Hazardous Operations Review of JFTA's Mobile Internal Combustion Engine (ICE) Vapour Treatment Unit.

Owner:

JFTA Environmental Solutions. 144 Hall Street Newport Victoria.

Background:

The objective is to assess the hazards associated with the operation of the ICE unit.

The Hazop is a stepwise process:-

- Consider each operational application, and the safety devices and protocols required to operate under those applications.
- Identify possible hazards and their causes
- Estimate consequences
- Assess existing safeguards
- Develop Standard Operational Procedures (SOP) to maintain a continuous safe operational standard.

System Description

The mobile vapour treatment unit uses the manifold vacuum created within the ICE to extract volatile hydrocarbon vapour from soil and groundwater matrices or from decommissioned tanks during tank degassing. The vapours are drawn into the ICE under vacuum and combusted in the same way vapours are combusted in a normal combustion engine, destroying approximately 99.9% of volatile vapours.

System Application Description

This HAZOP has identified three different applications which can be broken down into specific operational processes.

- **1) Soil Vapour Extraction (SVE)**. Generally this application will include the extraction of petroleum hydrocarbons from purpose built stockpiles or from in situ wells installed above the water table.
- **2) Multi Phase Extraction and Air Treatment (MPEAT)**. Process by which hydrocarbon soil vapour, Phase Separate Hydrocarbons (PSH) and dissolved phase hydrocarbon impacted groundwater are targeted via 50mm or 100mm monitoring wells.
- **3) Tank Degassing**. This application involves the extraction of hydrocarbon vapour from disused and decommissioned Aboveground Storage Tank's (AST's) or Underground Storage Tanks (UST's) to render the internal tank atmosphere inert.

Essentially, the three different applications offer the same treatment and operational process, however, each application requires the addition of process specific safeguards, including;

1) SVE

During this application both engines can be connected directly to the vertical Knock Out (KO) pot, which is equipped with a high level float switch, or directly to the individual stockpiles via code 1000 hoses. Stockpile SVE application has the capability of using the exhaust stream vapour to passively heat fresh air to draw into the stockpile with the aim of increasing soil core temperature which aids hydrocarbon volatilisation and reduces treatment timeframes. The air to air heat exchanger is equipped with a temperature control device which will draw ambient air into the heat exchanger for cooling if the preset temperature is reached. In addition, there is a temperature sensor located on the warm air inlet side of the SVE stockpile which will shutdown the system if the preset temperatures are breached.

2) MPEAT

This application will require a pre-treatment knockout (KO) vessel to be installed to contain PSH and Dissolved Phase (DP) impacted groundwater. The tank will be equipped with a float switch to automatically shutdown the system if activated. In addition, the existing (2x) 110 litre KO pot(s) on the system(s) are equipped with a secondary level float switch to maintain the required two lines of defence to safeguard against liquids being drawn into the engine(s). The pre-treatment KO tank will be pressure rated and equipped with a pressure release valve.

3) Tank Degassing
During this application both engines are connected directly to the vertical KO pot with flame arrestor which is also equipped with a pressure release kunkle valve. A 3 inch code 1000 hose will connect the vertical flame arrestor to the UST/AST.

System components for HAZOP study

The system has been broken down into sub-system called components for the purpose of the HAZOP.

The following components have been identified:

Component No.	Components
1.	Vapour source to ICE Unit(s) via extra capacity KO pots for MPEAT application and vertical KO pot with spark arrestor for tank degassing.
2.	ICE Units and Cabinet
3.	Hydraulic load module
4.	Heat exchanger operation

Component 1 is dependant on what application the system is being applied to and is explored under the previous System Application Description.

Component 2 is the main aspect of the unit as it houses the systems engines and computers, along with the hydraulic load unit, electrical circuitry, fire control system and the critical safety devices (LEL, auto-shutoff).

