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RISK ASSESSMENT AND SAFETY ANALYSIS FOR A JET FUEL TANK CORROSION RECERTIFICATION OPERATION

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ABSTRACT

Aviation Turbine Kerosene (ATK) or jet fuel is stored in stainless steel tanks or in epoxy coated tanks to prevent contamination through reaction with the tank sheets. Epoxy coated tanks overtime may develop cracks and coating defects which exposes the jet fuel to the steel surface. This is not optimal and it is an aberration to global best practices. Coating defects are corrected after surface preparation through blasting, and grit blasting is one of the common methods. Grit blasting is a hot work that may generate sparks which can be ignited by jet fuel fumes. In the oil and gas industry, personnel are moved via choppers to and from oil platforms and rigs, and this requires ready availability of jet fuel in storage tanks on oil platforms. Jet fuel tank repairs and recertification on offshore facilities where flammable crude oil and gas vapours may be present, coupled with jet fuel fumes is a high risk operation. This study presents a detailed job safety analysis and risk assessment that identifies potential hazards and the necessary safeguards and controls needed to safely manage tank recertification on offshore facilities toward preventing explosion and accidents.

Key words: Grit blasting, Jet A-1 aviation fuel, Process safety management, Risk assessment, Safeguard systems, Tank corrosion repairs.

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1. INTRODUCTION

Ensuring safety at work is the responsibility of all stakeholders. The vision of zero safety incidents and excellence in safety towards ensuring that systems are 100% safe, 100% of the time, must be established and driven by management for the planned safety milestones to be achieved. The role of managers is vital in ensuring plant safety, managers must be adequately trained and equipped with the right information, and procedural knowledge to ensure that all activities are carried out in line with risk based methodologies [1]. The work team on any task must demonstrate safety ownership at all times with the knowledge that they are not only responsible for their own safety but also for the safety of those around them. This level of

safety culture is achieved via adequate training [2], supervision, and risk based procedures with compliance checks at various points. In the oil and gas industry, hazards and risk can be effectively mitigated by ensuring inherent safety in plant design and work procedures [3, 4].

Hydrocarbon fuel storage tank fires and explosion has plagued the petrochemical industries over the years [5-8] with varying degrees of losses incurred in terms of cost, negative publicity, litigations and so forth. According to [6], most tank fire accidents occur during tank loading, maintenance and repair activities. This makes it mandatory to ensure that a detailed safety oriented risk based procedure is developed and deployed for tank maintenance repairs in order to prevent fire accidents, injuries and even fatalities. In the study by [9], workers exposure to benzene and jet fuel during an aircraft's jet fuel tank repair was analysed using breathing zone concentration level, and the result shows that there is a significant exposure to fuel fumes and benzene during the repair of the jet fuel tank.

Aviation Turbine Kerosene or Jet Fuel is a premium quality aviation fuel for turbo aircraft engines. To ensure aircraft safety, jet fuel must be of the right quality and specification at all point in the supply chain. The quality assurance of aircraft fuel is achieved via tightly controlled specifications and handling requirements. Various laboratory tests and checks have been developed for evaluating jet fuel quality, and jet fuel handling equipment in a bid to ensure quality and prevent fuel contamination. In order to prevent contamination in storage tanks, jet fuel must be stored mandatorily in stainless steel tanks or in epoxy-coated storage tanks, whether mobile or fixed tank.

Epoxy coated tanks are subjected to yearly visual checks and 5-yearly internal inspection and cleaning to ascertain the cleanliness of the tank and the integrity of the epoxy lining. Epoxy lining may deteriorate with time, and if any tank surface area with coating damage is identified, the tank must be repaired and recertified. Any localized coating damage on the tank surface can lead to a reaction between the exposed tank steel and jet fuel, resulting in fuel contamination and flight risk. This is below the expected standard operating conditions and does not meet up with global best practices. When such a condition is identified immediate corrective actions are planned and deployed.

