BIOGEN

Biogen Safe System of Work for Major AD Process Activities:

Decommissioning & Recommissioning an AD Process Tank

Contents:

SCOPE:

This document covers an anaerobic digestion process tank (AD Process Tank) containing a biogas atmosphere, that requires work being undertaken, such as:

- directly to the tank body, or on any attached port or branch prior to any robust isolation, such as repairs or improvement works, and/or
- internally, such as is inspections, repairs, improvement works, or tank clean outs (known as "De-Grits").

Starting Point: AD Process Tank online, operational with biologically active process material, and containing a biogas atmosphere.

Ending Point: AD Process Tank emptied, inspected (any planned works completed) and back online, again containing a biogas atmosphere connected to the site's gas balance system, following the complete decommissioning, and subsequent recommissioning of the AD Process Tank

KEY CRITERIA TO BE MET:

- After purging the tank with air, a methane in air concentration of 0.5% or less to be achieved on two consecutive hourly samples before any attempt to open the AD Process Tank manway.

- ATEX rated air movers with a minimum 4,000m^3/hr performance to be used.

- Successful leak test after closing the empty AD Process Tank will be a positive pressure of at least 5mbar after being left overnight at just below 25mbar (after re-seating the Pressure Relief Valve)

- When recommissioning the tank, and reintroducing biogas, two consecutive hourly readings of greater than 30% methane are required before the AD Process Tank can be re-opened to the site's Biogas Collection & Balance System.

Note on Biogen "De-Grit" Policy:

Grit formation within food waste AD process tanks is a slow sedimentation process that occurs naturally due to the presence within feedstock of components which are either non-organic or too dense and hard for effective breakdown by bacteria in any practical timeframe. Such items include bones, eggshells, nut shells, fruit stones, glass, metal, and stones, etc.

The sedimentation of grit within Digesters, is a very slow and gradual process, making it unlikely for pockets of organic material or biogas, to be trapped within the grit. Indeed, in all of Biogen's experience of de-gritting AD Process Tanks (20 Digesters de-gritted over 16 years) there has never been any pocket of undigested food waste or trapped biogas discovered. What we find is a dense, compact sediment of small, coarse particles, which, due to its coarseness and slow, gradual build-up if found to be stable with a high angle of repose.

The build-up of such material, commonly referred to as "grit", is tolerated until it begins to cause process difficulties, primarily in the form of increased wear and tear on pumps as the level of grit reaches the outlet ports feeding a particular pump. Potentially, the build-up of grit within a AD Process Tank could impact on its performance, by reducing its effective working volume, which would be detected by our regular monitoring of each Digester's biological health. However, in practice, the impact of grit on the process pumping systems triggers the need for a planned tank clean-out, or "de-grit", long before any adverse effect on AD Process Tank health.

This is to be expected, as the pumping systems, for example the heating, mixing and discharge duties, have their input lines taken from the lower 25% of a AD Process Tank's height to make the equipment and its isolation valves accessible to the operating teams.

As these early signs of the impending need for a de-grit can be seen before significant process impact occurs, we can safely plan these de-grit activities up to a year ahead.

Therefore, from experience, when we carry out de-grits the process tanks range from 20% to 35% full of sedimented grit.

Is there no effective alternative to de-gritting AD Process Tanks?

Biogen continues to look for technologies which can help improve our process, and in particular help with, reduce or eliminate the need for these major, disruptive AD Process Tank "De-Grit" activities. Despite numerous trials with equipment to avoid tank entries, or to remove the grit form the process to avoid the need for de-grits, none have been successful, as most originate from the water industry, where:

- The % dry mater of the process material is SIGNIFICANTLY lower than in food waste AD, making settling, filtering easier to encourage and achieve in the water industry.

The technologies require very large quantities of water to remove the grit. These quantities of water are small compared to the daily throughput of a water treatment facility, but on a food waste AD site, where all contaminated water must be retained within our process, this is impractical.

Some of the technologies we have investigated include:

Sedimentation Removal Pre-Digesters:
Various technologies have been tried to encourage grit removal before entering the process tanks. Many of these coming from the water sewage industry. However, because of the high % dry matter in the raw food waste (typically 15% to 35%) compared to water sewage works (around 5% dry matter) the process material has the consistency of a thick sludge.
This high % dry matter, and thick sludge consistency makes sedimentation difficult and much too slow compared to the realistic retention time achieved in "pre-AD Process Tank" process stage.
It is not until the process material reaches the AD Process Tanks, with typical average retention times in the order of 30 days or more, there is sufficient time for some of these non-digestible components to slowly settle over time.
Furthermore, as the food waste is broken down and digested, the average % dry matter within the AD Process Tanks becomes low enough to encourage sedimentation.

Continuous In-line Grit Removal from the AD Process Tanks:
Similar to the above, the % dry matter within the AD Process Tanks results in a material difficult to filter.
However, the main barrier to filtering, centrifuging, etc., is the removal of as yet undigested food waste along with the desired "grit".
This results in removing the very material we are trying to digest and convert to biogas along with the "grit" or contaminants, resulting in a thick sludge of undigested gritty food waste that would have to be disposed of at landfill – the very thing that the food waste AD is trying to avoid, i.e. the disposal of food waste to landfill and the release of greenhouse gases to the atmosphere.
The classification of this material as Category 3 Animal By-Product (ABP) also prohibits this under the ABP Regulations

However, we continue to look for new methods and technologies which may help in the future.

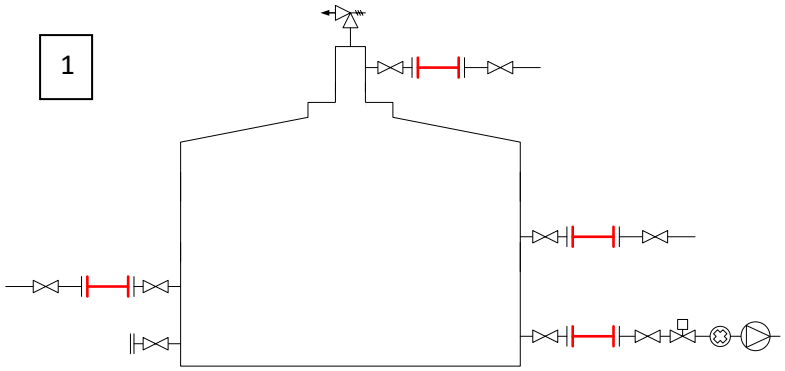
Over the 16 or so years of experience operating food waste AD plants, Biogen's typical need for a de-grit of a AD Process Tank ranges from every 4 to 7 years, typically 5 to 6 years. This period depends mainly on the type and quality of feedstock the site receives, the amount and effectiveness of mixing within the AD Process Tank, and the shape of the AD Process Tank (e.g., it's width and height). However, from experience, it is the feedstock which has the most impact.

The following is a break down, step-by-step, of how these major works are managed, the hazards involved and the controls to safely address these.

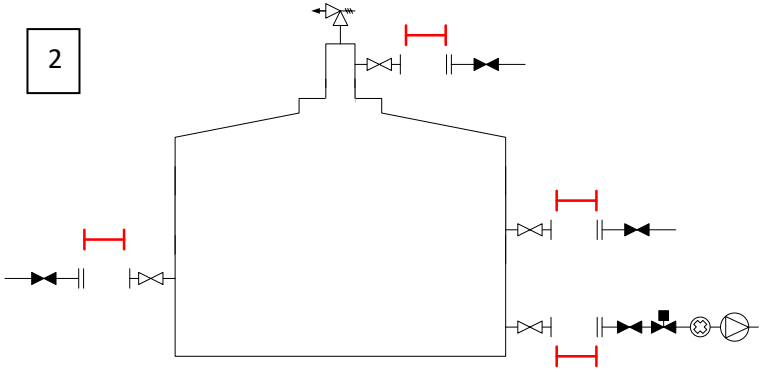
Note, though reference may be made in specific steps, this document does not attempt to address all general safety at work, such as basic PPE (anti-static safety boots & workwear, safety helmets, eye protection, hi-vis clothing), induction of contractors, etc. as these are dealt with via Standard Operating Procedures and the Permit to Work suite issued in association with these works. This document focuses on the particular hazards posed by the activity of decommissioning and recommissioning an AD Process Tank.

Biogen Standard of Full Tank Isolation

(Sometimes referred to as a “halo isolation”, referencing the imaginary hoop which should be able pass around the entirety of the tank, without hindrance of any pipework or service still attached to the rest of the site)



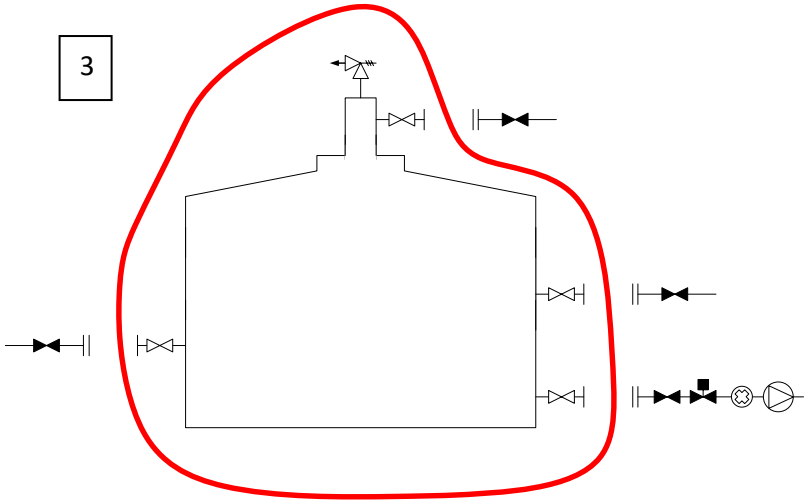
Process tanks fitted with “removable spool piece” (shown in red) between two manual valves, normally between the two valves closest to the tank



During the tank isolation, the two manual valves are closed, allowing the spool piece to be unbolted and removed.

