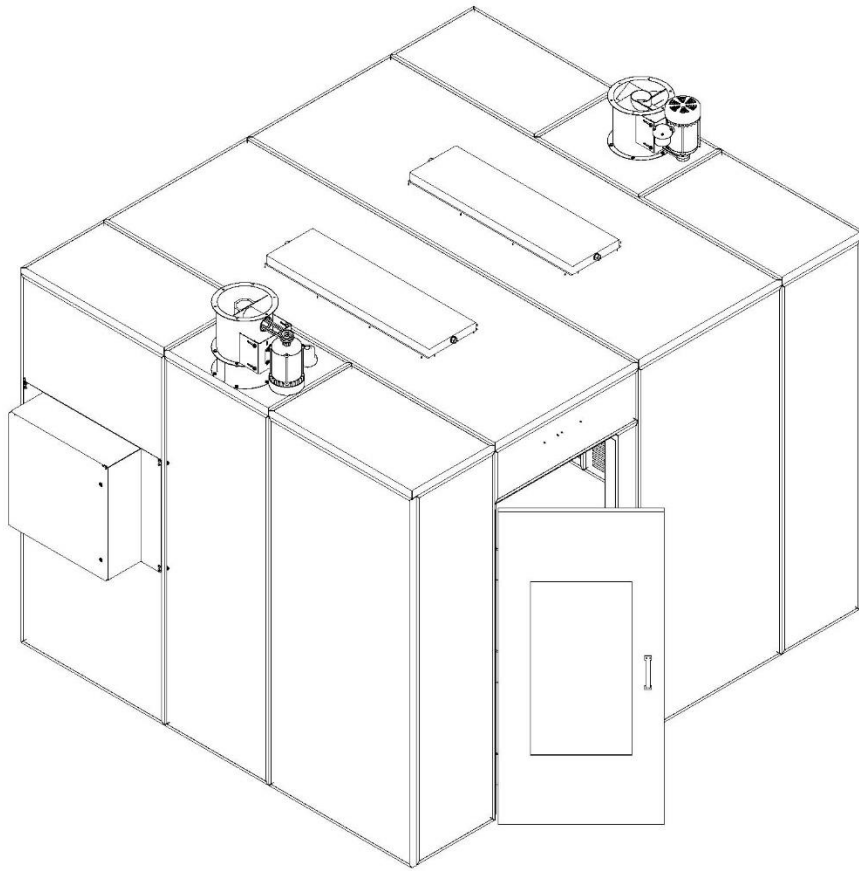


Safety Manual

HAL Extraction Technology Ltd.

Extraction Booth Systems



CAUTION: READ AND UNDERSTAND THIS BEFORE USE



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I. LEGAL DISCLAIMER

In no case shall the equipment manufacturer or its officers, employees, affiliates, agents, contractors, interns, suppliers, service providers or licensors be liable for any injury, loss, claim, or any direct, indirect, incidental, punitive, special, or consequential damages of any kind, including, without limitation lost profits, lost revenue, lost savings, loss of data, replacement costs, or any similar damages, whether based in contract, tort (including negligence), strict liability or otherwise, arising from your use of any of the service or any products procured, or for any other claim related in any way to your use of a service or any product, including, but not limited to, any errors or omissions in any content, or any loss or damage of any kind incurred as a result of the use of the service or any content (or product) posted, transmitted, or otherwise made available via any service, even if advised of their possibility. Because some states or jurisdictions do not allow the exclusion or the limitation of liability for consequential or incidental damages, in such states or jurisdictions, our liability shall be limited to the maximum extent permitted by law.

II. GENERAL SAFETY AND HEALTH PRECAUTIONS

A. SAFETY SYMBOLS

Throughout these instructions, these symbols are used to indicate that the instructions are critically important to installer and/or operator safety.

Explosion Hazard	
Flammability Hazard	

B. WARNING: USE OF HAZARDOUS MATERIALS POSES SEVERE INHERENT DANGERS

The use of flammable, combustible, toxic, or explosive liquids or gases is inherently dangerous and present real risks to workers and business owners including damaged health, injury, death, and property damage.