Tank recertification requires removing the whole epoxy coating on the tank and applying a new coating. The coat applied must be of good quality and must not be reactive with jet fuel. Tank surface preparation requires the removal of the old epoxy coat via tank blasting operation. Tank blasting is a hot work exercise which requires safety measures to prevent fire and explosion when working on flammable fuel tanks. The associated risk with the blasting operation is further increased by the confined nature of the tank, thereby requiring confined space entry safety training and safeguard requirements [10].

In the oil and gas industry, heavy traffic of crew movement is critical to their operation as various skilled personnel are moved from one location to another. The personnel are transported via airplanes from pick up points to oil and gas facilities on islands, and by choppers for offshore facilities and rigs. Hence, offshore platforms must be equipped with adequate jet fuel supply, and global best practice compliant jet fuel management systems. When tank coating defects are identified on jet fuel tanks on an offshore facility, the defect must be immediately corrected to prevent fuel related flight risk [11].

Conducting a grit-blasting hot work operation on an offshore platform where crude oil and gas are being produced creates a high level of risk of fire and explosion. Managing this requires adequate planning and interactions by multi skilled team of safety and subject matter experts. On oil and gas platforms (O&GP) there are multiple sources of flammable vapours

that must be well managed to prevent fire mishap. During jet fuel tank recertification, jet fuel is also added to the potential fuel mix that can be ignited during a hot work. In this study, a risk analysis of the jet fuel tank repair and recertification operation on an O&GP is presented. The study identifies the factors that may result in fire and explosion, and it also identifies controls for managing same.

2. JOB SAFETY ANALYSIS (JSA) FOR A GRIT BLASTING OPERATION

A detailed JSA is vital for preventing fire mishap during hot work. On O&GP multiple Simultaneous Operations (SIMOP) are taking place at the same time. On a platform, crude oil and gas are being processed, effluent water is being treated, choppers are landing and taking off on helipads, as planned by the flight control personnel and Health Liaison Officer (HLO), operators are conducting checks, maintenance personnel are busy with repairs, and all these are on-going virtually at the same time. Performing a grit-blasting operation on a jet fuel tank coupled with these series of concurrent events demands adequate safety considerations and planning.

Grit blasting operation requires some heavy equipment and machines that are often shipped to the platform and offloaded by hoist. The equipment includes Air Compressor, Blasting Pot, Airless Spraying Machine, CPF Filter, Air Tank and so forth. A typical jet fuel tank on an offshore platform deck is shown in Figure 1. The jet fuel tank is sandwiched amidst an array of process equipment and pipes.

Figure 1 A jet fuel tank on offshore O&GP

Safety is of essence for any operation, and maintenance activity on oil and gas facilities due to the high risk level of the operations, as a result of the flammable products.

