit tightly and without gaps. Cover glasses of acetate, at least three, must cover the faceplate.
- Capes and aprons must be in serviceable condition; no tears are allowed in the cape.

Sandblasting In Confined Spaces

- A positive means of communication shall be established between the sandblaster and his pot attendant.
- While sandblasting is in progress, the pot attendant shall not leave his post for any reason unless he provides a fully trained replacement for the period of his absence.
- In the event of an emergency, the pot attendant will close the choke valve. This will be a signal to the sandblaster that he must leave the confined space in the quickest and safest way, avoiding any possibility of injury during escape.

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- After the sandblaster has exited the confined space, the pot attendant will complete the shutdown procedure.

4.7 Repair of Sandblast Equipment

Sandpots and Associated Valves

- Repairs may be affected in the field if the following conditions are met:
- The person making the repairs must have thorough knowledge of the equipment on which the work is to be done.
- The proper tools and replacement parts are available

Hoses and Couplings

- Sandblast hoses and whip hoses may be repaired in the field providing they are serviceable after repair.
- Couplings may be replaced in the field when they become worn or otherwise damaged; however, the repair must be carefully done. All screws must be replaced in the coupling. No screws may penetrate the inner casing of the hose.
- Bull hose couplings may be replaced in the field, unless a hydraulic bonding tool is available; this tool is essential to ensure that the coupling stays on once they are replaced.

4.8 Modifications of Sandblasting Equipment

Sandpots

- No modifications may be made to a sandpot in the field.
- All modifications to sandpots must be checked out with the engineering department of the equipment manufacturer. Inadvisable modifications will not be made.
- All modifications involving cutting or welding fall under the ASME Code for Pressure Vessels; a code-certified welder must make the modifications.
- Any welding and/or cutting modifications to sandpots must be done in accordance with applicable provisions of the ASME Boiler and Pressure Vessel Code or applicable state or local regulations.

Other Equipment

No other sandblast equipment may be modified IN ANYWAY.

4.9 Respiratory Protection Guidelines

Air Quality

Air produced by a compressor and used for breathing purposes must conform to the Compressed Gas Association specification for Grade D air. The CGA imposes the following limitation on Grade D air:

- Oxygen Content: 19-23%
- Carbon Dioxide: <1000 parts per million (.1%)

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- Carbon Monoxides: <20 parts per million (.0002%)
- Oil Vapor: 5 mg per cubic meter
- Water Vapors: Varies - the water vapor present in the air must not be so great as to cause condensation in the air lines and subsequent delivery of liquid water into the sandblast hood.
- Carbon Monoxide Monitoring
- Air supplied by oil lubricated compressors must be monitored for carbon monoxide content. Carbon monoxide monitoring may be performed in the following manner:
- A continuous, in-line monitor may be installed.
- A purifying filter that removes carbon monoxide may be installed.
- The air may be tested at regular intervals with a detector type sampler designed for carbon monoxide. Test intervals will vary depending upon conditions. At least one test per shift must be made at anytime the compressor is used for breathing air. The results of the testing must be logged in Carbon Monoxide Monitoring of Breathing Air Form.
- An alarm with an automatic shutdown device should be utilized to indicate imminent compressive failure and/or overheating

Air Filters

- Filters used for purifying breathing air will be serviced regularly.
- Filters used to remove water vapor, oil mist and particulate from breathing air will be serviced at intervals not to exceed six months.
- Filters used to remove carbon monoxide from breathing air will be serviced according to the manufacturer’s recommendation; however, the intervals between services will not exceed one month or whenever the filter material changes color (if a color changing type), whichever is less.
- Records for servicing of filters for breathing air shall be recorded and maintained on file.

4.10 Blasting Medium

Silica sand should be substituted with a less hazardous blasting medium. However, substitute with caution. Expensive silica sand substitutes are reused and an accumulation of toxic dusts from paints and coatings may present additional hazards.

4.11 Sign Identification Notice

The blasting should be done in a specified area, where dust is visible, and the area roped, segregated or otherwise barricaded off.

Signs shall be placed at various points indicating the following text:

“CAUTION - SANDBLASTING AREA”

“Eye, Hearing and Respirator Protection required before entering”.