

Siting of Hydrocarbon Heat Pumps Guidelines

This information is supplied to inform the site risk assessment. Each site is different and requires a site-specific risk assessment carried out by a competent person.

Risks with flammable refrigerant

Fires start when there is sufficient fuel, oxygen & heat for a chemical reaction (combustion); gas explosions occur when a source of ignition is introduced to a mixture of flammable gas and air, the impact of a gas explosion depends on the locations, type of gas and the amount present.

Flammable gas can mix with air and create a potentially explosive atmosphere, heat or a spark can then ignite this mixture of fuel & air. For the atmosphere to be flammable, the gas concentration in air must be above the Lower Flammability Limit (LFL) & below the Upper Flammability Limit (UFL). *The LFL of R290 is 2.1% & the LFL for R600a is 1.5%.*

The risk of flammable gas explosion if release occurred without any control measures and met an ignition source is clearly **high/critical**.



Hazardous Area Classification (HAC)

The dangerous substances & explosive atmospheres regulations require employers to conduct risk assessments on potential explosive atmospheres. Zones where flammable gas may be released are classified as Zone 0 – 2.

- Zone 0: An area in which an explosive gas atmosphere is present continuously or for long periods
- Zone 1: An area in which an explosive gas atmosphere is likely to occur in normal operation
- Zone 2: An area in which an explosive gas atmosphere is not likely to occur in normal operation and, if it occurs, will only exist for a short time.

Clade do not assign a hazardous area classification to heat pumps, an explosive atmosphere is possible but only under critical failure of the system.

Principles of control

A gas explosion will not happen if leaks are detected & the gas exhausted safely from the area so that a flammable atmosphere does not occur. Control of ignition sources in the vicinity of potential leaking equipment further reduces the probability of a gas explosion occurring.

Control measures employed

Limited charge size

Amount of refrigerant present within systems is limited by BS:EN 378, depending on the location classification of the room charge size may be limited. Refer to BS:EN 378 1. Considerations must be made on locating the equipment.

For installation into a machinery room, refer to Clade document: **CCP028 Hydrocarbon plant room safe method of working implementation, process and procedures.**

Selection of components

Likely releases of flammable gas in system are identified & suitable electrical components selected accordingly. ATEX rated components are installed in areas of the machine that will still be running if a gas leak is detected, namely the emergency exhaust ventilation system.

ATEX is a name given to two European Directives for controlling flammable atmospheres.



Leak detection

System installed with gas detection, if it's detected at 20% of the LFL then it will completely shut off power to the system. This will stop the circulation & subsequent release of refrigerant, allowing refrigerant gas to disperse. Leak detection triggers a ventilation system, facilitating the safe removal of flammable gases & a return to below the LFL. A competent person would then need to repair leaks.

Strength testing & leak checks

Systems are all pressure tested prior to them being commissioned, this confirms that the vessels and associated pipework can contain refrigerant above the operating pressure. Pressure relief valves are fitted & vent to an external point, compliant with relevant legislation (Pressure System Safety Regulations) & a UK Conformity Assessment mark.



UKCA marks are replacing CE marks, now that the UK has left the EU.

Quality assurance & commissioning

All units go through a thorough QA process, pre-commissioning checks, before they finally signed off by a commissioning engineer at the customer's site. These checks include:

- Pressure relief valve pipe work
- Plant room extract system integrity and operation
- Electrical shutdown integrity and operation
- Gas detection integrity and operation.

Safe charging of refrigerant

Heat pumps are not in scope for the Gas Safe Register, commissioning engineers are suitably trained to work with Hydrocarbon refrigerants, holding City & Guilds qualification: Safe Handling of Hydrocarbon Refrigerants.

Ignition sources

Heat pumps should not be placed near to any fixed sources of ignition, heat & spark generating processes should also be kept clear of the exhaust vent. This should be considered when siting a heat pump, as well as when planning any changes in the area around one.

