Internship project

SUITABILITY OF INSTALLATION OF BULK WELDING GAS STORAGE

Brief

I've been tasked to investigate the possible installation of a type of gas store, to try replace individual cylinders and reduce downtime, and to find how to safely install and maintain the system following all regulations and safely systems.

Risk assessment

FOUND IN EXCEL

Regulations

Pressure Systems Safety Regulations (PSSR) 2000: Mandates the safe design, installation, and operation of systems containing pressure. It requires a Written Scheme of Examination (WSE) certified by a competent person for microbulk vessels, pipework, and relief devices.

Pressure Equipment Regulations 1999 (PED): Governs the design, manufacture, and conformity assessment of stationary pressure equipment operating above 0.5 bar.

UK Transportable Pressure Equipment (TPE) Regulations / TPED: Covers the manufacture, transport, and periodic inspection of transportable or mobile microbulk tanks and cryogenic receptacles. Requires the 'Rho' (ρ) or 'Pi' (π)

Health and Safety at Work etc. Act 1974: The primary piece of UK legislation outlining the general duties of employers, employees, and the self-employed to ensure safety in the workplace.

Control of Substances Hazardous to Health (COSHH) Regulations 2002: Affects cryogenic tanks because gases like argon and carbon dioxide displace oxygen, posing asphyxiation risks.

Regulations

Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) 2002: Requires risk assessments regarding fire and explosion hazards. While argon is inert, carbon dioxide can present asphyxiation and localized physical hazards, particularly in confined spaces.

Provision and Use of Work Equipment Regulations (PUWER) 1998: Places duties on employers to ensure that all work equipment (including cryogenic microbulk tanks) is suitable, maintained, and safe.

Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (CDG): Governs the transport of dangerous goods on UK roads. Transporting microbulk tanks requires adherence to ADR standards regarding vehicle ventilation, tank restraint, and driver training

PSSR 2000 Regulation 8 (Written Scheme of Examination): You cannot legally operate a microbulk tank without a Written Scheme of Examination (WSE) drawn up by a competent person before the system is pressurized.

Regulations

PSSR 2000 Regulation 12 (Maintenance): Mandates a strict, documented maintenance regime for the tank, its pressure-relief valves, and vacuum insulation systems.

COSHH Workplace Exposure Limits (WELs): Carbon dioxide has a strict legal workplace exposure limit under HSE EH40 guidelines. The 8-hour time-weighted average (TWA) is 5,000 ppm, and the 15-minute short-term exposure limit (STEL) is 15,000 ppm. Argon has no WEL but triggers COSHH under oxygen-depletion hazard assessments.

Management of Health and Safety at Work Regulations 1999: Requires a formal, written Risk Assessment covering cryogenic burns (contact with liquid at -186°C for argon and -78.5°C for CO_2 solid/liquid mix) and catastrophic pressure failure.

The Building Regulations (Part J / Part K): Governs the structural foundation pads required to support heavy cryogenic microbulk tanks. It also mandates adequate ventilation layouts for indoor or caged installations.

Regulations

Environmental Permitting (England and Wales) Regulations: Applies if your CO_2 or argon microbulk tank is part of a larger industrial process (e.g., food processing, water treatment) that requires an emissions or safety permit from the Environment Agency.

Planning (Hazardous Substances) Regulations 2015: While argon and CO_2 are non-flammable, storing them in massive bulk quantities near public areas can trigger hazardous substance consent thresholds if they pose a severe asphyxiation risk to the local population.

BCGA safety measures *cryogenic bulk tanks*

BCGA CP 36: Provides the standard for the safe operation of cryogenic liquid storage at users' premises.

BCGA CP 26: The code of practice for the storage and handling of bulk carbon dioxide.

BCGA CP 27: Focuses on transportable vacuum-insulated tanks up to 1,000 liters.

BCGA CP 48: Outlines the protocols for the safe filling of third-party owned microbulk tanks.

BCGA CP 4: Details the requirements for gas supply and distribution systems.

BCGA CP 22: Covers bulk liquid argon and nitrogen storage installations at production sites.