Once removed, the closed manual valve on the “LIVE” side, i.e., connected to the rest of the site, remains closed and has a blanking plate attached.

The manual valve connected to the tank can, as appropriate, be opened to allow the tank to be drained, or purged or vented.



As the diagram to the left shows, with the “removable spool pieces” removed, an imaginary hoop can pass around the entire tank, unhindered.

This ensures the tank is FULLY isolated and disconnected from the rest of the process, which continues to operate.

Summary of potential sources of DSEAR explosive atmospheres on Biogen AD Sites:

Note, **methane**, **hydrogen sulphide** and **ammonia** are the relevant gases for AD Process Tank decommissioning, de-grits, and subsequent recommissioning.

Substance	Key Hazard	Flammable Range (LEL – UEL % in Air)	Flash Point	Boiling Point	Vapour pressures kPa	Relative density to Air @ 20°C	Auto Ignition Temp.	Gas Group	T Class	Quantity	Comment
Methane	H220: Extremely flammable gas	4.4 – 17%	N/A	-161.5°C	N/A	0.6	595°C	IIA	T1	Main component of biogas, may be present throughout AD process plant	CAS 74-82-8 MIE 0.29mJ UN 1972 ADR 2.1 Packing Group -
Hydrogen Sulphide	H220: Extremely flammable gas H330: Fatal if inhaled	4.3 – 45.5%	N/A	-60.2°C	20°C – 1819 30°C – 2310 50°C – 3650	1.19	270°C	IIB	T3	Appx 1,000 - 5,000ppm of biogas composition ex warm digester	CAS 7783-06-4 MIE 0.068mJ UN 1053 ADR 2.3 / 2.1 Packing Group -
LPG / Propane	H220: Extremely Flammable gas	1.7 – 10.9%	-104°C	-42°C	20°C – 832.7 30°C – 1080 50°C – 1708	1.55	470°C	IIA	T1	27 and 47kg cylinders stored externally and used for maintenance activities, and flare ignition	CAS 74-98-6, MIE 0.24mJ UN 1978 ADR 2.1 Packing Group -
Iso-Butane	H220: Extremely Flammable gas	1.5 – 9.4%	-83°C	-11.7°C	20°C – 301.9 30°C – 410 50°C – 677.8	2.07	460°C	IIA	T1	500g each, several canisters internally	CAS 75-28-5 MIE 0.25mJ UN 1969 ADR 2.1 Packing Group -
Ammonia	H221: Flammable gas H331: Toxic if inhaled	14 – 32.5%	N/A	-33.4°C	20°C – 857 30°C – 1170 50°C – 2030	0.6	630°C	IIA	T1	Evolved in low ppm during waste separation	CAS 7664-41-7 MIE 680mJ UN 1005 ADR 2.3 Packing Group -

Exposure Limits for personnel, and the "5-Gas" monitor alarm triggers:

Gas Type	Workplace Exposure Limit, WEL 8-hour TWA	Short Term Exposure Limit, STEL 15-minute TWA	Biogen "5-Gas" Monitors		Further Information
			"Low Warning"	"High Alert"	
Hydrogen Sulphide	5 ppm	10 ppm	5 ppm	10 ppm	Biogen "Hydrogen Sulphide Awareness Procedure" & "Toolbox Talk – Hydrogen Sulphide"
Ammonia	25 ppm	35 ppm	25 ppm	35 ppm	Biogen "Ammonia Awareness Procedure"
Carbon Monoxide	20 ppm	100 ppm	20 ppm	100 ppm	
Methane			10% LEL	20% LEL	
Oxygen (low)			19.5%	18.0%	
Oxygen (high)			23.5%	25.0%	

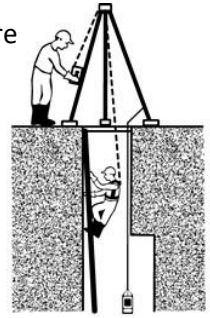
See also training package for "Powered Air Purifying Respirator Training".

Biogen Forced Air RPE units which are ATEX rated provide APF 20, while non-ATEX units can provide APF 40, utilising A2B2E2K1HgP R Filters (Organic gases and vapours (BP>65°C), inorganic, acid gases, ammonia, mercury vapour and particulates).

Levels of Confined Space Entry into AD Process Tanks:

NC2 - Confined space entry through the AD Process Tank's purpose-built access manway, with continuous ventilation and atmosphere gas monitoring, is deemed an NC2, medium Risk Confined Space Entry:

NC2

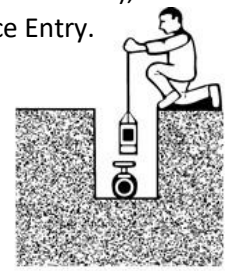


- Medium Risk Confined Space
  A medium risk confined space exists where there are access issues; a realistic expectation of encountering a specific risk; possible introduction of specified risks during the work activity.

- NC2 Classification
  - Vertical direct unobstructed access with continuous attachment to a man riding hoist or similar mechanical rescue device.
  - Escape Set (Self Rescue) breathing apparatus required to be taken into medium risk

NC1 - If side panels can be safely removed from the AD Process Tank (after consultation and confirmation from an AD Tank supplier and installer), then with continuous ventilation and atmosphere gas monitoring, the confined space entry is deemed an NC1 Low Risk Confined Space Entry.

NC1

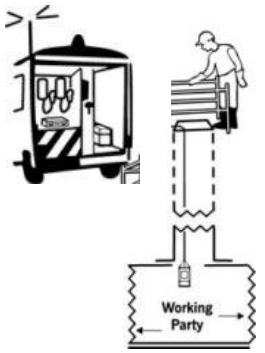


- Low Risk Confined Space
  A low risk confined space exists where there is easy entry/exit and natural ventilation.

- NC1 Classification
  - Low risk shallow entry with adequate natural or mechanical ventilation,
  - Where access is simple and unobstructed, and
  - There is no likely risk of flooding.

Note: Biogen AD Process Tank Confined Space Entry is managed so that it does **NOT** reach NC3 entry standard:

NC3



- When it is not possible to have persons permanently attached to a safety line.
- Usually, it will be a team entry which moves away from the entry point.
  E.g.: Man entry sewers, utility service subway tunnels, aqueducts, and complex wet walls.
- Working without an attached rescue line and includes working away from the point of entry.
- Escape Set (Self Rescue) breathing apparatus required to be taken into medium risk

METHODOLOGY – Biogen Safe System of Work for Decommissioning, "De-Grit" & Subsequent Recommissioning of an Anaerobic AD Process Tank

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
1	AD Process Tank online undergoing routine operations	Generation of biogas (at a typical 57% methane content, potentially ranging from 40% to 65%)	PLC & SCADA process monitoring & alarms to limit any potential loss of containment. Overpressure relief valves – venting any released biogas in a controlled manner to a safe place. DSEAR Hazardous Area Zoning & controls. DSEAR risk assessment & controls. ATEX rated equipment installed with inspection carried out by CompEx Ex01-Ex04 qualified person.	1	3	3	

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
2	**DECISION MADE TO DECOMMISSION THE AD PROCESS TANK**	Presence of biogas in an online AD Tank Will the Major Works trigger a CDM F10 notification to the HSE? Environment and ABPR issues – odour, safe and compliant disposal of the grit. Selection & Management of Contractors	Control of Change to be raised for the temporary decommissioning of the tank, considering implications of the overall site AD process, and other process tanks, the Gasholder, CHP(s), and Surplus Gas Flare. Separate forms raised for any engineering modifications which are planned. No decommissioning to start until the Control of Change is fully authorised. Will the major works last longer than 30 working days AND have more than 20 workers working at the same time at any point on the project? Or exceed 500 person days? Assessment to be made by the Head of Central Operations and the Operations Director. Environment Agency to be notified by the Biogen Compliance Team that a AD Process Tank decommissioning and de-grit is planned, plus any key local stakeholders as appropriate. Off-site odour checks to be considered. Safe & compliant disposal site & hauliers to be identified and booked by the Compliance & Commercial Teams, with both haulier and disposal site correctly permitted to receive and carry EWC 19 02 03 waste & hold ABPR licence. Head of Central Operations to check availability and agree dates of expected de-grit operation with key industrial cleaning contractor, from experience these are predominantly “Clearwater”, plus “GEWS” in North Wales and “Millers” in Southeast England. Request full RAMS, plus evidence of their team’s competence and qualifications, in particular Confined Space Entry, and associated equipment.	1	1	1	Adjacent AD Process Tanks can continue to operate, with monitoring of the biological health of the remaining AD Process Tank(s) to determine the appropriate throughput. CDM: Major works such as a AD Process Tank De-grit have never yet triggered CDM. To date there has never been 20 or more workers on site at one time. The trigger to consider is the 500 person days. However, all previous undertakings have fallen short, with the closest tasks reaching just short of 350 days (major improvement works planned with the empty AD Process Tanks). First choice contractor is Clearwater Industrial Services are the main contractor used, based upon many years’ experience with Biogen. However, we continue to assess other potential contractors.