**NO SINGLE PIECE OF EQUIPMENT, SYSTEM,
PERSONAL PROTECTIVE DEVICE, OR PROCEDURE CAN
ALONE FULLY PROTECT AGAINST THESE HAZARDS.**



It is the responsibility of the owners and users of HAL Extraction Booth Systems to know and understand the hazards of any solvents, liquids, or chemical products being used and to take all appropriate safety and operating precautions for the hazard faced.

The effective prevention of fires, injuries, and accidents when working with hazardous materials requires the use of many overlapping protective systems to reduce the risks to manageable levels. The following list is not meant to be exhaustive; additional measures may be appropriate for your specific use:

- Training of personnel and operators;
- Use of and enforcement of use of appropriate personal protective equipment;

- Use of well-designed and properly engineered extraction equipment that has been reviewed by a Professional Engineer or Certified Industrial Hygienist, as appropriate;
- Documented Standard Operating Procedures for the specific facility and products generated;
- Warning signs;
- Appropriate exiting;
- Exhaust ventilation that is not recirculated;
- Toxic or Flammable Liquids and Gases;
 - Control of sources of ignition;
 - Proper equipment grounding;
 - Full-time monitoring of gases with alarm systems to warn of hazardous conditions;
 - Automatic fire protection systems in use and in working order in work areas;
 - Prohibition on use of non-rated electrical equipment in work areas;
- Job safety assessments;
- And, compliance with all applicable safety and environmental rules and regulations.

Each of these measures provides some measure of risk reduction, but none are adequate by themselves. When your pants might fall down, and you are at risk of embarrassment. To prevent embarrassment, you may choose to wear a belt, suspenders, or an elastic waistband. When your life is at risk, you may want all the protections in place.



WHEN LIVES ARE AT RISK, ALL APPROPRIATE PROTECTIVE MEASURES MUST BE IN PLACE



Interference with the Booth System ventilation, design, operating procedures, electrical equipment or other features may reduce their effectiveness and allow fire, injury, or death to occur.



C. WARNING: LPG CONTAINER FILLING PROHIBITED

The HAL Extraction Booth System is designed for plant oil extraction procedures. Some of those extraction procedures use butane and/or propane (liquid petroleum gas or LPG) as solvents. The System is NOT designed for LPG liquid transfer to or from bulk storage tanks as regulated by NFPA 58.

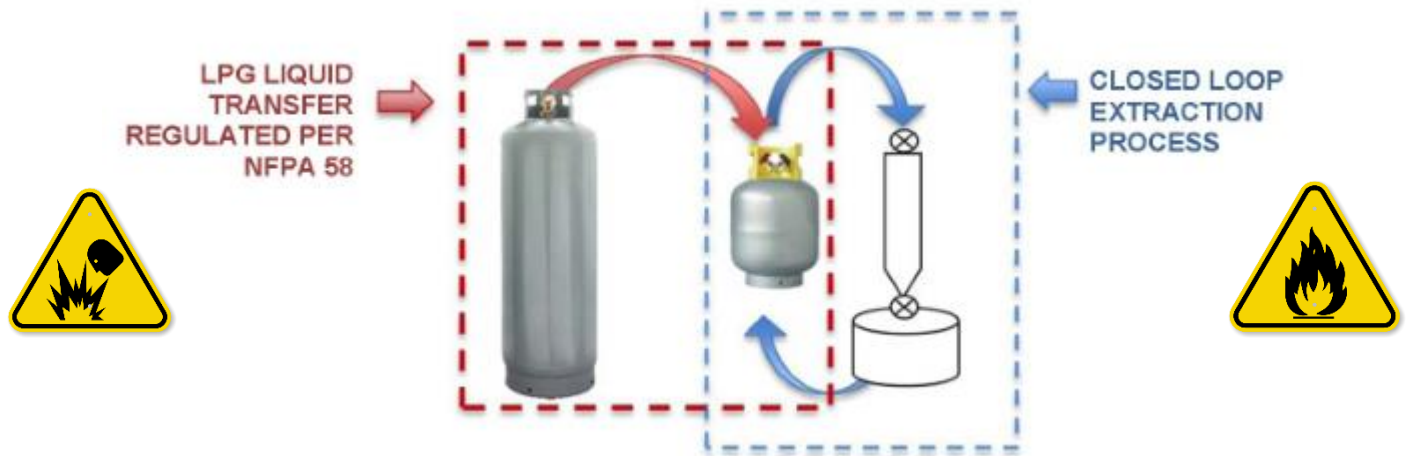


Figure 1: LPG Liquid Transfer vs. Closed Loop Extraction (image from Denver Fire Department)