Access control

Access should be controlled with only authorised and inducted individuals gaining entry. Full understanding of the precautions should be required before access is permitted; only competent engineers who understand the risk should be permitted to work on the system.

Risk mitigation

Flammable gas is hazardous, but risks are well managed with engineering design & administrative control. The likelihood of a leak occurring is sufficiently low & there are safeguards in place to deal with one should it occur. With all the control measures it is expected to be a **Tolerable** risk level.



Risks & Siting Considerations

Hazard	Harm / How harm will come about	Siting Considerations
Leaked Refrigerant – flammable gas	Potential for gas to leak & form vapor cloud above LFL. A source of ignition would initiate gas explosion.	2.5 metre zone around exhaust vent to be clear of sources of ignition, vehicle parking bays, smoking areas. Handover of equipment to customer, O&M manual to state risks & prohibition of ignition sources.
Leaked Refrigerant – flammable gas	R290 & R600a are heavier than air. Potential for gas to settle in drains, or area of low airflow around exhaust vent, leaving flammable gas cloud at low level. Risk of explosion if ignition source is met.	Drains to be 2.5 metres away from emergency exhaust ventilation. Where a zone of open air does not exist around exhaust ventilation, considerations to be made on amount of airflow. The ability of exhaust to sufficiently disperse the flammable gas into the zone. (Site specific: Install Ducting to move further from Drains)
Leaked Refrigerant – flammable gas	R290 & R600a are heavier than air. Potential for flammable gas to be drawn into air inlet. Windows or other openings potentially able to allow flammable gas inside building. Risk of gas explosion if ignition source is met.	3 metre zone around exhaust ventilation to be clear of air inlets. Customer to be informed of risks associated with flammable gas being drawn into air inlet. (Site specific: Install ducting to move further from air inlet)
Fire - heat	The flammable gas contained within the heat pump would add load to any fire that had started in the area.	Combustibles to be kept clear of heat pump, reducing chance of an external fire exposing the unit to heat & compromising the containment of flammable gas. Customer to include existence of heat pump in their emergency manual – share with fire brigade on arrival. Fire risk assessment to be updated when heat pump is installed.
Lightning	The flammable gas contained within the heat pump would add load to any fire that had started in the area.	Consider whether lightning protection is installed on buildings. If no lightning protection is present, customer to consider risk & seek guidance from lightning protection consultancy.
Impact from vehicles	Vehicles could collide with the unit & cause a release of flammable refrigerant.	Heat pumps not to be installed on traffic routes without consideration of impact protection & signage. Measures must be proportionate to the risk, more control measures will be required as the traffic & speed increase. <i>Impact protection measures also help to deter people from parking immediately next to access doors & emergency exhaust ventilation.</i>

Hazard	Harm / How harm will come about	Siting Considerations
Works at height	Those attempting to access the unit for maintenance could fall if it's positioned too close to the edge of a roof.	Customer to install edge protection if unit is to be positioned near exposed roof edge. Min 2.4M if unit is only 1M away from edge Ensure access can be achieved all around e.g. for work at height equipment which may be used to gain access to the fans atop the unit.
Unauthorized access	Those attempting to access the unit for maintenance could fall if it's positioned too close to the edge of a roof.	Adequate security measures to be in place to prevent unauthorized access to equipment. Unit to be located in area not easily accessed by persons out of hours. Keys for access into unit retained by authorized persons only.
Overloaded roof. Ground incapable of supporting weight of heat pump.	A heat pump placed on a roof or ground that's unsuitable could cause entire collapse of structure, injuring those inside the building & compromising integrity of flammable gas system.	Load bearing capacity of roof to be considered when selecting potential locations for units. Entire load of all equipment present on roof to be taken into account. <i>Professional assistance may be required from structural engineer.</i> Loads of units communicated to customer prior to planning installation, verifiable on the data plate affixed to the unit.
Insufficient routes or access methods for delivery of heat pump & servicing.	Heat pumps can weigh several tonnes, this is a weight that can only be transported over obstacles by a crane & is difficult to move along the floor using wheeled manual handling equipment.	Survey of site to include delivery vehicle access, possible positioning of crane, approximate radius of lift, overhead cables or obstructions, slinger & signaller access. For loads to be moved along the floor into their final position, shortest distance of travel to be established & route to be suitable for use of wheeled manual handling aids. Route of access for refrigerant to be taken to the heat pump for charging & servicing.