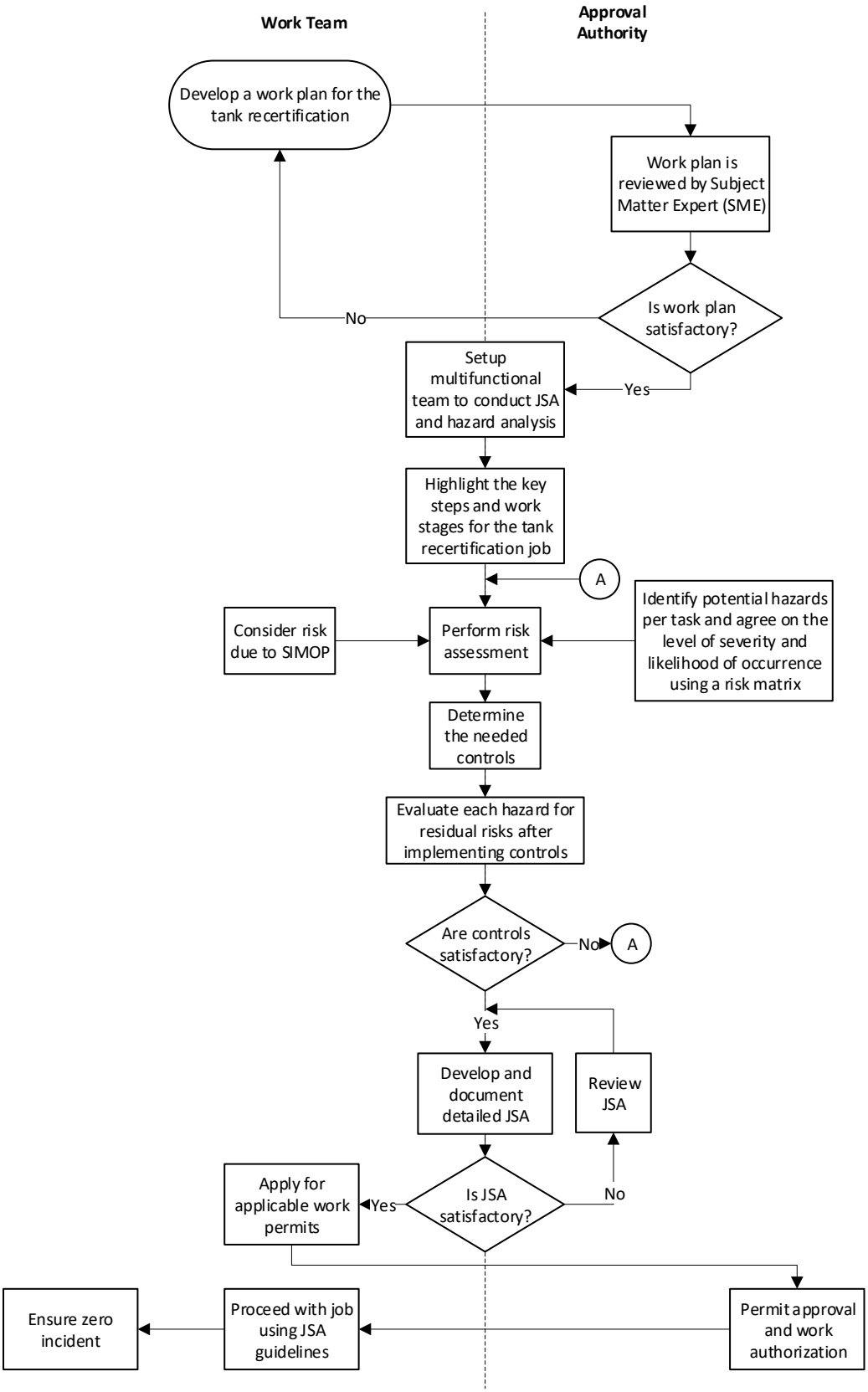

Figure 2 A flow chart showing the JSA process

Adequate procedures must be available to guide JSA toward preventing poor safety analysis that could allow a potential hazard go unnoticed and unmitigated. Presented in Figure

2, is a detailed and well-structured procedure for conducting a JSA for the tank recertification exercise. The flow chart shows the critical steps and the stakeholders involved.

For safety reasons, there must not be any flammable vapour within a 15m radius of a hot work site; this is monitored using a gas tester. Also, material movement, purging, flushing and draining must be stopped before performing hot work activities.