DO NOT CONDUCT LPG TANK OR BOTTLE FILLING OPERATIONS WITHIN THE EXTRACTION BOOTH
DOING SO MAY RESULT IN INJURY OR DEATH

D. FLAMMABLE GASES AND EXPLOSION HAZARDS

1. FIRE TRIANGLE



Understanding the Fire Triangle is essential for anyone working with flammable liquids. Fire requires three components to occur: Oxygen, Fuel, and Heat. Each of these make up a separate leg of the triangle.

If any one component is not present, fire will not occur. The HAL Extraction Booth System is designed to reduce the concentration of solvent in the air and to reduce the presence of ignition sources.

Bringing items, equipment, or materials into the Booth System that can act as an ignition source can restore the heat leg of the triangle and may result in injury or death.

The release of fuel in the form of solvent vapor into the Booth System can restore the fuel leg of the triangle and may result in injury or death.



IF AN UNCONTROLLED RELEASE OF FLAMMABLE SOLVENT VAPOR OCCURS INSIDE THE BOOTH SYSTEM IMMEDIATELY EXIT AND CLOSE THE DOOR BEHIND YOU.



2. LOWER EXPLOSIVE LIMIT

Many of the solvents used in plant oil extraction systems are flammable when the concentration of the solvent in air is within the range of flammability. If there not enough of a solvent in the air to support combustion, the concentration of the solvent is below the “Lower Explosive Limit” or “LEL”. One way to improve safety is to make sure that the concentration of a flammable solvent in air is always well below the LEL.

The LOWER EXPLOSIVE LIMIT is the lowest concentration of a flammable vapor in air that is capable of supporting combustion.

Table 1: Lower Explosive Limit of Some Solvents



Solvent	(LEL) Volume %	% in Air at 10% of LEL	% in Air at 25% of LEL
Butane	1.6	0.16	0.40
Ethanol	3.3	0.33	0.83
Isopropyl Alcohol	2.0	0.20	0.50
Propane	2.1	0.21	0.53



Once the concentration of a solvent in air is above its LEL, any contact with an ignition source such as an open flame, spark, electrical contacts, heating coils, or lit cigarette can ignite the solvent. Fire and/or explosion is the result.

We see in Table 1 that the LEL for butane is 1.6% in air. So, 100% of the butane LEL is 1.6% in air. If the concentration of butane in air is $\frac{1}{2}$ of the LEL, or 0.8%, then the concentration is at 50% of the LEL.


When using flammable solvents, keep the concentrations below 10% of the Lower Explosive Limit during routine work, and always keep the concentrations below 25% of the LEL even when problems occur.

The HAL Extraction Booth Systems are designed to increase the ventilation flow rate when the concentration exceeds 10% of the LEL and illuminate a warning light. When the concentration reaches 25%, an audible alarm sounds. When the audible alarm sounds, turn off sources of flammable gas release and leave the area until the alarm is no longer sounding.


3. FLASH POINT

The danger of flammable and combustible liquids rises along with temperature. Liquids that are cold enough to not evaporate sufficient vapor to support combustion are said to be below the “Flash Point” of the liquids. Once a liquid is warm enough to evaporate sufficient vapor to support combustion, the flammability danger increases dramatically.

Table 2: Flash Points for Common Solvents




Solvent	Flash Point °F
Butane	-76
Ethanol	63
Isopropyl Alcohol	53
Propane	-156



4. IGNITION SOURCES



KEEP IGNITION SOURCES OUT OF THE BOOTH SYSTEM

- 
- *No Smoking*
 - *No Open Flames*
 - *No Unrated Electrical Equipment*
 - *No Static Spark Sources*
 - *No Electric Heaters or Heat Guns*
 - *No Welding or Metal Cutting*
 - *No Ungrounded Equipment*

*Ignition sources inside or near the Booth System
may result in serious injury or death.*

5. FIRE TRIANGLE



Understanding the Fire Triangle is essential for anyone working with flammable liquids. Fire requires three components to occur: Oxygen, Fuel, and Heat. Each of these make up a separate leg of the triangle.