Exclusion Zone – Heat pumps located outside

R290 & R600a are heavier than air, there's the potential that it can settle on the floor & an explosive atmosphere can form/remain in place. It can also settle in drains & be drawn into air circulation systems, not only would it be unlikely for these air circulation systems to be rated for circulating flammable gas, the building which they are drawing air into could also contain ignition sources.

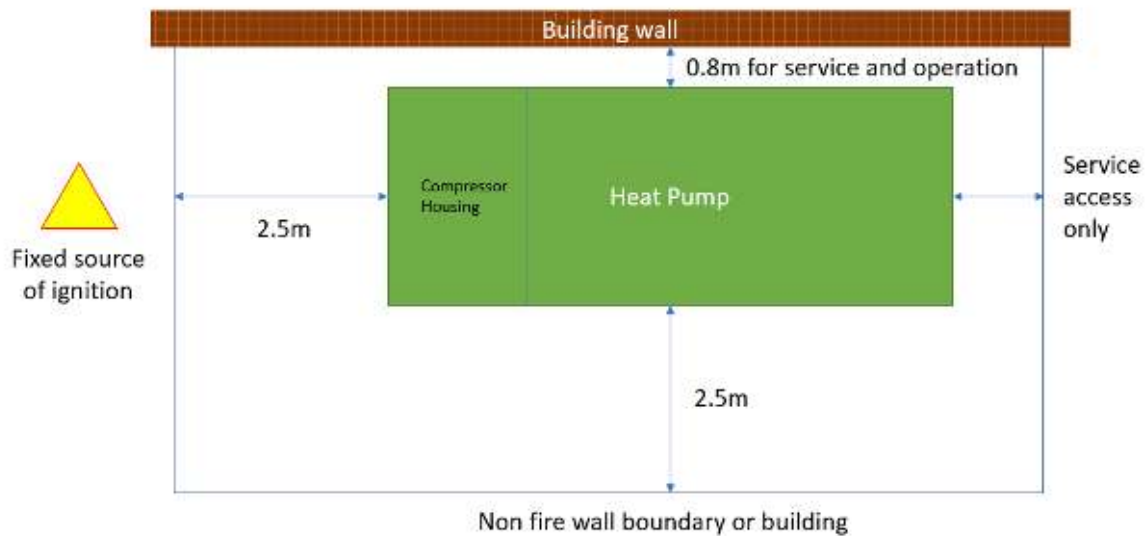
Windows & openings must be 2.5 metres away unless they are more than 400mm above the exhaust vent.

Drains must be 2.5 metres away.

Air handling unit intake must be at least 3 metres away. Consideration must be given to the direction in which the AHU draws air from. Ducting may be required to route exhaust away from the capture zone.

Sources of ignition must be 2.5 metres away from any sources of ignition.

Impact protection: Heat pumps must be protected from significant risk of collision with vehicles & plant.



Free flow of air

As propane is heavier than air, it can settle at ground level and be shielded from the wind. Free flow of air around the exhaust vent is how flammable gas is brought back down to a level below the lower flammability limit (2.1%). The more air passing around the exhaust vent, the quicker a vapor cloud is dispersed.

If there is not an area around the exhaust vent that's free from obstructions, consideration should be given to the items in the surrounding area & whether they'll reduce air flow significantly. The proximity of drains, inlets and ignition sources may need to be further away if the exhaust vent is in a restricted area. If the unit is to be enclosed inside a compound for acoustic reasons, consider ducting to exhaust outside of compound.