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
3	**REDUCE THE LEVEL WITHIN THE AD PROCESS TANK :** **For Pasteurisers (and their Buffer or Dump Tanks)** they are emptied by their normal BATCH process, down to the grit level. **Skip to Step 6.** **Raw Waste Buffer Tanks** (RWBT) are not refilled and their contents are fed to Digesters as normal until they are empty and the grit level is reached. The AD process can continue by by-passing the RWBT and feeding Digesters directly from the "Front-End Processing", and this methodology & safe system of work is covered in dedicated documentation. Once the grit level is reached, **skip to Step 6**. **For DIGESTERS:** Lower the working level within the Digester down to the grit level by increased transfer out of the tank, via its routine discharge line to the pasteurisation process. (Note: Feeding of the Digester, at the reduced rates, can continue as required, until its level reaches down to 70%.) Progress overseen by the Head of Central Operations and the Operations Director, but this activity is under the control of the Site Management. Continue to Step 4.	Generation of biogas (at a typical 57% methane content, potentially ranging from 40% to 65%) Removal of active Digester material, generating biogas and containing food waste pathogens such as e-coli and salmonella.	PLC & SCADA process monitoring & alarms to limit any potential loss of containment. Overpressure relief valves – venting any released biogas in a controlled manner to a safe place. DSEAR Hazardous Area Zoning & controls. DSEAR risk assessment & controls. ATEX rated equipment installed. For Digesters, continue to undergo the routine Pasteurisation Process. However, we are now increasing the frequency of pasteurisation batches to begin lowering the level of material within the Digester. The pasteurisation process is a batch process within the Pasteurisation System and involves raising the temperature of the process material to 70 degree C and holding it for at least 60 minutes at 70°C or higher. This is sufficient to remove the food waste pathogens, as required by the Animal By-Products Regulations. We believe these temperatures may also impact on the bacteria required for anaerobic digestion, with the potential, therefore, to restrict the amount of anaerobic digestion beyond this stage. However, this is not yet known for certain, and further research is being undertaken to better understand how the AD bacteria are impacted by our pasteurisation process. Digester biology monitoring continues to avoid overfeeding Management of these activities to continue within standard Operations forums, in particular the Weekly Operations Meetings (chaired by Operations Director), Operations Projects Meetings (chaired by Head of Central Operations).	1	3	3	AD Digesters routinely operate between 85% and 95% full. RWBT routinely operate anywhere from empty to 85%, as they act as a buffer. Pasteurisers, and their Buffer or Dump Tanks operate batch process and a routinely filled and emptied in cycles. All routine process controls remain in place. DSEAR zoning controls remain active. PLC & SCADA process control and monitoring in place. Note that AD Process Tank feeding will be reduced to 50% of normal and can continue, as required, until the AD Process Tank level lowers to 70% full.

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
4	**For DIGESTERS:** **STOP FEEDING THE DIGESTER:** Once the Digester level has been taken down to 70% (or earlier, as appropriate – A Site, Central Operations Team, and Operations Director decision) the feeding of the AD Process Tank, or Digester, is to be stopped. IMPORTANT - Other AD process activities remain ongoing in the Digester, such as Digester temperature control (maintaining an operating temperature between the optimal 37°C to 41°C for the anaerobic digestion bacteria), while the next step (#5) will take the liquid, or sludge, level of the Digester down as low as possible through the standard Digester Discharge route through the Pasteurisation Process (Step 5). From this point on, leadership of the task falls under the Head of Central Operations or his nominated Deputy. Default responsibility lies with the Operations Director.	Routine AD process hazards: Generation of biogas (at a typical 57% methane content, potentially ranging from 40% to 65%) Removal of active Digester material, generating biogas and containing food waste pathogens such as e-coli and salmonella	PLC & SCADA process monitoring & alarms to limit any potential loss of containment. Overpressure relief valves – venting any released biogas in a controlled manner to a safe place. DSEAR Hazardous Area Zoning & controls. DSEAR risk assessment & controls. ATEX rated equipment installed. Continue to undergo the routine Pasteurisation Process. However, we are now increasing the frequency of pasteurisation batches to begin lowering the level of material within the Digester. The pasteurisation process is a batch process within the Pasteurisation System and involves raising the temperature of the process material in batches to 70 degree C and holding it for at least 60 minutes at 70°C or higher. This is sufficient to eliminate pathogens within the food waste, as required by the Animal By-Products Regulations. These temperatures will also kill all bacteria required for anaerobic digestion, thereby making the process material inactive, or inert. This the standard process for "Post-Pasteurisation AD", as employed by Biogen. Management of these activities to continue within standard Operations forums, in particular the Weekly Operations Meetings (chaired by Operations Director), Operations Projects Meetings (chaired by Head of Central Operations).	1	3	3	This process continues until no more process material can be removed from the Digester via this route. Note, as the level lowers towards the grit level, it may prove difficult to keep the Digester on temperature is the grit repeatedly blocks or damages the circulation pump feeding the External Heat Exchanger System. For as long as possible we continue to keep the Digester contents at optimum temperature for anaerobic digestion (37°C to 41°C) to continue breaking down food waste. This will continue until we reach down to the grit level and/or grit is pulled through into the Heating Circulation System. If the tank has internal heating coils these will remain operational until the emptying of the Digester reaches the grit level.

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
5	**For DIGESTERS: EMPTYING FREE MOVING AD PROCESS TANK MATERIAL (SLUDGE) FROM THE AD PROCESS TANK:** To lower the Digester level from 70% down to the grit level in the base of the tank via by increased levels of Pasteurisation batches will take anywhere from 1 to 2 weeks, sometimes longer depending, on other site activities. With feeding of the Digester stopped in Step 4, at 70% level or earlier, biogas generation will diminish. The optimum anaerobic digestion process temperature, between 37°C to 41°C, is to be maintained as normal, until the heating system struggles as the grit level is approached. Maintaining the optimum conditions while emptying the Digester will allow the AD bacteria to function effectively for full digestion of feedstock and conversion to biogas. Normally a 2 weeks or more process. The Head of Central Operations, or his nominated deputy, controls this step. Default responsibility lies with the Operations Director.	Routine AD process hazards: Generation of biogas (at a typical 57% methane content, potentially ranging from 40% to 65%) Removal of active Digester material, generating biogas and containing food waste pathogens such as e-coli and salmonella.	PLC & SCADA process monitoring & alarms to limit any potential loss of containment. Overpressure relief valves – venting any released biogas in a controlled manner to a safe place. DSEAR Hazardous Area Zoning & controls. DSEAR risk assessment & controls. ATEX rated equipment installed. Experience of the AD Process: • Within 2 hours of stopping the feed into an active Digester the biogas generation will begin to fall. • Within a further 6 hours biogas generation will have fallen to less than 50%. • Within a further 6 hours biogas generation will have fallen to less than 25%. • Within 24 hours of stopping the feed into a Digester, the biogas generation will have fallen to less than 15% • Within 48 hours of stopping the feed into a Digester, the biogas generation will have fallen to less than 10% • Before 7 days has been reached since stopping the feeding of the Digester, biogas generation will have fallen to less than 5% HOWEVER, this does **NOT** eliminate the risk. AD activity will have greatly diminished, but biogas generation is still capable of continuing. Therefore, further controls and safety precautions, for example regarding Confined Space Entry and control of Hot Works, MUST be followed to manage the hazard. Management of these activities to continue within standard Operations forums, in particular the Weekly Operations Meetings (chaired by Operations Director), Operations Projects Meetings (chaired by Head of Central Operations).	1	3	3	Note, the process of lowering the tank contents through the Pasteuriser normally takes 2 weeks. Therefore without feeding the Digester with fresh feedstock during this period, and maintaining optimum anaerobic digestion conditions, the bacteria will have had time to break down the organics within the Digester (as temperature control and mixing continues), with biogas production diminished to well below 5%. But NOT eliminated.

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
6	**REACHING THE GRIT LEVEL:** Raw Waste Buffer Tanks - stop their normal operation of feeding Digesters once they reach their grit level. Pasteurisers (and their Buffer and Dump Tanks) are emptied as per their batch cycle and taken down to their grit level. Digesters stop being emptied via the Pasteurisation process once the grit level is reached and stop maintaining the contents temperature. Reaching the grit level is determined by blockages of the outlet line and pump with grit. The Head of Central Operations, or his nominated deputy, controls this step. Default responsibility lies with the Operations Director.	Although biogas generation will be minimal, the AD Process Tank still contains a biogas atmosphere above the grit level, and is still connected to all routine process lines, including the biogas collection/balance system.	PLC & SCADA process monitoring & alarms to limit any potential loss of containment. Overpressure relief valves – venting any released biogas in a controlled manner to a safe place. DSEAR Hazardous Area Zoning & controls. DSEAR risk assessment & controls. ATEX rated equipment installed. Manually isolate and lock off hot water supply to the external Heat Exchanger(s) or Internal Heating Coil(s) as appropriate. Management of these activities to continue within standard Operations forums, in particular the Weekly Operations Meetings (chaired by Operations Director), Operations Projects Meetings (chaired by Head of Central Operations). From this point, in addition to the above management methods, the Central Operations Team will begin to attend site and hold regular daily meetings to : - review related accidents, incidents or near misses - review progress, - review and discuss the next steps.	1	3	3	

7	**ISOLATE THE AD PROCESS TANK FROM THE REST OF THE AD PROCESS:** Isolate the following services: • AD Process Tank Feed Line • AD Process Tank Discharge Line • AD Process Tank Heating Circulation System • Hydraulic Mixing System Secure isolation to be achieved by: • Closing, then chaining and locking manual valves, and • Removing the air supply from automated valves (where present) • Locking of the power supply to the associated pump. Controlled and documented under the safe isolation system. The Head of Central Operations, or his nominated deputy, controls this step. Default responsibility lies with the Operations Director.	The AD Process Tank will still contain a biogas atmosphere (at a typical 57% methane content, potentially ranging from 40% to 65%). Adjacent AD tanks still online and operational, therefore potential risk of biogas release from them in the event of a process abnormality	PLC & SCADA process monitoring & alarms to limit any potential loss of containment. Overpressure relief valves – venting any released biogas in a controlled manner to a safe place. DSEAR Hazardous Area Zoning & controls. ATEX rated equipment installed. Isolate all services by closing, chaining, and locking (as per the Biogen Isolation Lock-Out Procedure) the two manual valves closest to the tank and then removing the Removable Spool Piece pipework from between the two closed valves. If an Automated Valve is in the process line, then the air is to be disconnected, causing the air-fail-closed spring-loaded valve to close as an additional precaution. All process services are to be isolated in this way, including: • AD Process Tank Feed Line & Discharge Lines • AD Process Tank Heating Circulation System • Hydraulic Mixing System (if present) All work in zoned areas to use non-sparking tools. The Central Operations Team leading the work must liaise with the Site Manager to survey the entire AD Process Tank to determine whether any other services specific to the tank are present. If so, then they must be isolated as above. The keys are to be secured in a lock off box with two locks, one for the permit issuer and one for the permit holder so that neither can remove an isolation without the others permission, as per the Lock off Procedure. Management of these activities to continue within standard Operations forums, PLUS On-Site Daily Central Operations Team Meetings.	1	3	3	The purpose of these isolations is to begin the process of physically isolating the entire process tank from the rest of the still operational site. By physically disconnecting all services, by dropping out a removable spool piece between two closed and locked valves we aim to create an isolated tank, physically disconnected from the rest of the site's AD process, around which, an imaginary hoop could be passed entirely around the tank. Within Biogen this is sometimes referred to as a "Halo Isolation". **HOWEVER, NOT UNTIL THE COMPLETION OF STEP 9 IS THIS FULLY ACHEIVED.**