BCGA CP 34: Defines the application of pressure equipment safety regulations at customer sites.

BCGA CP 41: The design, construction, and operation of filling stations. Governs the delivery vehicle side, transfer hoses, and couplings during the loading process.

BCGA safety measures *cryogenic bulk tanks*

BCGA CP 18: Outlines the safe handling and operations involving special gases.

BCGA CP 44: Sets the requirements for the safe storage of gas cylinders and bundles used in welding and general manufacturing.

BCGA CP 47: Focuses on the use and inspection of individual portable or mobile cylinder gas equipment (commonly applies to MIG/TIG welding sets)

Asphyxiation (BCGA GN2 & CP 22): Both argon and CO_2 are classified as asphyxiants. Because they displace oxygen in the air, BCGA guidelines mandate strict ventilation and risk assessments in confined spaces

BCGA CP 30: Gas Systems Near Consumer. Details safety criteria for installing gas equipment and pipework close to the point of use, protecting operators from leaks.

BCGA GN 41: Gas Detection Systems. Recommends where and how to install oxygen depletion and CO_2 monitors in rooms where these gases could pool.

BCGA TIS 20: Pressure Regulators. Guides the safe selection, fitting, and end-of-life replacement criteria for gas regulators.

BSI regulations *Cryogenic Microbulk Tank*

BS EN 13458 Cryogenic vessels and stationary pressure-insulated vessels.

BS EN 13445 Unfired pressure vessels (design rules for the tank shell).

BS EN 13480 Metallic industrial piping (rules for the gas distribution pipework leading from the tank).

BS EN 13648-1:2008 – Cryogenic vessels. Safety devices for protection against excessive pressure. Safety valves for cryogenic service.

BS ISO 21014:2019 – Cryogenic vessels. Cryogenic insulation performance.

ISO 20421: Covers the large-scale, static vacuum-insulated vessels if the microbulk application scales up past 1,000 liters.

ISO 21009: Specifies the requirements for the static, vacuum-insulated cryogenic vessels used for microbulk systems up to 1,000 liters

BSI regulations *Cryogenic Microbulk Tank*

ISO 21010: Defines gas/material compatibility for cryogenic vessels. It ensures that the stainless steel materials and seals used in the tank remain chemically resistant and structurally sound at temperatures below -186° C

ISO 11114-1 & ISO 11114-2: Used alongside ISO 21010 to evaluate metallic and non-metallic material compatibility with argon (inert/asphyxiant) and carbon dioxide (oxidizing/corrosive if moisture is present)

ISO 10297: Specifies the design, type testing, and manufacturing requirements for cryogenic cylinder and tank valves.

ISO 17879 & ISO 24490: Outline the specific design, testing, and sizing requirements for cryogenic pressure-relief devices (burst discs and relief valves) necessary to prevent over-pressurization from liquid-to-gas expansion.

ISO 23208: Specifies the cleanliness requirements for cryogenic service. It ensures that tanks handling medical, food-grade CO2, or high-purity argon are free of hydrocarbons.

ISO 21013: Details the requirements for safety devices associated with cryogenic vessels (e.g., pressure relief accessories).

Dangers with cryogenic gas storage

Gas expansion

Carbon dioxide in Liquid form -78.33C Expansion ratio 535 to 1

Argon in Liquid form -186.11C Expansion ratio 847 to 1

This can cause a pressure related explosion if no pressure is able to be released and endanger infrastructure and personnel around the tank in the short and long term due to environmental impacts

Argon Cryogenic Temperatures: Liquid Argon is stored at roughly -186, where as liquid CO2 is kept much warmer, around -20C to -40C. If piping networks cross or touch without vacuum insulation, the liquid Argon line will easily freeze the CO2 line solid, creating a high-pressure pipe rupture hazard

Dangers and controls with cryogenic burns

Continued exposure of naked flesh to cold atmospheres can result in frostbite. There usually is sufficient warning by local pain whilst the freezing action is taking place. Rewarming with lukewarm water at 42C to 44C is generally sufficient safeguard againstinjury

always refer to the Cryogenics Safety Manual

Correct hazard signs and trainings should be given and installed to the surrounding areas and employees

Dangers and control of asphyxiation

Evacuate the Area: If you suspect an argon leak or notice sudden light-headedness, leave the area immediately.