3. THE RISK ASSESSMENT

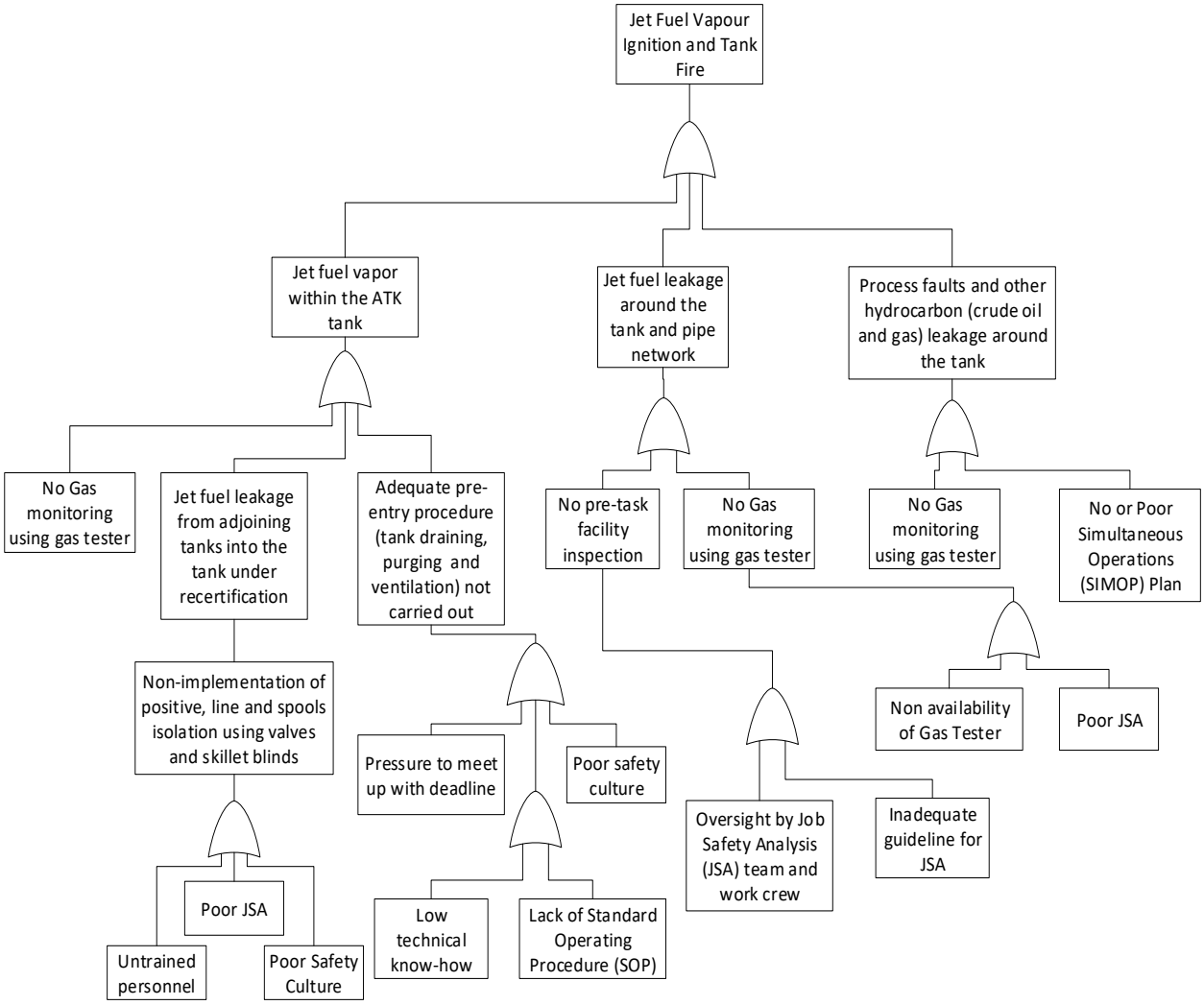

Figure 3 Tank Ignition Fault Tree

Multiple sources of energy are available in a facility, and these are potential source of hazards if not well managed. These energy sources includes electrical, mechanical, chemical, gravity, motion, pressure, temperature, sound and so forth. A poor and reactive safety culture is a flirt with accident [12], and accidents can be prevented through adequate risk assessment [13-16]. A detailed risk assessment helps to determine how these sources can impact the safety of the tank recertification exercise, and to develop control actions to mitigate any potential mishap. According to [17], risk assessment can be fortified through sociotechnical oriented safety perspectives, as it deals with unobvious risks hidden in assumptions and believes. A fault tree of how the jet fuel tank could be ignited during the grit blasting operation is presented in Figure 3. Preventing fire during hot work, where generation of spark is imminent, requires the elimination of flammable vapours so as to break the fire triangle.