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
8	**<u>ELECTRICAL ISOLATION OF THE AD PROCESS TANK:</u>** To remove potential sources of ignition, ALL electrical equipment and instruments attached to the AD Process Tank to be isolated with all power supplies disconnected in the ground level Control Panel local to the AD Process Tank. • AD Process Tank High Level switch x2 (located on the tank roof) • AD Process Tank Radar Level measurement (located on the tank roof) • AD Process Tank Pressure Transducer level measurement (located at the tank base) • AD Process Tank Temperature Measurement Probes: (Located in the side of the tank and/or in the Heating Circulation System). The Head of Central Operations, or his nominated deputy, controls this step. Default responsibility lies with the Operations Director.	The AD Process Tank will still contain a biogas atmosphere (at a typical 57% methane content, potentially ranging from 40% to 65%). Adjacent AD tanks still online and operational, therefore potential risk of biogas release from them in the event of a process abnormality	PLC & SCADA process monitoring & alarms to limit any potential loss of containment. Applicable to the other AD process tanks once the electrical isolations made to the tank being decommissioned. Overpressure relief valves – venting any released biogas in a controlled manner to a safe place. DSEAR Hazardous Area Zoning & controls. DSEAR risk assessment & controls. ATEX rated equipment installed. Working at Height Permit to be issued. This work to be carried out by a trained person (CompEx Ex01-Ex04 or equivalent), who must also check that their ATEX integrity has not been compromised and is still sound. Power supply to be removed in the ground level Control Panels. Work to be carried out with a “G7” personal gas monitor, continuously monitoring as detailed earlier, in particular alarming at 10% of methane’s LEL, with work to cease and the area vacated on the sounding of ANY alarm. Daily On-Site Meetings to manage these activities, with higher level management via Weekly Operations Meetings and Operations Projects Meetings.	1	4	4	

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	

9	**ISOLATE THE AD PROCESS TANK FROM THE SITE'S GAS BALANCE / COLLECTION SYSTEM:**
	
	Isolate the AD Process Tank from the site's Biogas Collection & Balance System
	
	• A member of the Central Operations Team, wearing RPE, to close the two manual valves, closest to the AD Process Tank, on the AD Process Tank's individual Biogas Outlet Line.
	
	• Once both manual valves are locked closed, the purpose made "removable spool piece" between the two closed manual valves can be unbolted with NON-SPARKING tools and removed.
	
	• The exposed faces of the two closed manual valves must then have a blanking plate bolted in position, using NON-SPARKING tools.
	
	The Head of Central Operations, or his nominated deputy, controls this step.
	
	Default responsibility lies with the Operations Director.
		The AD Process Tank will still contain a biogas atmosphere (at a typical 57% methane content, potentially ranging from 40% to 65%).
		
		Adjacent AD tanks still online and operational, therefore potential risk of biogas release from them in the event of a process abnormality
			PLC & SCADA process monitoring & alarms (of other AD process tanks) to limit any potential loss of containment.
			Overpressure relief valves – venting any released biogas in a controlled manner to a safe place.
			DSEAR Hazardous Area Zoning & controls.
			DSEAR risk assessment & controls.
			ATEX rated equipment installed.
			
			Working at Height Permit to be issued.
			
			The AD Process Tank's connection to the site's Biogas Collection & Balance System must be isolated in the same way, with two closed and locked manual gas isolation valves, with the removable spool piece in between dropped out.
			
			Suitable forced air RPE to be worn, with fresh filter cartridges installed each day during the de-grit.
			
			All staff are to wear a G7 personal gas detection device
			
			All work in zoned areas to use non-sparking tools.
			
			All work to stop and the area vacated on sounding of any alarm or at Site Management's request.
			
			Daily On-Site Meetings to manage these activities, with higher level management via Weekly Operations Meetings and Operations Projects Meetings.
				1	4	4	Completion of this step provides a AD Process Tank fully and physically isolated from the rest of the AD process with:
							
							• All piped services physically disconnected from the AD Process Tank by means of removed spool pieces, giving a physical break within the AD Process Tank's:
							  • Gas Collection / Gas Balance pipework
							  • Feed & Discharge lines
							  • Heating & Circulation
							  • Hydraulic Mixing
							
							• The simple guide for this standard of isolation is to consider an imaginary hoop, and being able to pass this completely around the AD Process Tank.
							This is often referred to as a "Halo Isolation".
							
							• In addition, the power supply has been securely isolated from all electrical items and equipment attached to the AD Process Tank.

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
10	**INITIAL VENTING OF THE AD PROCESS TANK TO ATMOSPHERE** Once step 7, 8 AND 9 have been completed (removing power supply from all electrical equipment on the tank and isolating the process tank's connection to the sites Biogas Collection & Balance System), the tank needs to be vented to atmosphere as follows: • Wearing forced air RPE, remove the dome and the weights (for setting the activation pressure of the relief valve) from the tank's Pressure Relief Valve to allow any pressure within the tank to escape though the relief valve. • With the open Pressure Relief Valve having released any built-up biogas pressure in the AD Process Tank, the Central Operations Team, wearing forced air RPE, must then open the "Liquid Relief" lid (or hydraulic release flap) on the top of the tank and leave wide open to fully open the tank to atmosphere. The Head of Central Operations, or his nominated deputy, controls this step. Default responsibility lies with the Operations Director.	The process tank still contains biogas (at a typical 57% methane content, potentially ranging from 40% to 65%). Adjacent AD tanks still online and operational, therefore potential risk of biogas release from them in the event of a process abnormality	PLC & SCADA process monitoring & alarms (of other AD process tanks) to limit any potential loss of containment. Overpressure relief valves – venting any released biogas in a controlled manner to a safe place. DSEAR Hazardous Area Zoning & controls & ATEX rated equipment installed. The DSEAR calculations show the limit of a release from a process tanks' pressure relief valve while under normal operation. However, in this situation the resulting zone is reduced as the tank is no longer under normal operating conditions, as: • The main body of active AD Process Tank material has been removed from the tank • No further feeding of food waste is taking place • AD Tank disconnected from the rest of the site process. Working at Height Permit to be issued to Central Operations; roof access with forced air RPE (fresh filter cartridges installed each day during the de-grit) and G7 personal gas monitors, using non-sparking tools. If there is any wind present on the top of the tank while undertaking these tasks, then those undertaking the task are to stand upwind of the pressure relief valve (PRV). Once any pressure escaping through the PRV has diminished the Central Operations Team, still wearing forced air RPE can fully open the hydraulic relief flap valve, as the PRV will have released any pressure within the tank. Daily On-Site Meetings to manage these activities.	1	4	4	Gas generation from the AD Process Tank will now be minimal, because: • Free moving process material has been removed from the AD Process Tank • Therefore, its volume of potentially active material is minimal. • However, in addition, the temperature of any remaining material will have fallen below the conditions required for viable biological activity Normal air movements and convections currents will allow a slow rate of venting and dilution.

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
11	**CONTINUED VENTING OF THE AD PROCESS TANK TO ATMOSPHERE** The AD Process Tank, with its pressure relief valve opened and hydraulic release flap/lid fully open, must be left to vent naturally to atmosphere for AT LEAST 24 hours. The Head of Central Operations, or his nominated deputy, controls this step. Default responsibility lies with the Operations Director.	Extreme care is required as the tank internal atmosphere will pass through the upper explosive limit (UEL) of 17%, and the lower explosive limit (LEL) of 5% in air. Adjacent AD tanks still online and operational, therefore potential risk of biogas release from them in the event of a process abnormality	Within the tank there are no sources of ignition. Electrical power isolated from AD Process Tank equipment. Access to AD Process Tank roof & the open hydraulic release flap and pressure relief valve is prevented by access-preventing plates locked on to the cat ladder(s) (with a site process isolation lock and a Central Operations Team lock) to the process tank being decommissioned, and any adjacent process tank which allows access via high level walkway. DSEAR zoning (based upon the release of biogas through either the Pressure Relief Valve or Hydraulic Release Flap while the tank is fully operational generating biogas) DSEAR risk assessment & controls; ATEX rated equipment on adjacent process tanks Power supply to all electrical equipment on the tank being vented to atmosphere has been removed. AD Process Tank roof access prevented by Biogen standard access ladder barrier, secured by both Central Operations Team Site isolation padlocks. Allowing the tank to vent naturally, avoids suddenly forcing out the biogas within the tank into the atmosphere, but rather allows natural air movement to work for at least 24 hours to steadily dissipate and dilute the biogas. Daily On-Site Meetings to manage these activities, with higher level management via Weekly Operations Meetings and Operations Projects Meetings.	1	4	4	Gas generation from the AD Process Tank will now be minimal, though not eliminated, because: • Free moving process material has been removed from the AD Process Tank • Therefore, its volume of potentially active material is minimal. • However, in addition, the temperature of any remaining material will have fallen below the conditions required for viable biological activity Normal air movements and convections currents will allow a slow rate of venting and dilution. Note, only restricted ventilation is possible at this stage.