First Aid & Rescue: If someone has collapsed, do not rush in without an air-supplied respirator. Retrieve the victim only when it is safe to do so. Immediately move them to a well-ventilated area.

Oxygen Therapy: Once in a safe environment, administer 100% oxygen. Severe cases may require hospitalization for mechanical ventilation or hyperbaric oxygen therapy to reverse brain hypoxia.

Call Emergency Services: Dial 999 (or your local emergency number) to request medical assistance.

Dangers and control of asphyxiation

Oxygen Content (Vol %)	Effects and Symptoms (at atmospheric pressure)
11-14	Diminution of physical and intellectual performance without person's knowledge.
8-11	Possibility of fainting after a short period without prior warning.
6-8	Fainting within a few minutes; resuscitation possible if carried out immediately.
0-6	Fainting almost immediate; death ensues; brain damage even if rescued

Microbulk storage *previous quote*

Previous quote for two 950l and one 2000l would cost £1130 a month

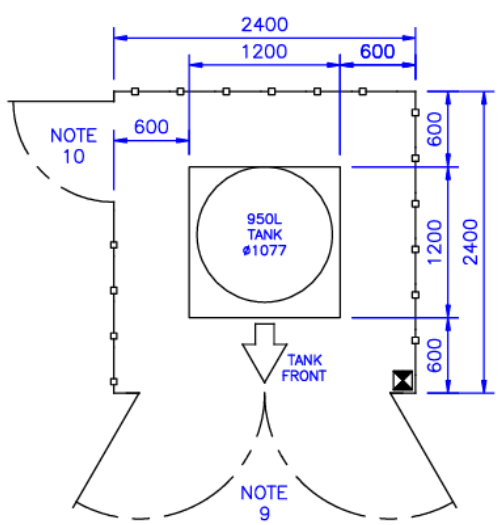
950 od argon for workshop 3

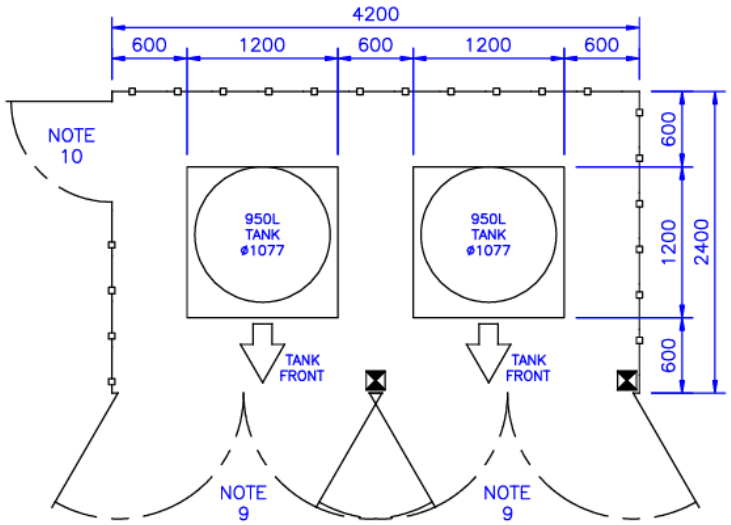
950 and 2000 for argon and carbon dioxide mix for workshop 1 and 2