An activity is termed complex if the available knowledge of its consequences are inadequate, and this makes risk assessment difficult [18]. Every activity in the tank recertification exercise must be assessed to identify potential hazards so that an appropriate mitigation can be deployed as a control. After identification of controls, an assessment to identify any residual risk needs to be performed to evaluate the effectiveness of the control [15]. Table 1 summarizes the potential hazards during the tank recertification exercise and the necessary controls to checkmate the identified hazards.

Table 1 Potential hazards and controls for each step of the tank recertification exercise

S/N	Core Task Activity	Potential Hazard	Mitigation
1	Tank preparation for entry by draining tank of jet fuel, locking all valves, isolation from other connected tanks, tank manhole opening for ventilation and degassing, and proper tank washing	Jet fuel vapour inhalation Asphyxiation Skin, eye contact with jet fuel resulting in irritation Slip, trip and fall Poor manual handling Heat stress Dropped object Jet fuel spillage Potential for fire and explosion	Work plan and tool box meetings Adequate supervision Barricade of work area Safety and Work in Progress signage Jet A-1 Safety Data Sheet Job Safety Analysis (JSA) Lock out/Tag out Permit to Work (PTW) Eye on task and path Eye wash and safety showers Gas monitoring Fire watch Positive tank isolation (skillet blind) Fire extinguisher
2	Erection of scaffold in and around the tank as applicable	Slip, trip and fall Poor manual handling Dropped object Pinch point Fall from height Over reaching or twisting Sprain and strain Poor lifting technique Adverse weather	Stop Work Authority Incident reporting Scaffold inspection and green tag approval Certified scaffold builders Body harness Eyes on task Rest breaks Eyes on task and path Gas monitoring Lifting technique training Stop Work Authority
3	Mobilization of workers, equipment, spares and supplies to work site. Rigging and hoisting for lifting equipment	Crush or struck injury Property damage Sling snap Slip, trip and fall Poor manual handling Dropped object Sharp fragments and abrasion Repetitive motion injury Trapped between objects Inclement weather	Pre-mobilization equipment check and approval Barricade of work area Trained and certified personnel Proper load evaluation Use appropriate gloves Approved rigging and lifting procedure Stop work authority Eyes on task and path Stay off the line of fire Check rigging tools and line before lifting
4	Safety based positioning and set up of equipment and materials	Pinch point Slip, trip and fall Poor manual handling Dropped object Paint spill Equipment damage Poor lifting technique Head bump Loose items	PPE Eye on task and path Permit to Work Body harness Work plan firm coupling of all hoses and items placed at height Keep loose items in a container Palletise paint containers