Component 3 hydraulic load module increases the total process flow/treatment capacity of the ICE system. Loading the system is accomplished by adding a hydraulic pump, driven by the engine, where hydraulic oil is pumped through a closed loop system consisting primarily of a hydraulic oil reservoir tank, air to liquid heat exchanger, filter, a single mechanical control valve and various manually operated mechanical control valves. All manually operated valves are preset for specific operating conditions. The system's main pressure relief valve is factory set to 3000 PSI. A second relief valve across the primary control valve (a 1 inch needle valve) is set to 2500 PSI. The failure mode of both pressure relief valves is open. All high pressure hoses are rated at 4000 PSI working pressure and 16000 PSI burst pressure. All return hoses are pressure relieved at less then 100 PSI, hoses are rated at 600 PSI working pressure or greater. All pressure regulators valves are set to a maximum of 2000 PSI. All secondary pressure hoses are rated at 3000 PSI working pressure and 12000 PSI burst pressure. The hoses for the hydraulic motor, used for the blower unit are rated at 4000 PSI working pressure and 16000 PSI burst pressure.

Component 4 An automated by-pass valve is installed on the fresh air inlet side of the heat exchanger that will open and/or close to atmosphere to maintain a temperature as programmed in the Controller. This temperature is preset at the factory to maintain a temperature not to exceed 220 degrees C as measured at the discharge of the unit. Higher or lower temperature settings can be programmed so that the desired temperature might be obtained and controlled at the point where the heat source is to be used. A high level temperature switch is situated at the inlet to the stockpile, which would be connected to the heat source to shut the system down in the event preset temperatures are exceeded. **Note. Access to trailer deck is not permitted whilst system is operational or until approximately 15mins after system has been shutdown.**

SAFTEY FEATURES

FIRE PROTECTION SYSTEM

The fire protection system on the unit consists of a Kiddie IND 21 dry chemical suppression system. The system is actuated by either one of the “2 rate of rise” detectors located in the engine compartment or the manual actuator located adjacent to the control panel. The “rate of rise” detectors are preset to actuate if the temperature rises at a rate equal or greater than 10°C in one minute at temperatures greater than 230°C.

SPARK ARRESTORS

A spark arrester is installed on the engine exhaust to protect the well gas source from any flash back from the engine. A flame arrester pad is located in the carburetor adapter plate located between the carburetor and intake manifold. There is an additional flame arrestor situated on top of the vertical KO pot used during tank degassing.

GUARDING OF MOVING PARTS

The protection of personnel from potential injury from moving parts is accomplished by design and additional safeguards incorporated into the system. The engine compartment, where the fan and belts are located, is fitted with switches that will not allow the engine to start and/or will shut the system down if the doors are open or raised. The doors on the engine compartment shall be closed and locked during operation of the engine. The engine fan is protected with a shroud for additional guarding.

Additional Safety Components / Features

- High Coolant Temperature Automatic Shutoff set at 105° C
- High Exhaust Temperature Safety Shutdown
- High Heat Exchanger Temperature Safety Shutdown
- High Hydraulic load Temperature Safety Shutdown
- High Blower Temp shut down
- High Blower Pressure Limit Switch
- LEL to prevent engines starting if detecting the presence of vapours
- Vacuum relief valve on vertical KO pot for tank degassing
- Low Oil Pressure Automatic Shutoff set at 140 Kpa
- Engine Over-Speed Protection set at 2500 rpm (programmable)
- Automatic Oil Level Regulator
- Oversize Radiator Coolant System
- Low/High Battery Voltage Safety Shutdown

JFTA Mobile ICE unit August 2007				
Component #1: Down-well stinger/Tank to System during SVE/MPEAT and tank degassing depending on application number.				
Application No	**Guide words**	**Possible Causes**	**Consequences**	**Existing Safeguards**
1, 2, 3	High Pressure	• None	• NA	• NA
1, 2, 3	Low Pressure	• None	• NA	• NA
2, 3	High Vacuum	• Tight formation restricted airflow into tank, no bleed air, Blockage etc.	• Tank Deformation, (KO tank or degassing tank) • Reduced flow rate/ treatment timeframe • Engine choke/Shutdown	• Pressure release valve on tank AND • Tank vacuum rating to exceed 70 kPa.
2	Low Flow - liquid	• Tight formation restricted liquid flow into tank, no bleed air, blockage etc.	• Reduced flow rate/ treatment timeframe	• Operator awareness/training, control
1, 2	Low Flow – vapour	• Tight formation restricted vapour flow into tank, no bleed air, Blockage etc.	• Reduced vapour flow rate/ treatment timeframe	• Operator awareness/training, control
2	High/excess flow – liquid	• Loose formation / sandy • High hydraulic conductivity	• Over filling of tank • Liquid being drawn into engine	• Tank to be fitted with float switch shut system down if this occurs. • A secondary float switch is positioned at the KO pot at the inlet manifolds prior to the engine manifold. • ie. Two lines of defence against liquids being drawn into the engines.
1,2	High/excess flow – Vapour	• Loose formation • Sandy stockpile • Large or uncovered stockpile • Open well head	• NA	• NA
2	Low Temp	• Extreme weather	• Freezing vapour/liquid lines • Freezing liquid in tank • Increase in tank/line vacuum • Blockage	• Pressure release valve on tank AND tank vacuum rating should exceed 70 kPa