Argon is £1.35 per L

Carbon dioxide is 42p per KG

Delivery is £60 per fill





NOTES
1. DIMENSIONS ARE IN MILLIMETRES UNLESS STATED OTHERWISE.
2. TANK PLINTH TO BE IN ACCORDANCE WITH AIR PRODUCTS SPECIFICATION 320-05-005-GB & ENGINEERING STANDARDS 4EQ15860E & 4GN90825E.
3. INSTALLATION TO COMPLY WITH BCGA CODE OF PRACTICE CP26: 'BULK LIQUID CARBON DIOXIDE STORAGE AT USER PREMISES' & CP36: 'BULK CRYOGENIC LIQUID STORAGE AT USER PREMISES'.
4. ALL WEIGHTS, MEASURES & POSITIONS OF EQUIPMENT SHOWN ARE APPROX. & MAY BE SUBJECT TO CHANGE.
5. CONSIDERATION TO BE GIVEN TO DELIVERY VEHICLE POSITION DURING OFF LOADING OF THE PRODUCT.
6. FOR INFORMATION REGARDING THE INSTALLATION REFER TO THE TECHNICAL SPECIFICATION.
7. DENOTES LIGHTING FOR NIGHT TIME DELIVERY (BY CUSTOMER):150 WATT SON-TXL (HIGH PRESSURE SODIUM FLOODLIGHT MOUNTED ON 3.5m STANCHION, OR 100 LUX ILLUMINATION LEVEL ON FRONT OF TANK.
8. IF REQUIRED A 1.8m HIGH NON-COMBUSTIBLE SECURITY FENCE/CAGE TO BE INSTALLED FOLLOWING INSTALLATION TO PREVENT UNAUTHORISED ACCESS TO EQUIPMENT (BY CUSTOMER).
9. 2m WIDE DOUBLE 180° OPENING GATES FOR ACCESS TO TANKS, POSITIONED CENTRALLY TO TANKS (IF REQUIRED).
10. 800mm WIDE EMERGENCY EXIT (IF REQUIRED).
11. DENOTES TANKER CEEFORM SOCKET, HIGH PRESSURE INSTALLATIONS ONLY (BY CUSTOMER):
    415V 63A 50Hz 5-PIN (4 PIN+E) BS4343 IP65 CEEFORM 17 (REFER TO SPECIFICATION 17.005), LOCAL ISOLATION SWITCH, 30mA TP RCD (LEGRANDE PREFERRED), ENCLOSURE TO HAVE RCD RESET FLAP SUCH THAT FLAP CAN BE LIFTED AND RCD RESET WITHOUT THE AID OF A TOOL, INSTALLATION IN ACCORDANCE WITH BS7671.
12. FOR OXYGEN INSTALLATIONS, CONCRETE TANKER APRON SHALL BE 2500mm BY 2500mm MESH REINFORCED. THE LONG DIMENSION BEING PERPENDICULAR TO THE CENTRE LINE OF THE VEHICLE AXIS. THE TANKER APRON SHALL DRAIN SURFACE WATER TO ONE SIDE.