If any one component is not present, fire will not occur. The HAL Extraction Booth System is designed to reduce the concentration of solvent in the air and to reduce the presence of heat that may be present in the form of ignition sources.

Bringing items, equipment, or materials into the Booth System that can act as an ignition source can restore the heat leg of the triangle and may result in injury or death.

The release of fuel in the form of solvent vapor into the Booth System can restore the fuel leg of the triangle and may result in injury or death.



IF AN UNCONTROLLED RELEASE OF FLAMMABLE SOLVENT VAPOR OCCURS INSIDE THE BOOTH SYSTEM IMMEDIATELY EXIT AND CLOSE THE DOOR BEHIND YOU.



Interference with the Booth System ventilation, design, operating procedures, electrical equipment or other features may reduce their effectiveness and allow fire, injury, or death to occur.



E. SAFETY FUNCTIONS OF SYSTEM



This HAL Extraction Booth System is designed to be used for the extraction of plant oils using solvents. The Booth System, when properly installed and operated, will reduce the risks associated with the use of flammable and/or asphyxiating solvents used in plant oil extraction. Use of the Booth System for other purposes has not been evaluated and may result in injury or death.



The HAL Extraction Booth System uses a number of complementary safety features.

1. EXPLOSION-PROOF VENTILATION

The Exhaust and Makeup Air fans, motors, and appropriate fixtures supplied are rated as explosion-proof for use with solvents including butane, propane, ethanol, isopropyl alcohol, hexane, or heptane. Use with any other flammable or combustible solvent, liquid, or gas is prohibited.

Exhaust and Make-Up fans and fan motors are rated as explosion-proof to Class I, Division I, Group D requirements. Control Panels are designed and constructed to meet UL standards for control panels used with explosion-proof rated areas.

2. MAKE-UP AIR SUPPLY

Makeup Air ventilation may be passive through filters located above the Air Supply Plenum or active through Makeup Air fans also above the Air Supply Plenum.

The PASSIVE MAKE-UP AIR SYSTEM relies on the Exhaust Fan to pull air from the Booth System exterior through the air filters located above the Make-Up Air Plenum through the Plenum, across the Booth System interior, and into the Exhaust Air Plenum. This relies on there being sufficient air supply to the Passive Make-Up Air System in the location where the Booth System is located. It is critical that there be sufficient air supply to match the Booth System exhaust flow rate during normal operation AND during high-flow rate operation.

A powered automatic air damper (not supplied) that opens upon Booth System activation to supply an air intake source to the Booth System area is one approach that has been used to provide sufficient make-up air.



Figure 2: Example of an Automatic Air Damper



THE LACK OF SUFFICIENT MAKE-UP AIR SUPPLY TO THE BOOTH SYSTEM
WILL REDUCE AIR FLOW RATES AND MAY RESULT IN INJURY OR DEATH
DO NOT STARVE THE SYSTEM OF AIR



The ACTIVE MAKE-UP AIR SYSTEM uses an air supply fan and motor to bring outside air into the Booth System and push air through the Make-Up Air Plenum. The Active air supply fan should bring ducted air from outside the building directly to the Booth System and should be separate from the building air supply system.

The make-up air fan and motor supplied with the Booth System is rated as explosion-proof and is the same as the exhaust air fan and motor.

EXHAUST AIR SYSTEM

The EXHAUST AIR SYSTEM is used to pull air that may contain flammable or toxic gases from the interior of the Booth System and exhaust it to the exterior of the building. Exhausted air must not be recirculated to the interior of the building. Exhaust ducts must be rated for hazardous location duty per IMC 510 code.

3. GAS SENSOR – EXPLOSION-PROOF

The Gas Sensors used are explosion-proof infrared gas analyzers constructed to analyze for a specific airborne gas. Sensors are supplied at client request for solvents such as butane, propane, ethanol, isopropyl alcohol, or carbon dioxide. Each sensor is calibrated to read the levels of the specific solvent written on the label at the top of the sensor cylinder.



MAKE SURE THAT THE SENSOR YOU ARE USING CORRESPONDS
TO THE SOLVENT YOU ARE USING



Sensors for carbon dioxide (CO₂) are set to read in parts per million (ppm). Sensors for flammable solvents are set to read in percent of the lower explosive limit (%LEL).