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
12 Part 1 of 2	**PURGING FRESH AIR THROUGH THE AD PROCESS TANK GAS SPACE:** After AT LEAST 24 hours of natural ventilation, test the atmosphere within the AD Process Tank, wearing Forced Air RPE via the 1" port under the PRV, and if the % methane level has reached 5% or less, then an ATEX rated Forced Air Mover is to be secured over the open Hydraulic Release port, so that it draws fresh air from outside into the AD Process Tank to ensure the tank atmosphere is taken down to 0.5% or less. If the atmosphere is still above 5%, then allow the tank to naturally vent for a few more hours and test again, repeating until <5% is achieved. An ATEX forced air mover, with a minimum capacity of 4,000 m^3/hr is to be used. The target concentration to be achieved, once the ATEX Forced Air Mover is deployed, is 0.5% methane or less on two consecutive hourly samples, before progressing further. Part 2 continued on next page...	Extreme care is required as the tank internal atmosphere will pass through first the Upper Explosive Limit (UEL) for methane of 17% in air, and then through the Lower Explosive Limit (LEL) for methane in air of 5%. Potential hazard raising the forced air mover up to the top of the AD Process Tank. Adjacent AD tanks still online and operational, therefore potential risk of biogas release from them in the event of a process abnormality. Continued...	PLC & SCADA process monitoring & alarms (of other AD process tanks) to limit any potential loss of containment. Overpressure relief valves – venting any released biogas in a controlled manner to a safe place. DSEAR Hazardous Area Zoning & controls. ATEX rated equipment installed. With power supply to all electrical equipment attached to the Tank removed, there are no sources of ignition. Access to the Tank roof & open hydraulic release flap and pressure relief valve is prevented by access-preventing plates locked on to the cat ladder(s) (with a site process isolation lock and a Central Operations Team lock) to the process tank being decommissioned, and any adjacent process tank which allows access via high level walkway. Working at Height Permit to be issued, requiring forced air RPE (fresh filter cartridges installed each day during the de-grit) and G7 personal gas monitor. Specific Permit to Work with a Working at Heights supporting permit required to address the safe lifting operation of the ATEX Air Mover up to the Tank roof using approved & inspected lifting equipment, undertaken by a trained "slinger" (Central Operations Team). Access to the tank roof prevented by the Biogen standard access ladder barrier, onto which the Central Operations Team also place an isolation padlock in addition to the Site's isolation padlock. Continued...	1	4	4	Note: From experience decommissioning over 20 AD Process Tanks it typically takes 24 to 36 hours to naturally vent down to ,5% methane in the upper portion of the AD Process Tank. With the ATEX Air Mover installed, it typically takes another 24 to 36 hours to achieve less than 1% methane within the tank, and a total of 36 to 48 hours with the Forced Air Mover to achieve less than 0.5% methane within the AD Process Tank's atmosphere. Note 1: An ATEX forced air mover, with minimum 4,000 m^3/hr capacity to be used. Note 2: In Step 10 the internals of the Pressure Relief Valve have been removed, leaving a full bore, unrestricted 6" pipe to allow the incoming air from the Forced Air Mover to safely escape the AD Process Tank. Continued...

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
12 Part 2 of 2	Continued... Measurement of the methane content of the atmosphere within the AD Process Tank to be taken from the 1" sample port underneath the Pressure Relief Valve using a Geotech Portable Gas Analyser. The Head of Central Operations, or his nominated deputy, controls this step. Default responsibility lies with the Operations Director.		Continued... The Central Operations Team will periodically monitor the atmosphere within the process tank, at around 2-hour intervals, using a Geotech Portable Gas Analyser and a 1" sample port underneath the Pressure Relief Valve, and wearing forced air RPE throughout. The Geotech Portable Gas Analyser will have been calibrated by the Biogen Research Team beforehand. Daily On-Site Meetings (chaired by Head of Central Operations) to manage these activities, in particular to: - review related accidents, incidents or near misses - review progress, - review and discuss the next steps. - review and obstacles or deviations from the plan. Regular higher-level management continues via Weekly Operations Meetings (chaired by Operations Director) and Operations Projects Meetings will continue to monitor and review. .				Continued... Note 3: Although larger Forced Air Movers are available, from experience they become more difficult to manoeuvre & secure in place on top of the tank, plus the 4,000 m3/hr units have proved to more than capable in purging AD Process Tanks. Note 4: There is still restricted ventilation at this stage. With a single air mover working at the top of the tank, its impact will be restricted towards the base of the tank. In addition, "heavier than air" biogas may increase the presence of methane towards the lower reaches of the tank.

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
13	**REMOVING FURTHER PROCESS LIQUID (OR SLUDGE)** The time spent purging can allow the settling of remaining free material, or process "liquid" or sludge. Once < 0.5% methane in the Tank's air space achieved on two consecutive hourly samples, further attempts can be made to drain off any remaining process liquid or sludge, within the tank. This is achieved by carefully opening the various isolated ports around the tank (these are the manual valves remaining attached to the tank ports, after dropping out all the removable spool pieces in Step 7. This may be achieved by directly connecting a Vacuum Tanker or a pump to the port, or by constructing a mini-bund under the port to drain any process material into while a vacuum tanker is present to collect any material that drains into the mini-bund. This process is continued around as many of the ports in the bottom third or quarter of the tank to drain any free-flowing process material from the tank. Head of Central Operations, or deputy, controls this step. Default responsibility with Operations Director.	Potential release of process material from the ports as they are opened, potentially releasing some amount of biogas, containing methane, hydrogen sulphide or ammonia. Adjacent AD tanks still online and operational, therefore potential risk of biogas release from them in the event of a process abnormality	ATEX rated forced air mover, with a minimum capacity of 4,000 m^3/hr, installed on the open "liquid relief" port on the Tank roof, continuously blowing fresh air into the tank. Central Operations Team carries out this step, wearing forced air RPE, with methane, hydrogen sulphide & ammonia filter. Selected industrial cleaning contractor now on site with Vacuum Tank and/or DISAB unit, etc, after Biogen approval of their submitted RAMS and evidence of competence. Upon the release of a significant amount of process liquid More than the minibund could hold), then the manual valve will be closed, and a Vacuum tanker, present throughout this step, to immediately collect any released material (for safe return to the AD process). "G7" personal gas monitors to be worn, for methane, hydrogen sulphide, ammonia, & carbon monoxide. Access to the area around the Process Tank to be cordoned off and under the control of the Central Operations Team. From experience, there is a very strong probability that at this stage any remaining process material is below 30°C, i.e., below required condition for anaerobic digestion bacteria to be active. Furthermore, due to the purging of air through the Tank, the material exposed to air is now aerobic. However, though the risk is small, precautions and controls remain to manage the presence of any biogas. Daily On-Site Meetings, led by Head of Central Operations to manage these activities.	1	3	3	The temperature of any remaining material will have fallen below the conditions required for viable biological activity, plus the atmosphere inside the AD Process Tank is now aerobic. The sedimentation process is slow and gradual, making it unlikely for pockets of organic material or biogas, to be trapped within the grit. NOTE – Up until this stage, all activities have been carried out by Biogen personnel. From step 13 through to Step 24 the selected "industrial cleaning" contractor is also involved and managed by the Head of Central Operations or his nominated deputy.

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
14	**OPENING THE TANK MANWAY** **RECHECK OF THE ATMOSPHERE WITHIN THE AD PROCESS TANK** Once no more free flowing process material or sludge can be removed from the Tank's ports, then the Central Operations Team can begin to prepare for the careful and controlled opening of the Tank manway door. NOTE - If the tank has two manways, then the UPPER one must be attempted first, as this doorway will be closer to the top of the residual grit sediment, if not already above. The first step is to retest the atmosphere within the air purged atmosphere, as detailed earlier, to ensure the air space remains at 0.5% methane or less. If not, continue purging with fresh air & retest every 2 hours. With the tank air space at <0.5% methane the ATEX rated forced air mover on the AD Process Tank's open hydraulic release port must have its direction **REVERSED**, so that it now pulls the atmosphere out of the tank. Head of Central Operations, or deputy, controls this step. Default responsibility with Operations Director.	Adjacent AD tanks still online and operational, therefore potential risk of biogas release from them in the event of a process abnormality. Working at height activity	An ATEX rated forced air mover, with a minimum capacity of 4,000 m^3/hr, installed on the open "liquid relief" port on the AD Process Tank roof, running day & night. Central Operations Team to carry out this step, wearing forced air RPE, with methane, hydrogen sulphide and ammonia filters (fresh filter cartridges installed each day during the de-grit). Personal "G7" Gas Monitors, calibrated for methane, hydrogen sulphide, ammonia, and carbon monoxide, to be worn. Working at Height Permit to be issued for Central Operations to sample the AD Process Tank atmosphere through the 1" port on the roof, requiring forced-air RPE and G7. Access to the area around the Process Tank to be cordoned off and under the control of the Central Operations Team. Daily On-Site Meetings to manage these activities, with Biogen and Contractor staff present, with higher level management via Weekly Operations Meetings and Operations Projects Meetings overseeing progress.	1	4	4	Note: Where a tank is fitted with two manways, one above the other, then it is always the UPPER door that is used first. The temperature of any remaining material will have fallen below the conditions required for viable biological activity, plus the atmosphere inside the AD Process Tank is now aerobic. The sedimentation process is slow and gradual, making it unlikely for pockets of organic material or biogas, to be trapped within the grit. Note, there is still restricted ventilation at this stage. With a single air mover working at the top of the tank, its impact will be restricted towards the base of the tank. In addition, "heavier than air" biogas may increase the presence of methane towards the lower reaches of the tank.