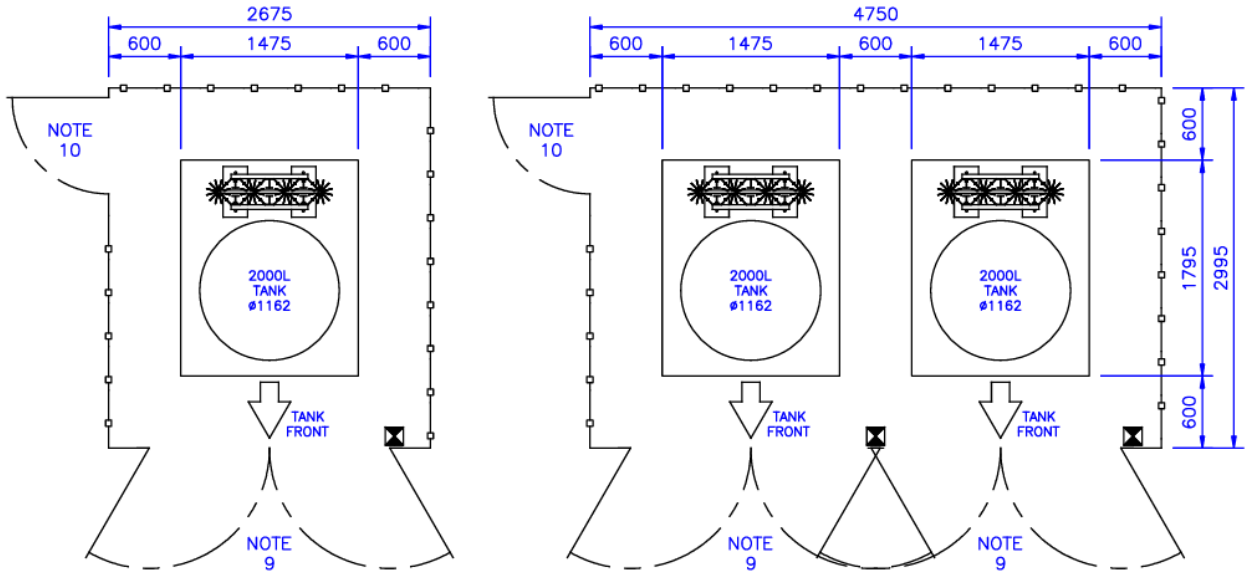
REV	REVISION	DATE	DRAWN	CHKD	APPD
P0	PROVISIONAL ISSUE	02:03:16	AL	AH	DP

U.K. CUSTOMER ENGINEERING

AIR PRODUCTS

TITLE: 950L TANK GENERIC COMPOUND LAYOUT

SCALE: –	PROJECT No. TBA	DRG. No.	STD08L012D
DISC No. –		CAD Ref.	STD08L01203
FUNCTIONAL LOCATION: TBA		SHT. 3	OF 4



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P0	PROVISIONAL ISSUE	02:03:16	AL	AH	DP

U.K. CUSTOMER ENGINEERING

AIR PRODUCTS

TITLE: 2000L MP/HP TANK GENERIC COMPOUND LAYOUT

SCALE: –	PROJECT No. TBA	DRG. No.	STD08L013D
DISC No. –		CAD Ref.	STD08L01301
FUNCTIONAL LOCATION: TBA		SHT. 1 OF 1	

Findings for microbulk tank

3000L Argon - £18,500-32,000 exc VAT and installation 650/month

1000L Argon - £15,000-18,000 exc VAT and installation 550/month

1000L CO2 - £18,000-21,000 exc VAT and installation 500/month

One 1000 litre and two 3000 litre

All tanks are holding gases in liquid form so they are cryogenic

One of the 1000 litre tanks our going to be housed by the stainless workshop contain pure liquid argon at around -185 degrees

The other two tanks are to be held at workshop 2 and our to contain liquid carbon dioxide and liquid argon to mix a 80-20 argon carbon mix

3000l argon tank and a 1000l tank of carbon dioxide using gas mixer to supply the correct m21ArC20 gas

Findings for microbulk tank

BOC

950L cryogenic of argon and carbon dioxide a 300kg and 750L would cost £400 a month per vessel

Delivery £15,000 including pipework and mixer

£10,000 without

£2L for argon and 0.60pKG for carbon dioxide

£100 delivery, 13 delivery's a year

Maintenance included

Gas mixer *using the company WITT gas*

Bm-2m high pressure mixer

£5,000 – £12,000

The gas mixer should allow for a 20% carbon dioxide and 80% argon

Main Group M2 (Medium oxidizing gas mixtures)

These mixtures contain higher concentrations of CO_2 (typically 5% to 25%), blended with Argon.

Common Designations: ISO 14175-M20-ArC-8 (8% CO_2) or ISO 14175-M21-ArC-20 (20% CO_2)

Safety measures for the microbulk tanks

Pressure relief valves

NABIC 500L Pressure relief valve - £330.75 ex VAT

Niezgodka Type 50 Safety Valve Temperature: -200 to 280 degC

£600 to £850

Cut of valves

Rp 1/2 inch Gas 2-Way Brass Ball Valve £17.36 excl VAT

EXH self reliving high pressure regulator

monitoring systems

Oxygen Deficiency and Enrichment Safety Alarm with Horn Strobes

£1,500.00

Implications of installation

Before an installation can take place, suitable foundations are required for each cryogenic tank. The civil engineering requirements are agreed with the cryogenic tank supplier, but the responsibility for their installation is usually with the site owner or operator. There is also a requirement to ensure there is safe and adequate access for replenishment tankers.