JFTA Mobile ICE unit August 2007				
Component #1: Down-well stinger/Tank to System during SVE/MPEAT and tank degassing depending on application number.				
Application No	**Guide words**	**Possible Causes**	**Consequences**	**Existing Safeguards**
			• Decrease Process / treatment times	
1,2,3	High Temp	• Extreme weather	• Excess vapour buildup in tank and/or stockpile	• SOP to degas tank prior to shutdown • Constant vapour abatement while system is in operation
1,2,3	Mechanical	• NA	• NA	
		•	•	
		•	•	
		•	•	
		•	•	
		•	•	
		•	•	
		•	•	
		•	•	

JFTA Mobile ICE unit August 2007				
Component #2: ICE Units and Cabinet				
Application No	**Guide words**	**Possible Causes**	**Consequences**	**Existing Safeguards**
1,2,3	High Pressure – ICE	• NA	• NA	• NA

1,2,3	Low Pressure – ICE	• NA	• NA	• NA
1,2,3	High Vacuum	• NA	• NA	• NA
1,2,3	High Temperature	• Extreme weather • Engine overexertion ie excess load and/or high RPM	• Stress on equipment • Equipment failure • Overheating	• High temperature Shutoff • High RPM shutdown • Auto Fire suppression system
1,2,3	Low Temperature	• Extreme weather	• Cold lines – Longer warm-up times. • Starter motor wear	• Auto warm-up • Keep oil levels maintained
1,2,3	Vapour release from inlet manifold	• Engine Shutdown • Disconnected hose	• Possible explosion	• LEL monitoring upon engine restart. • 12000 CFM exhaust fan replacing air while unit is in operation
1,2,3	Mechanical	• Placing hand in or near fan and or belt during operation	• Serious injury or loss of hand	• Automated shutoff if doors are open • Engines wont start if doors are open

Component #3: Hydraulic load module

Application No	Guide words	Possible Causes	Consequences	Existing Safeguards
1,2,3	High Pressure – Hydraulic hoses	• Full closure of primary load valve	• Line failure	• Burst pressure exceeds maximum load pressure
1,2,3	Low Pressure – Hydraulic hoses	• NA	• NA	• NA

JFTA Mobile ICE unit August 2007

1,2,3	High Vacuum	• NA	• NA	• NA
1,2,3	High Temperature	• Engine overexertion ie excess load applied and/or high RPM	• Stress on equipment • Equipment failure • Overheating • Line rupture	• High temperature Shutoff • Hydraulic oil to air heat exchanger • High RPM shutdown • Auto Fire suppression system
1,2,3	Low Temperature	• Extreme weather	• Cold lines – longer warm-up times.	• Keep oil levels maintained
		•	•	•
		•	•	•
		•	•	•
		•	•	•

JFTA Mobil ICE Unit August 2007

Component #4: Air to Air Heat Exchanger

Application No	Guide words	Possible Causes	Consequences	Existing Safeguards
1,2,3	High Pressure	• NA	• NA	• NA
1,2,3	Low Pressure	• NA	• NA	• NA
1,2,3	High Vacuum	• NA	• NA	• NA
1,2	High Temperature	• Prolonged use • Reduced or low	• Stress on equipment • Equipment failure	• High temperature control valve to draw air from atmosphere if preset temperatures are reached • High RPM shutdown • High temperature shutdown at inlet to stockpile if preset

		airflow	• Overheating • Line deformation	temperatures are breached
		•	•	•
		•	•	•
		•	•	•
		•	•	•
		•	•	•