5	Tank entry	Asphyxiation Jet fuel vapour inhalation Slip, trip and fall Poor manual handling Heat stress Fall from height Poor lighting and visibility Head bump	Trained Entry and Fire Watch Supplied air Blower fan Eyes on task and path Body harness Emergency response plan Intrinsically safe lighting Communication equipment to alert Rescue Team
6	Dry abrasive blasting of tank surface to at least SA-2.5 (near white metal) [19, 20]	Asphyxiation Poor lighting and vision Inhalation of dust fumes Pressure blow out Slip, trip and fall Heat stress Moving and rotating machine parts Dust accumulation Noise Fire and vapour ignition Cloud of spent grit may impact landing chopper Lightning strike Rain - leading to flash rust	PPE Air supplied blasting hood and suit Ear plugs and gloves Fire watch Positive tank isolation (blind skillet) Hose whip check and safety pin Confined space certified blaster Emergency response plan Extractor blower fan Inspection of hoses and couplings before use Safety line Rest breaks Gas monitoring Simultaneous operations plan Air compressor should be placed far from any source of hydrocarbon Ground all equipment Stay clear of the line of fire Hazard warning signs Communication with flight control Stop work authority Cover manhole during rain Fire extinguisher
7	Removal of spent grit from tank	Inhalation of dust fumes Slip, trip and fall Heat stress Poor visibility Poor lifting	Eyes on task and path Intrinsically safe lighting Grit evacuation plan Nose mask Blower fan Adequate supervision
8	Tank surface preparation for painting	Slip, trip and fall Heat stress Manual handling	PPE Eyes on task and path Blower fan Adequate supervision
9	Paint preparation - thinner application and mixing	Ingestion, inhalation, skin and eye contact with paint Paint spill Thinner ignition Asphyxiation Ignition of paint fume	Certified painter Paint Safety Data Sheet Cartridge respirator and other PPEs Containment and absorbent pads Spill response plan Eye wash and safety showers Stop work authority Prepare paint in an open space Fire extinguisher
10	Airless spray painting of tank surface and Wet Film Thickness (WFT) test	Oxygen deficiency Ingestion, inhalation, skin and eye contact with paint Noise Pressure blowout Fall from height Poor visibility Slip, trip and fall	PPE DuPont Tyvek coverall Confined space certified painter air supplied painting hood Stay clear of the line of fire Containment and absorbent pads Extractor blower fan Safety line

		Paint fume ignition	Rest breaks Emergency self-contained breathing apparatus (SCBA) Whip check and safety pin Eyes on task and path Eye wash stations Prevent excessive hose dangling Ground all equipment Fire extinguisher
11	Paint drying interval	Inclement weather Slip trip and fall	Proper housekeeping Cover tank manhole during rain
12	Paint quality test – Dry Film Thickness (DFT) & holiday test	Slip trip and fall Heat stress	Keep manhole open Eyes on task and path Blower fan Gas testing
13	Scaffold removal	Slip, trip and fall Fall from height Poor lifting and manual handling Pinch point Poor lighting (internal scaffold) Tendency to scratch painted surface with pipes	Body harness Appropriate hand glove and other PPE Intrinsically safe lighting Rest breaks Trained scaffold technicians Entry and safety watch Eyes on task and path JSA
14	Housekeeping	Slip, trip and fall Improper waste disposal Manual handling Poor lifting Dust inhalation	PPE Work plan Waste separation Adequate supervision Eye wash station
15	De-mobilization from work site, rigging and hoisting	Slip, trip and fall Poor lifting Manual handling Crush or struck Injury Property damage	PPE Eyes on path and task Adequate supervision Certified riggers PTW JSA

An Emergency Response Plan (ERP) with a ready to go Emergency Response Team (ERT) must be provided, all through the tank recertification work period. This is to ensure readiness to manage any eventualities. An intrinsically safe radio communication device must be available to the work crew for reaching the ERT using pre-agreed call signs. Likewise, the fire fighting team must be duly aware of the on-going activity and must be ready to respond if any fire ensues. Safety may seem, effort and cost intensive, but the cost of an accident is multifold and unlimited; inclusive of various litigation costs and fatalities. Safety at all times and in all activities is paramount. Safety remains the wise option in preventing accidents.

4. CONCLUSIONS

Preventing fire and explosion during jet fuel tank recertification exercise in an oil and gas platform requires adequate job safety analysis, and risk assessment towards identifying all potential hazards, and deploying necessary controls for preventing same. Tank recertification entails tank surface blasting which is commonly achieved via grit blasting through a hot work process. The blasting operation is followed by a spray painting operation using wet film thickness as a guide for ensuring the right amount of paint is deposited per paint layer. These operations are hazard prone, and the associated risk becomes more critical when the recertification exercise is to be performed on an oil and gas facility where flammable products are produced, and vapours may be present in the atmosphere. In this study, a step wise risk

assessment was performed and necessary controls for managing the identified risks per work activity were identified. Safety is the prevailing directive for preventing fire and explosion during jet fuel tank restorative repairs and recertification.

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