Static cryogenic tanks are generally classified as pressure vessels, as such new tanks and their associated systems must be manufactured and put into service in accordance with the Pressure Equipment (Safety) Regulations.

Refilling a non-flammable cryogenic bulk tank (like liquid nitrogen or argon) requires a paved tanker access road (minimum 3.0 m wide), a turnaround radius, and a secure, well-ventilated unloading pad. The delivery truck needs a minimum 15 m clearance from flammable sources, and all fill connections must be positioned to avoid confined spaces

In the UK, an argon cryogenic microbulk tank must maintain a minimum separation distance of 3 meters from a car park.

Implications of installation

If your facility owns the microbulk tank outright instead of leasing it, you must hire a certified third-party cryogenic service provider. They must be fully qualified to perform the technical inspections and pressure testing that a gas supplier would normally cover.

Security Perimeter: The tank must be enclosed in a secure, lockable compound (usually a palisade or mesh cage) to prevent unauthorized access or vehicle impact

Minimum height: Must stand at least 1.8 meters tall.

Open mesh fencing: Provides excellent ventilation and visibility.

Crash-rated bollards: Protects against vehicle impacts.

Always refer to the BCGA CODE OF PRACTICE 36 if unsure

Requires 4m3 of concrete to hold the weight

Has to be a AIR PRODUCTS cryogenic tank otherwise we cant use them to refill the argon or co2

Piping

£24,258.08 + VAT for workshop 1 and 2 using previous quotations

22 ports

£9,367.63 + VAT for workshop 3 with previous quotes

7 ports

ISO 13703-3 / ASME B31.3: The international and global standards for metallic process piping fabrication, welding, inspection, and testing. This ensures the downstream ring main or manifold handles the gas pressure safely.

ISO 14175: Governs the shielding gases used for arc welding and cutting, classifying purity levels and mixing tolerances delivered from the supply system.

BCGA CP 39: Dictates the mandatory ongoing examination, inspection, and maintenance regime required for the pipeline before and during its service life

Workshop 1 & 2 consumption

For flux-cored arc welding (FCAW) using gas-shielded wires, set your shielding gas (typically 100% CO_2 or a 75/25 Argon/CO_2 mix) to 10 to 15 lpm (liters per minute) under standard conditions.

30-40CFH

1litre of CO2 equals 550L of gas

1000L of liquid = 550,000L of gas

1 litre of liquid argon is resultant of 850L of gas

3000L of liquid= 2,550,000L of gas

22 bays in both workshop 1 and 2 so a consumption of 330LPM

9,393.9 minutes of continues use for both workshops 156.6 hours

Workshop 3 consumption

TIG welding gas consumption typically ranges from 8 to 15 liters per minute (LPM) (approx. 17 to 32 Cubic Feet per Hour, or CFH) depending on your cup size, joint configuration, and draft conditions. You can calculate a cylinder's lifespan by dividing its total capacity by your flow rate

1000L of liquid Argon = 850,000L of gas

Workshop 3 contains 7 welding bays so has a consumption of 105LPM

8,905.2 Minutes of continuous use for the entire workshop 148.4 hours

Workforces opinions

Workshop 2,3, mostly positive and wanting the system but a little concerned about mobility.

Workshop 1, also agreeing but worried about portability and mobility restrictions

Benefits

Cryogenic bulk tanks allow for continuous uninterrupted use of gas and also makes sure all gas is used in the tank with little residue.