The infrared gas analyzers built into the sensors are calibrated to the gas printed on the label. A sensor calibrated to one flammable gas such as butane will also respond when exposed to another flammable gas such as propane.



CAUTION: A SENSOR CALIBRATED TO ONE GAS WILL GIVE AN
INACCURATE RESPONSE WHEN EXPOSED TO ANOTHER.



4. USING MIXTURES OF BUTANE AND PROPANE SOLVENTS

Some plant oil extraction system operators use mixtures of butane and propane as solvents. When mixtures of butane and propane are used, there is overlap in the sensor response to both butane and propane. In those cases, a butane sensor alone will provide a response (in terms of the %LEL) close to the mixture's actual flammability characteristics.

5. VENTILATION CONTROLS

The Ventilation System takes fresh air from the Makeup Air System and moves the incoming air through the Air Supply Plenum to be released inside of the Booth System. A base flow rate of fresh makeup air is set to accomplish several objectives:

- Dilution or Area Ventilation moves air through the Booth System interior to dilute and remove stray vapors or gases that may occur during normal operation. This is meant to provide overall air changes throughout the interior.
- Air Capture Velocity is the rate of air movement across the interior of the Booth System and is usually measured in Linear Feet Per Minute (FPM). The Booth System is designed to provide the highest Air Capture Velocity across the bottom 12" of the air column next to the floor surface to collect heavier than air gases.
- During base flow rate operations, the Booth Systems are set to have an exhaust air flow rate of 500 cubic feet per minute (CFM). For Models 70, 105, and 140, this will provide an Air Capture Velocity of approximately 40 FPM across the floor surface. The 35 FPM for the Extra-Large Booth System Model 340) This is to take gases near the floor surface and move them across the width of the Booth System so that any substantial leaks may be quickly detected by the Gas Sensor.
- When the Gas Sensor detects flammable gas at or above 10% of the Lower Explosive Limit, the Control Panel increases the air flow rate to supply an Air Capture Velocity of between 75 and 100 LFM across the floor of the Booth System. This allows for faster capture and clearance of flammable gases from the Booth System.

6. TOXIC OR ASPHYXIATING GASES

Carbon dioxide (CO₂) is often used as a solvent for plant oil extraction. A HAL Extraction Booth System, when equipped with a CO₂ sensor, is also designed to help control exposures to CO₂ which is often used as a solvent for plant oil extraction.

- Carbon dioxide is present in the atmosphere at a concentration of around 400 ppm.
- CO₂ has an occupational exposure limit of 5,000 parts per million (ppm) averaged over an 8-hour work day.
- CO₂ has a short-term exposure limit of 30,000 ppm.
- When the Gas Sensor detects CO₂ concentrations at or above 5,000 ppm, the Control Panel increases the air flow rate to supply an Air Capture Velocity of between 75 and 100 LFM across the floor of the Booth System. This allows for faster capture and clearance of CO₂ gases from the Booth System.

7. ALARM HORN AND LIGHT

When the gas sensor detects a gas concentration, the Booth System initiates several actions:

At the lower set-point, (10% of the LEL for flammable solvents), the Control Panel

- Increases the ventilation flow rate, and
- Illuminates the Warning Light

At the higher set-point, (25% of the LEL), the Control Panel also

- Sounds the Warning Horn.

8. EXITING

Exit doors are equipped with panic bars and swing out from the interior of the Booth System.

9. FIRE SUPPRESSION SYSTEM (SUPPLIED BY OTHERS)

The HAL Extraction Booth System does not come equipped with an automatic fire suppression system. However, an approved fire suppression system is required by several codes and regulations for work with flammable liquids, gases, and solvents. HAL Extraction Technology Ltd. strongly urges purchasers of its Booth Systems to work with local fire protection companies to select, install, and operate an approved automatic fire suppression system. Such a system is a critical part of the overall protection requirements.



WHAT DOES “EXPLOSION-PROOF” MEAN?

According to the NEC, “apparatus is enclosed in a case that is capable of withstanding an explosion of a specified gas or vapor that may occur within it and of preventing the ignition of a specified gas or vapor surrounding the enclosure by sparks, flashes, or explosion of the gas or vapor within, and which operates at such an external temperature that a surrounding flammable atmosphere will not be ignited thereby”

This definition applies to individual electrical components such as switch boxes, junction boxes, conduit, motors, lights, or outlets. The overall HAL Extraction Booth System is NOT designed to contain an explosion.