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
15	**PREPARING THE MANWAY FOR OPENING** One of the site's "Telehandler" units, or equivalent, to be positioned facing the manway with its hydraulic arm positioned a few inches away from the manway door. At least two of the retaining bolts on the access manway door are replaced with long threaded bolts, secured tight in place. (These will be used to slowly and carefully control the gradual opening of the door). Once done, the remaining bolts can be removed, with the door held by nuts on the long, threaded bolts. If not already present from Step 13, a large minibund to be constructed under and around the manway area. An EMPTY Vacuum Tanker to be positioned in a safe, non-DSEAR zoned area, with the open end of a connected flexible hose positioned within the minibund under the manway door. The vacuum tanker to be running and pulling through the hose in readiness. The Head of Central Operations, or his nominated deputy, controls this step. Default responsibility lies with the Operations Director.	Adjacent AD tanks still online and operational, therefore potential risk of biogas release from them in the event of a process abnormality. Movement of vehicles adjacent to pedestrian workforce. Potential sources of static charge from Telehandler, Vacuum Tanker & hose, and workwear.	An ATEX rated forced air mover, with a minimum capacity of 4,000 m^3/hr, installed on the open "liquid relief" port on the AD Process Tank roof, running day & night, pulling from the AD Process Tank. Routine use of personal G7 gas monitors in the AD process area. Access to work area around the AD Process Tank cordoned off and controlled by the Central Operations De-Grit Team. Banksman to assist the Telehandler driver manoeuvring safely into position. Telehandler to be temporarily earthed to nearest Site earthing point, in case of static charge from electrics. Vacuum tanker to be situated as far from the AD Process Tank as practical for safe operation. Vacuum tanker and hose to be earthed to nearest site earthing point. G-clamps to be on hand to assist with any temporary holding closed of the manway door if necessary. Routine, anti-static safety footwear & workwear to be worn. De-Grit team to be made aware of the access & egress routes of the bund, and ensure a clear path is maintained. Daily On-Site Meetings to manage these activities, with Biogen and Contractor staff present, with higher level management via Weekly Operations Meetings and Operations Projects Meetings overseeing progress & issues.	1	4	4	Note, there is still restricted ventilation at this stage. With a single air mover working at the top of the tank, its impact will be restricted towards the base of the tank. In addition, "heavier than air" biogas may increase the presence of methane towards the lower reaches of the tank.

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
16	**BEGIN THE SLOW & CONTROLLED OPENING OF THE MANWAY DOOR** A member of the Central Operations Team wears a harness and an attached lifeline under the control of another member of the "De-Grit" Team. The harnessed member of the team, wearing forced air RPE steps to the side of the manway door, to begin very slowly releasing the manway door, by: • Carefully wind the retaining nuts back along the long thread bolts, to slowly, and in a controlled manner, open the manway door in small increments. • Pause & assess after each inch of opening. • Note the hydraulic arm of the adjacent Telehandler to be positioned within inches of the manway door to restrict any sudden opening. If it is deemed there is no safe method of accessing the door to close it, then the AD Process Tank is to be left draining into the site's purpose made concrete bund and the area evacuated. The Head of Central Operations, or his nominated deputy, controls this step. Default responsibility lies with the Operations Director.	From experience the grit built up inside the AD Process Tank is stable. However, this cannot be guaranteed until its stability is directly seen and evaluated. Until the manway is opened fully, there remains uncertainty as to the presence of any free-flowing liquid or sludge still held within the tank. There is, therefore, the risk of a sudden release of material when opening the manway door. Potentially free-flowing sludge, or grit, and/or a release of trapped biogas Potential sources of static charge from Telehandler, Vacuum Tanker & hose, and workwear.	ATEX rated forced air mover, with a minimum capacity of 4,000 m^3/hr, installed on the open "liquid relief" port pulling out of the AD Process Tank, running day & night. Personal "G7" Gas Monitors, for methane, hydrogen sulphide, ammonia, and carbon monoxide, to be worn. Team member turning the nuts on the threaded bolts to be wearing: • Forced air RPE (fresh filter cartridges installed each day during the de-grit) • Harness, with a lifeline attached a hoist located on the "hinge" side of the manway door, under the control of at least two other members of the team acting as "Standby" • Standby Person or persons, also wearing forced air RPE. An EMPTY Vacuum Tanker to be positioned in a safe area, with the open end of a connected flexible hose positioned within the minibund under the manway door. Tanker to be running and pulling through the hose in readiness. Telehandler (Central Operations Team driver) positioned in advance, with its hydraulic arm within a few inches of the manway door, to restrict any sudden opening in the unlikely event of ALL the bolts in the manway door failing. Telehandler, Vacuum Tanker & hose, earthed to nearest Site earthing point; anti-static safety footwear & workwear. Access to work area around the AD Process Tank cordoned off and controlled by the Central Operations De-Grit Team. Bund exit routes understood and clear. Daily On-Site Meetings to manage these activities.	2	3	6	Where a tank is fitted with two manways, one above the other, then it is always the UPPER door that is used first. The temperature of any remaining material will have fallen below the conditions required for viable biological activity. Along with an aerobic atmosphere, this will restrict AD activity within the tank. The sedimentation process is slow & gradual, making it unlikely for pockets of biogas, or organic material, to be trapped within the grit. Risks remain, hence the controls need to be in place. At this stage the tank still has restricted ventilation from a single air mover on the roof. Covered in detail in the Permit to Work, workwear, disposable overalls, and safety gloves required to avoid contact with AD process material and grit. See COSHH assessment.

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
17	**CONTROLLED OPENING OF THE AD PROCESS TANK MANWAY DOOR** Gradually open the manway door along the long bolts. If material is released, either grit and or process liquid or sludge, NO FURTHER OPENING is carried out until the vacuum tanker on hand has cleared the released material from the minibund, AND the release of material from the tank stops. SHOULD the flow of material out of the partly opened manway become too much for the vacuum tanker to cope with, the manway door is to be closed, preferably by retightening the nuts along the long bolts, or, if not possible to do safely, or if the door needs to be closed quickly, the Telehandler on hand is to carefully and slowly push the door closed, directed by a second team member who has good vision of the manway and the team, assisting the driver. If the harnessed team member controlling the door opening is unable to move out of the way, the Standby Person or Persons are to immediately remove him from the area using the attached lifeline. Head of Central Operations, or deputy, controls this step. Default responsibility with Operations Director.	Although from experience the grit built up inside the tank is quite stable, there is uncertainty regarding its stability (until it can be directly seen and evaluated). Also, until the manway is opened fully, there remains uncertainty as to the presence of any free-flowing liquid or sludge still held within the tank. There is, therefore, the risk of a sudden release of material when opening the manway door.	ATEX rated forced air mover, with a minimum capacity of 4,000 m^3/hr, installed on the open "liquid relief" port pulling out of the AD Process Tank, running day & night. Team member turning the nuts on the threaded bolts to be wearing: • Forced air RPE (fresh filter cartridges installed each day during the de-grit) • Harness with a lifeline attached, under the control of at least one other member of the team acting as Standby. • Standby Person or persons, also wearing forced air RPE. Vacuum Tanker to be positioned in a safe area and left running, with the open end of a connected flexible hose positioned within the minibund under the manway door. Telehandler positioned in advance, with its hydraulic arm within a few inches of the manway door, to restrict any sudden opening in the unlikely event of ALL the bolts in the manway door failing, and in readiness to assist closing the door if required to. If it is deemed there is no safe method of accessing the door to close it, then the AD Process Tank is to be left draining into the site's purpose made concrete bund and the area evacuated Access to work area around the AD Process Tank cordoned off and controlled by the Central Operations De-Grit Team. Daily On-Site Meetings to manage these activities, with Biogen and Contractor staff present, with higher level management via Weekly Operations Meetings and Operations Projects Meetings overseeing progress & issues.	2	3	6	The temperature of any remaining material will have fallen below the conditions required for viable biological activity, plus the atmosphere inside the AD Process Tank is now aerobic. The sedimentation process is slow and gradual, making it unlikely for pockets of organic material or biogas, to be trapped within the grit. At this stage the tank still has restricted ventilation from a single air mover on the roof. Risks remain, hence the controls need to be in place. Covered in detail in the Permit to Work, workwear, disposable overalls, and safety gloves required to avoid contact with AD process material and grit. See COSHH assessment.

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
18	**FULLY OPENING THE MANWAY DOOR** Diligently follow Step 17, and "inch" the manway door open when any flow of material from the widening opening stops. By following Step 17, once the manway door has been fully opened with no further release of material from within the tank, then the Central Operations Team can ensure any remaining closed valves on the AD Process Tank ports are now opened to increase the number of entry points for fresh air to be pulled into the AD Process Tank by the ATEX rated forced air mover on the open port at the top of the tank. The Central Operations "De-Grit" team will then assess the nature and volume of the grit build up they can see. Step 19 NOTE: While within this step, if at the end of the working day the manway door has not yet been fully opened, then the door is to be reclosed and bolted to make safe. **RETURNING TO STEP 16 EACH TIME WORK RECOMMENCES** The Head of Central Operations, or his nominated deputy, controls this step. Default responsibility lies with the Operations Director.	Although from experience the grit built up inside the tank is quite stable, there is uncertainty regarding its stability (until it can be directly seen and evaluated). Potential sources of static charge from Telehandler, Vacuum Tanker & hose, and workwear.	An ATEX rated forced air mover, with a minimum capacity of 4,000 m^3/hr, installed on the open "liquid relief" port on the AD Process Tank roof, running day & night, pulling from the AD Process Tank. With no heat supply to maintain temperature for several days, and an air-based atmosphere, the material remaining in the tank will have cooled below the temperature required for anaerobic bacteria to function, plus all surfaces exposed to air will now be aerobic. This is a visual assessment, made externally, of the grit inside the AD Process Tank, its height and stability. Manway door to be reclosed and bolted whenever the area is vacated, e.g., at the end of a working day. Access to work area around the AD Process Tank cordoned off and controlled by the Central Operations De-Grit Team. Telehandler, Vacuum Tanker & hose, to be earthed to nearest Site earthing point, and anti-static safety footwear & workwear to be worn. Daily On-Site Meetings to manage these activities, with Biogen and Contractor staff present, with higher level management via Weekly Operations Meetings and Operations Projects Meetings overseeing progress & issues.	1	3	3	The Central Operations Team make a **continual, ongoing assessment of the grit** sediment, how it stacks, its stability, **throughout** the de-grit operation. The temperature of any remaining material will have fallen below the conditions required for viable biological activity & the atmosphere inside the AD Process Tank is now aerobic. The sedimentation process is slow & gradual, making it unlikely a pocket of biogas, or organic material , to be trapped within the grit. However, this is not taken for granted, hence the controls in place. These statements are based on our experience from 20 previous AD Process Tank de-grits, though we need to gather documented evidence to back this. We will record all future monitoring results going forward.