It also allows for cheaper rates of gas due to the large quantity

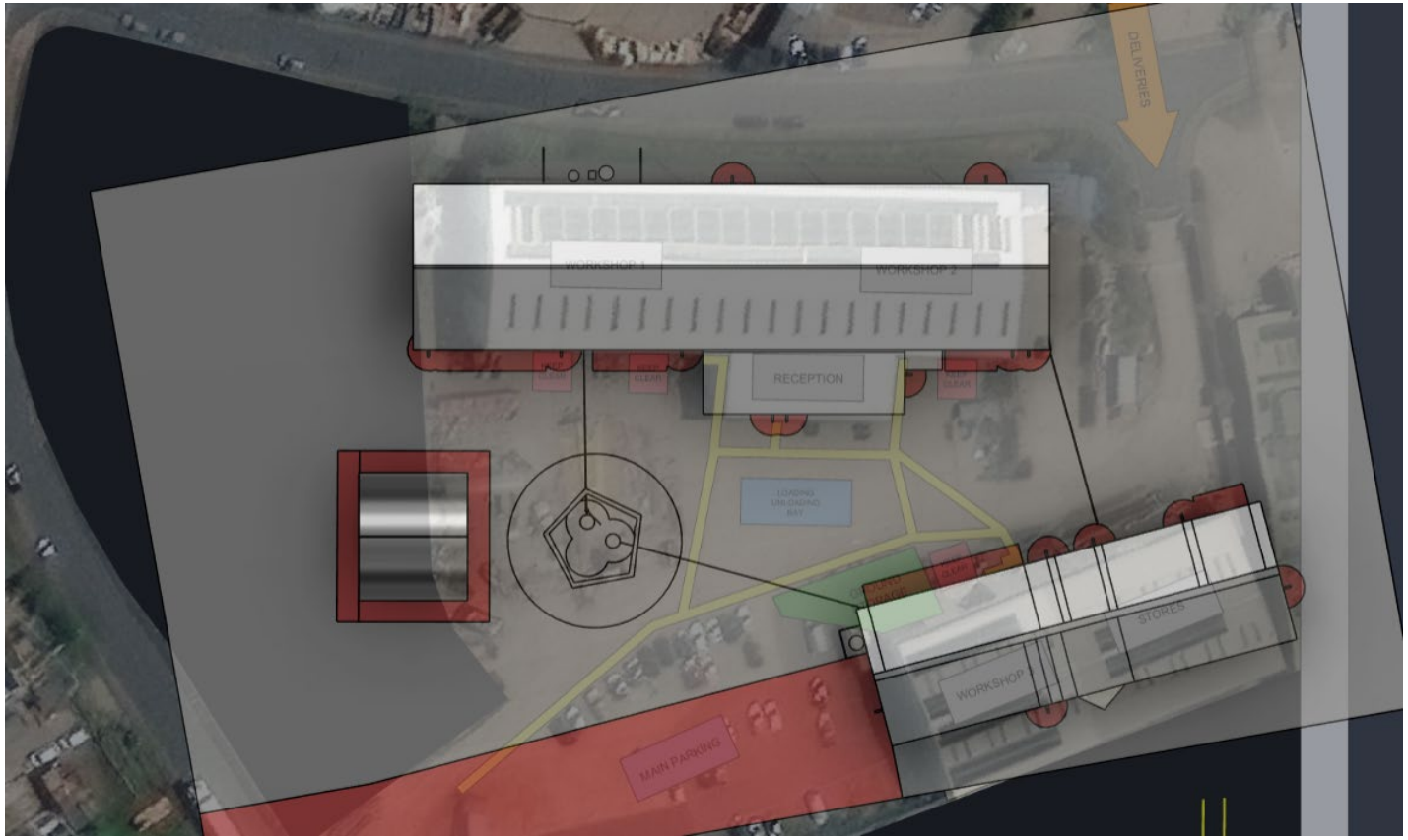
Allows for a minimized area for storage and reduction of clutter around the workshops

BUT the cryogenic tank are expensive to operate over long periods due to how they expel gas to relieve the pressure inside the tank causing loss or valuable gas and money

Design 1

The 1000L an 3000L argon and CO2 will be housed behind workshop 1 and the 1000L for workshop 3 will be housed by the side facing the car park