The interior of the HAL Extraction Booth System is not designed to contain an explosion as defined by the NEC. The individual components that are used in the design and construction of the Booth System are designed to be explosion-proof or intrinsically safe. Describing the interior of the Booth System as explosion-proof means that all the components within the interior are rated as explosion-proof or intrinsically safe.

THE INTERIOR OF THE BOOTH SYSTEM IS CONSIDERED EXPLOSION-PROOF ONLY IF ALL COMPONENTS AND EQUIPMENT WITHIN THE BOOTH ARE EXPLOSION-PROOF OR INTRINSICALLY SAFE RATED.

ADDITION OF EVEN A SINGLE NON-RATED PIECE OF ELECTRICAL EQUIPMENT INTO THE BOOTH ENVELOPE WILL INVALIDATE THE RATING OF THE BOOTH SYSTEM.



WHAT DOES "INTRINSICALLY SAFE" MEAN?

Intrinsic safety (IS) is a protection technique for safe operation of electrical equipment in hazardous areas by limiting the energy, electrical and thermal, available for ignition. Voltage and current is limited to ensure that no sparks with sufficient energy capable of igniting a flammable mixture of gas can occur.



10. EXHAUST VENTILATION



The HAL Extraction Booth System exhausts air from inside the Booth System. The Booth System is designed for use with gases, solvents, or fumes that are heavier than air, so most of the exhaust vent area is located near the floor on the Exhaust Plenum.



USE OF THE SYSTEM WITH FLAMMABLE SOLVENTS WITH DENSITIES CLOSE TO OR LIGHTER THAN AIR MAY RESULT IN INJURY, DEATH, OR DESTRUCTION OF PROPERTY.

DO NOT USE OR STORE HYDROGEN, METHANE, OR ANHYDROUS AMMONIA IN THE SYSTEM.

11. EXPLOSION VENTING PRESSURE RELIEF



If an explosion were to occur inside a HAL Extraction Booth System, the rapid release of large quantities of gas can increase the pressures inside the booth dramatically. These over-pressures can cause severe injuries or death. HAL Extraction Booth Systems are equipped with NFPA 68 rated explosion venting relief panels designed to release at 0.5 pounds per square inch of differential pressure between the inside and outside of the booth. This is to help reduce the potential for injury or death in case of an explosion.

The pressure relief panel is secured to the wall of the booth by cables to prevent the relief panel from becoming a hazardous projectile in case of an explosion.

Keep the exterior of the pressure relief panel clear of storage so that the vent will be free to operate.

F. OPERATOR SAFETY AND HEALTH

G. TRAINING

Do not use or operate the HAL Extraction Booth System without detailed and thorough training. Training in the following topics is mandatory prior to use:

- Carefully read and understand the Booth System operating manual.
- Operation, control, and maintenance of the Booth System.
- Required safety and health protection measures and procedures.
- Personal protective equipment required and how to use that equipment.
- Facility-specific Standard Operating Procedures for the extraction method in use.
- Use and operation of the extraction system in use.
- Basics in the chemistry and physics of the extraction process.
- Required personal protective equipment.
- Safety data for solvents and chemicals in use.
- Purpose and operation of all ancillary equipment.
- Pressure vessel hazards, operation, and protective measures.
- Applicable regulations, standards, and codes.

H. PERSONAL PROTECTIVE EQUIPMENT REQUIRED

It is the responsibility of purchaser and operator of a HAL Extraction Booth System or owner to evaluate the need for personal protective equipment (PPE) based on the extraction system and solvent used. It is also the responsibility of same to ensure that PPE is provided at no expense to workers, and to enforce the use of appropriate PPE.

- Eye protection (safety glasses minimum)
- Flame-resistant fabric coveralls (for use with flammable solvents)
- Nitrile gloves

Detailed and complete PPE requirements must be prepared by the owner and/or operator prior to the use of the HAL Extraction Booth System based on the solvent used, flammability and/or toxicity concerns, the extraction system used, and regulatory compliance needs.

Air-purifying respirators are often not recommended for use with typical plant oil extraction systems and solvents. However, each employer should perform a job hazard analysis to include an evaluation of whether respirators are needed for the work performed.