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
19	**ASSESS THE TANK AND THE NEXT STEP:** • GRIT LEVEL ABOVE THE OPEN MANWAY: After opening the AD Process Tank, if the level of grit is ABOVE the open manway door, then the first step is, by means of a vacuum tanker operated fully from outside the tank (and using a jet wash if necessary to free the compacted grit) to clear the area immediately behind the open manway, and then clear a route up through the grit adjacent to the manway until the full height of the grit can be determined. • GRIT LEVEL NOT HIGHER THAN THE OPEN MANWAY: If the level of grit is NOT higher than the open manway and allows the full extent of the grit sediment within the tank to be seen, then the first step is to clear the area behind the manway with the vacuum tanker (and jet wash). **IMPORTANT - NO ENTRY ALLOWED INTO THE AD PROCESS TANK AT THIS STAGE** The Head of Central Operations, or his nominated deputy, controls this step. Default responsibility lies with the Operations Director.	Although from experience the grit built up inside the tank is quite stable, there is uncertainty regarding its stability (until it can be directly seen and evaluated).	An ATEX rated forced air mover, with a minimum capacity of 4,000 m^3/hr, installed on the open "liquid relief" port on the AD Process Tank roof, running day & night, pulling from the AD Process Tank. With no heat supply to maintain temperature, and an air-based atmosphere, the material remaining in the tank is aerobic and too cool to sustain anaerobic digestion. This is a visual assessment, made externally, of the grit inside the AD Process Tank, its height and stability. Manway door to be reclosed and bolted whenever the area is vacated, e.g., at the end of a working day. Access to work area around the AD Process Tank cordoned off and controlled by the Central Operations De-Grit Team. Daily On-Site Meetings to manage these activities, with Biogen and Contractor staff present, with higher level management via Weekly Operations Meetings and Operations Projects Meetings overseeing progress & issues.	1	3	3	IMPORTANT – The Central Operations Team make a **continual, ongoing assessment of the grit** sediment, how it stacks, its stability, its wetness/dryness, **throughout** the de-grit operation. Covered in detail in the Permit to Work, workwear, disposable overalls, and safety gloves required to avoid contact with AD process material and grit. See COSHH assessment. Until a clear route exists for fresh air to be pulled through the open manway, via a clear route through the grit to the Air Mover on the AD Process Tank roof, there still remains restricted ventilation within the AD Process Tank, with the risk of "heavier than air" biogas at the base of the AD Process Tank.

Step	Action	Hazard	Control	Residual Risk			Comments
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20	**CLEARING THE GRIT SEDIMENT FROM BEHIND THE MANWAY TO ASSESS AND PLAN FOR SAFE CONFINED SPACE ENTRY** Once the height of the grit within the tank has been determined, then the next step is to clear as far into the tank as possible, down to the tank floor using a vacuum tanker and jet wash, working from the open manway – i.e., OUTSIDE the AD Process Tank. If the tank has a lower manway, then this can also be fully opened at this stage to assist in the process. **STILL NO ENTRY ALLOWED INTO THE TANK** **ASSESSMENT OF THE GRIT** Assessment of the stability of the grit sediment prior to entry to be made by the experienced Central Operations "De-Grit team"; is it free flowing, or compacted, and how high is the sediment. If the height & instability of the sediment is a concern, then the de-grit continues from **OUTSIDE** of the tank using vacuum tanker hose extension and jet washer. Head of Central Operations, or deputy, controls this step. Default responsibility with Operations Director.	Although from experience the grit built up inside the tank is quite stable, there is uncertainty regarding its stability (until it can be directly seen and evaluated). Potential sources of static charge from Telehandler, Vacuum Tanker & hose, and workwear.	An ATEX rated forced air mover, with a minimum capacity of 4,000 m^3/hr, installed on the open "liquid relief" port on the AD Process Tank roof, running day & night, pulling from the AD Process Tank. With no heat supply to maintain temperature, and an air-based atmosphere, the material remaining in the tank is aerobic and too cool to sustain anaerobic digestion. This is a visual assessment, made externally, of the grit inside the AD Process Tank, its height and stability. Manway door to be reclosed and bolted whenever the area is vacated, e.g., at the end of a working day. Access to work area around the AD Process Tank cordoned off and controlled by the Central Operations De-Grit Team. Telehandler, Vacuum Tanker & hose, to be earthed to nearest Site earthing point, and anti-static safety footwear & workwear to be worn. Daily On-Site Meetings to manage these activities, with Biogen and Contractor staff present, with higher level management via Weekly Operations Meetings and Operations Projects Meetings overseeing progress & issues. Note, at this point grit is very wet after use of a jet wash to guide the grit into the vacuum tanker, and so is offloaded in a dedicated bay within the Reception Hall for free liquor to drain (back into the AD process).	1	3	3	IMPORTANT – The Central Operations Team make a **continual, ongoing assessment of the grit** sediment, how it stacks, its stability, its wetness/dryness, **throughout** the de-grit operation. The temperature of any remaining material will have fallen below the conditions required for viable biological activity, plus the atmosphere inside the AD Process Tank is now aerobic. The sedimentation process is slow and gradual, making it unlikely for pockets of organic material or biogas, to be trapped within the grit. However, this is not taken for granted, hence the controls in place.

Step	Action	Hazard	Control	Residual Risk			Comments
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21 **Part** **1 of 2** Cont...	**CONFINED SPACE ENTRY INTO THE AD PROCESS TANK:** Once the stability of the grit sediment allows safe entry into the tank, then this is to be carried, and managed under an NC2 category Confined Space Entry Permit. Entry made by personnel wearing air line fed, full breathing apparatus, wearing harness and lifeline. In addition to the vacuum tank hose position close to the edge of the grit sediment, for the removal of grit, a SECOND vacuum hose to be in place and available for a quick connection outside of the tank to the Vacuum Tanker, for removal of any material which slips down to where the operator(s) inside the tank is(are) working. (Note a second vacuum hose is used, as the first and main hose may be deep in the tank, and difficult to reposition closer to the manway if required.) Grit is removed from the AD Process Tank by shovelling and/or jet washing the grit to the open end of the vacuum tanker's pipe. Continued...	Although from experience the grit built up inside the tank is quite stable, this cannot be guaranteed (requiring regular checks and reassessment) However, there remains a potential hazard from: • Methane • Hydrogen Sulphide • Ammonia • Movement of the grit sediment	ATEX rated forced air mover, with 4,000 m^3/hr minimum capacity, installed on the open "liquid relief" port on the AD Process Tank roof, pulling fresh air through continuously. Where possible, smaller ATEX rated Air Movers will be put in place over accessible open ports at the base of the tank, to provide additional introduction of fresh air, and increased air movement within the tank. NC2 confined space entry: • Breathing Apparatus fed via an air line to be worn, • Harness and lifeline to be worn • A second vacuum hose to be in place and available for a quick connection outside of the tank to the Vacuum Tanker, for removal of any material which slips down to where the operator inside the tank is working. (Note a second vacuum hose is used, as the first and main hose may be deep in the tank, and difficult to reposition closer to the manway if required. • All team trained in Confined Space Entry (NC1 & 2) • Continual assessment and monitoring of the confined space entry conditions, such as methane, oxygen, hydrogen sulphide, ammonia, carbon monoxide in the air, the temperature, and the stability and nature of the grit. • Confined Space "Top Man" and "Runner" to be in attendance throughout the Confined Space Entry. • If either of these have to leave for any reason then the Confined Space Entry must stop, and the AD Process Tank evacuated immediately. • All team wearing personal gas monitors Continued...	2	3	6	IMPORTANT – The Central Operations Team make a **continual, ongoing assessment of the grit** sediment, how it stacks, its stability, its wet/dryness, **throughout** the de-grit. The operator inside the tank manoeuvres the vacuum tanker hose as little as possible and uses jet-wash or shovel to bring the grit to the hose. Covered in detail in the Permit to Work, workwear, disposable overalls, and safety gloves required to avoid contact with AD process material and grit. See COSHH assessment. Continued...