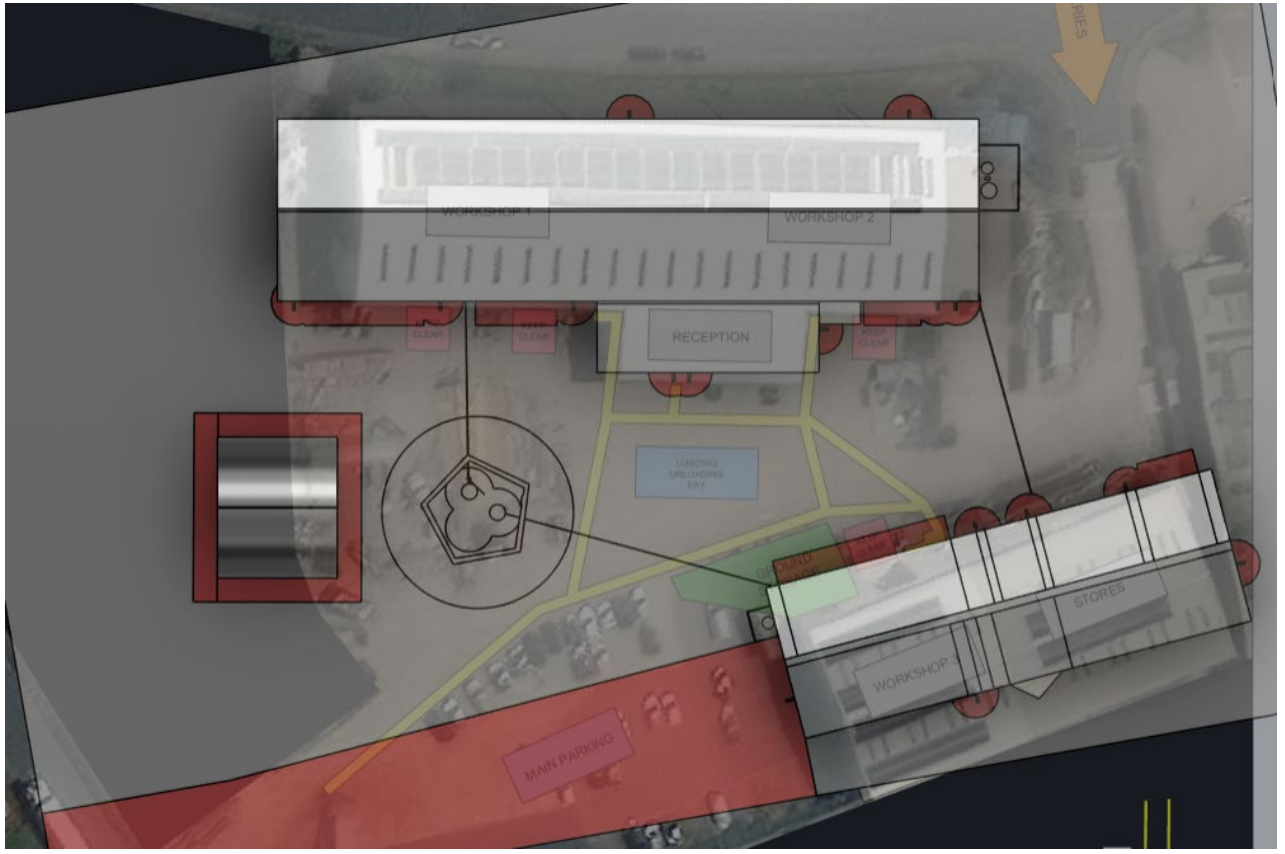
May have issues refuelling from public road due to parked cars
There will be 1.8 meter fencing 3M around the tanks and space for access to refill



Design 2

Design 2 keeps the position of the 1000L by workshop 3 but moves the 3000 and 1000L to the right side of workshop 2 where the containers are allowing for a easy refill

Car park will have to be modified to allow a 3m secluded area and refuelling



Cost comparison

Armulta spends £22,913.40 a year on gas excluding delivery at 2110 of liquid gas

The whole cryogenic system will cost £5,880 for 4000L of argon and 1000L of co2 (liquid)

Argon is £1.35 per L

Carbon dioxide is 42p per KG

Type of store	Litres of Liquid gas	fill cost
Cylinders	2110	£1909.45 per month
cryogenic system	5000	£5,880 per fill

Any Questions?