III. OPERATING THE HAL EXTRACTION BOOTH SYSTEM

The HAL Extraction Booth System is designed for ease of use by the operator.

A. TURNING ON THE BOOTH SYSTEM

The power switch has three user-controlled positions. These include:

Off

On - Exhaust Fan System

On- Exhaust Fan System and Area Lighting

The master disconnect on the side of the control panel is for use by electricians and system service only. The master disconnect shuts off all power to all components of the HAL Extraction Booth System including sensors, lights, alarms, fans, motors, and internal control panel components.

The LED readout on the control panel is set to read the percentage of the lower explosive limit. (100% of the LEL is the point at which the minimum concentration of gas that can support combustion is present.)

B. USING THE BOOTH SYSTEM

1. ALWAYS KEEP THE DOOR TO THE BOOTH CLOSED.

Open the door only for entry and exiting of the booth. Propping the door open will seriously interfere with the air flow and may allow flammable and/or toxic vapors to escape.

2. DO NOT BLOCK AIR MAKE-UP OR EXHAUST VENTS

The free flow of air across the booth is necessary for optimal operation.

3. PERFORM WORK THAT WILL RELEASE FLAMMABLE VAPORS ON A TABLE AT THE EXHAUST WALL OF THE BOOTH.

The middle vents on the air plenum panels are designed to be just above the standard work table or bench height. This is to improve capture of residual solvents released during handling of fresh oil or spent feed or cleaning equipment with flammable liquids.

4. CONTROL FLAMMABLE VAPOR RELEASE FROM SPENT FEED

If you collect spent feed or trim in a trash can, place a metal can with a height that is near the bottom of the middle exhaust vents on the air plenum panel. Place the top edge of the metal can against the exhaust air plenum panel. That will allow vapors to be captured and exhausted from the building.

5. NEVER BRING ANY ELECTRICAL EQUIPMENT INTO THE BOOTH THAT IS NOT RATED AS EXPLOSION-PROOF

Electrical motors can produce sparks, electrical heating elements can ignite vapors, and switches and outlets can spark. Bringing any non-rated equipment into the booth defeats the entire purpose of the HAL Extraction Booth System.



6. KEEP ANY POTENTIAL SOURCES OF IGNITION AT LEAST 5 FEET FROM THE DOOR TO THE BOOTH.

The area within five feet of the door is Class 1, Division 2 explosion proof space.

7. DO NOT BLOCK THE SENSOR.

The sensor controls the ventilation rate based on the concentration of flammable gas in the area.

8. USE HAND-HELD FLAMMABLE GAS METERS TO FIND RELEASES OF FLAMMABLE GAS.

When you identify releases, change your procedures to minimize the release of flammable gas.

9. NEVER IGNORE THE ALARM.

If the system is detecting flammable gas sufficient to set off the audible alarm, change your procedures to reduce the release of flammable gas.

10. IF THE HORN SOUNDS, TURN OFF SOURCES OF SOLVENT VAPOR, AND LEAVE THE BOOTH.

The horn will sound only if the level of flammable gas exceeded 25% of the lower explosive limit (LEL). Close the door to the booth behind you. Do not return to the interior of the booth until the horn has ceased to sound and the levels have returned to below 25% of the LEL.

11. KEEP THE EXHAUST FAN ON AT ALL TIMES FLAMMABLE SOLVENTS, LIQUIDS, OR GASES ARE STORED IN THE BOOTH

Stored containers can have small leaks that may result in high concentrations of flammables over time if no ventilation is occurring.

IV. MAINTAINING THE HAL EXTRACTION BOOTH SYSTEM

A. CHANGE MAKE-UP AIR FILTERS ON A REGULAR BASIS.

Filters should be changed once every three months or sooner in dusty conditions.

B. CHECK THE CALIBRATION OF THE SENSOR ON AT LEAST AN ANNUAL BASIS.

The use of a challenge gas with a known concentration of flammable gas such as 50% of the LEL may be used to check the instrument span and response. A bottle of clean air may be used to check the zero point of the system.

C. SERVICE AND LUBRICATE MOTOR AND FAN BEARINGS ACCORDING TO THE MANUFACTURERS'S RECOMMENDATIONS.

V. CONTACT INFORMATION

Please contact HAL Extraction Technology Ltd. with any questions you have regarding use of the HAL Extraction Booth Systems.

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