Step	Action	Hazard	Control	Residual Risk			Comments
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21 **Part** **2 of 2**	Continued... The Head of Central Operations, or his nominated deputy, controls this step. Default responsibility lies with the Operations Director.	Potential sources of static charge from Telehandler, Vacuum Tanker & hose, and workwear. Haulage and disposal of unpasteurised, ex-AD Process Tank grit.	Continued... Rotate the workforce inside the Process Tank as appropriate Manway door to be reclosed and bolted whenever the area is vacated, e.g., at the end of a working day. Access to work area around the AD Process Tank cordoned off and controlled by the Central Operations De-Grit Team. Although wearing air line Breathing Apparatus, the confined space is to be immediately evacuated on the sounding of methane alarms, with the ATEX air mover left running, requiring the De-Grit team to stop and reassess. Telehandler, Vacuum Tanker & hose, to be earthed to nearest Site earthing point, and anti-static safety footwear & workwear to be worn. Fully compliant disposal of grit to an authorised and correctly permitted receiving site, controlled by Duty of Care documentation managed by the Biogen Compliance & Commercial Teams. A compliant disposal site & hauliers to be identified and booked by the Compliance & Commercial Teams, with both haulier and disposal site correctly permitted to receive and carry EWC 19 02 03 waste & hold ABPR licence. Daily On-Site Meetings to manage these activities, with Biogen and Contractor staff present, with higher level management via Weekly Operations Meetings and Operations Projects Meetings overseeing progress & issues.	2	3	6	Continued... The temperature of any remaining material will have fallen below the conditions required for viable biological activity, plus the atmosphere inside the AD Process Tank is now aerobic. The sedimentation process is slow and gradual, making it unlikely for pockets of organic material or biogas, to be trapped within the grit. However, this is not taken for granted, hence the controls in place.

Step	Action	Hazard	Control	Residual Risk			Comments
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22 **Part** **1 of 2**	**DE-GRIT USING MINI-EXCAVATOR - CONSIDERATION** If the AD Process Tank is designed to allow removal of the tank panels containing the manway(s), and immediately above and/or below, then, once a clear working space has been achieved behind the panels via the BA air-line method above, these tank wall panels can be removed. Once these panels are removed it allows a small digger/excavator and conveyor belt to enter the tank to complete the de-grit in a less labour-intensive manner. See Step 23. If panels **CANNOT** be removed from the tank, then the entire de-grit continues as above, under **NC2 Confined Space Entry** on air-line BA, harness, and lifeline, removing the grit by digging by hand or jet washing the grit towards the vacuum tanker pipe, moving to **STEP 24** when all the grit has been removed. Continued...	Although from experience the grit built up inside the tank is quite stable, this cannot be guaranteed (requiring regular checks and reassessment) Potential hazards from the de-grit process are: • Methane • Hydrogen Sulphide • Ammonia • Movement of the grit sediment Continued...	ATEX rated forced air mover, with 4,000 m^3/hr minimum capacity, installed on the open "liquid relief" port on the AD Process Tank roof, pulling fresh air through continuously. NC2 confined space entry: • Breathing Apparatus fed via an air line to be worn, • Harness and lifeline to be worn • A second vacuum hose to be in place and available for a quick connection outside of the tank to the Vacuum Tanker, for removal of any material which slips down to where the operator inside the tank is working. (Note a second vacuum hose is used, as the first and main hose may be deep in the tank, and difficult to reposition closer to the manway if required. • All team trained in Confined Space Entry (NC1 & 2) • Continual assessment and monitoring of the confined space entry conditions, such as methane, oxygen, hydrogen sulphide, ammonia, carbon monoxide in the air, the temperature, and the stability and nature of the grit. • Confined Space "Top Man" and "Runner" to be in attendance throughout the Confined Space Entry. • If either of these have to leave for any reason then the Confined Space Entry must stop, and the AD Process Tank evacuated immediately. • All team wearing personal gas monitors Rotate the workforce inside the Process Tank as appropriate Manway door to be reclosed and bolted whenever the area is vacated, e.g., at the end of a working day. Continued....	2	3	6	IMPORTANT – The Central Operations Team make a **continual, ongoing assessment of the grit** sediment, how it stacks, its stability, its wetness/dryness, **throughout** the de-grit operation. The operator inside the tank manoeuvres the vacuum tanker hose as little as possible and uses jet-wash or shovel to bring the grit to the hose. The temperature of any remaining material will have fallen below the conditions required for viable biological activity, plus the atmosphere inside the AD Process Tank is now aerobic. The sedimentation process is slow & gradual, making it unlikely for pockets of material or biogas, to be trapped within the grit. However, this is not taken for granted, hence the controls in place.

Step	Action	Hazard	Control	Residual Risk			Comments
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22 **Part** **2 of 2**	Continued... Head of Central Operations, or deputy, controls this step. Default responsibility with Operations Director.	Continued... Potential sources of static charge from Telehandler, Vacuum Tanker & hose, and workwear. Haulage and disposal of unpasteurised, ex-AD Process Tank grit.	Continued... Access to work area around the AD Process Tank cordoned off and controlled by the Central Operations De-Grit Team. Telehandler, Vacuum Tanker & hose, to be earthed to nearest Site earthing point, and anti-static safety footwear & workwear to be worn. A benefit of de-gritting the tank via excavator onto a conveyor belt, is that no jet wash water is required, therefore keeping the grit dry, and allowing it to be transferred directly into an approved HGV Bulker for transfer to the disposal site, rather than having to offload into the site's Reception Hall first to drain. Fully compliant disposal of grit to an authorised and correctly permitted receiving site, controlled by Duty of Care documentation managed by the Biogen Compliance & Commercial Teams. A compliant disposal site & hauliers to be identified and booked by the Compliance & Commercial Teams, with both haulier and disposal site correctly permitted to receive and carry EWC 19 02 03 waste & hold ABPR licence. Daily On-Site Meetings to manage these activities, with Biogen and Contractor staff present, with higher level management via Weekly Operations Meetings and Operations Projects Meetings overseeing progress & issues.	2	3	6	Continued... Covered in detail in the Permit to Work, workwear, disposable overalls, and safety gloves required to avoid contact with AD process material and grit. See COSHH assessment.

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
23 **Part** **1 of 2**	**REMOVAL OF TANK PANELS** Clear grit from inside of the manway panels De-grit activities are suspended, while up to two men enter the Confined Space under air line fed BA, with harness and lifeline to unfasten the bolts on the panels inside the tank to allow the safe removal. This may require Hot Work to remove the bolts, and would require atmosphere testing, personal gas monitors in place to detect methane, & authorisation of the Hot Work Permit by the Operations Director. Once the panels have been removed (enough to allow safe entry by the mini excavator and a conveyor belt) then a SECOND air mover is utilised, positioned by the large opening, pushing fresh air INTO the base of the tank, while the ATEX rated air mover continues to pull out of the roof. Once the panels are out and a second air blower is positioned by the opening, blowing fresh air into the AD Process Tank (while the original air blower on the AD Process Tank roof remains pulling air through the roof opening), then from this point, while the tank panels remain out, AD Process Tank entry is now managed by NC1 Confined Space Entry Permit, with RPE.	Although from experience the grit built up inside the tank is quite stable, this cannot be guaranteed (requiring regular checks and reassessment) Potential hazards from the de-grit process are: • Methane • Hydrogen Sulphide • Ammonia • Movement of the grit sediment Continued...	Confirmation from tanks supplier that the AD Process Tank can safely have these manway panels removed. Tank Security – once the work is ended for the day, access to the tank area is fenced off, and the excavator left blocking the hole in the tank, and with both air movers running continuously. ATEX rated forced air mover, with 4,000 m^3/hr minimum capacity, installed on the open “liquid relief” port on the AD Process Tank roof, pulling fresh air through continuously. NC2 confined space entry: • Breathing Apparatus fed via an air line to be worn, • Harness and lifeline to be worn • A second vacuum hose to be in place and available for a quick connection outside of the tank to the Vacuum Tanker, for removal of any material which slips down to where the operator inside the tank is working. (Note a second vacuum hose is used, as the first and main hose may be deep in the tank, and difficult to reposition closer to the manway if required. • All team trained in Confined Space Entry (NC1 & 2) • Continual assessment & monitoring of the confined space entry conditions, such as methane, oxygen, hydrogen sulphide, ammonia, carbon monoxide in the air, the temperature, and stability & nature of the grit. • Confined Space “Top Man” and “Runner” to be in attendance throughout the Confined Space Entry. If either of these have to leave for any reason then the Confined Space Entry must stop, and the AD Process Tank evacuated immediately. Continued...	2	3	6	IMPORTANT – The Central Operations Team make a **continual, ongoing assessment of the grit** sediment, how it stacks, its stability, its wetness/dryness, **throughout** the de-grit operation. The temperature of any remaining material will have fallen below the conditions required for viable biological activity, plus the atmosphere inside the AD Process Tank is now aerobic. The sedimentation process is slow and gradual, making it unlikely for pockets of organic material or biogas, to be trapped within the grit. However, this is not taken for granted, hence the controls in place.

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
23 Part 2 of 2	Continued... Head of Central Operations, or deputy, controls this step. Default responsibility with Operations Director.	Continued... Potential sources of static charge from Telehandler, Vacuum Tanker & hose, and workwear.	Continued... Although wearing air line Breathing Apparatus, the confined space is to be immediately evacuated on the sounding of methane alarms, with the ATEX air mover left running, requiring the De-Grit team to stop and reassess. Access to work area around the AD Process Tank cordoned off and controlled by the Central Operations De-Grit Team Telehandler, Vacuum Tanker & hose, to be earthed to nearest Site earthing point, and anti-static safety footwear & workwear to be worn. Daily On-Site Meetings to manage these activities, with Biogen and Contractor staff present, with higher level management via Weekly Operations Meetings and Operations Projects Meetings overseeing progress & issues.	2	3	6	Continued... Covered in detail in the Permit to Work, workwear, disposable overalls, and safety gloves required to avoid contact with AD process material and grit. See COSHH assessment.

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
24 Part 1 of 2	**AD PROCESS TANK DE-GRIT VIA REMOVED TANK WALL PANELS, USING EXCAVATOR & CONVEYOR BELT:** • Work inside the AD Process Tank can now be managed by NC1 Confined Space Entry Permit • Forced Air RPE (rather than full BA) • Personal Gas Monitors to be worn, and set to "RPE Mode", monitoring methane, ammonia, carbon monoxide (for excavator exhaust fumes) and H_2S. • No other personnel inside the AD Process Tank while the excavator in operation, loading grit onto the conveyor belt. • Conveyor belt removes grit from the AD Process Tank and loads into a dumper truck which only enters none-DSEAR Zones areas of the AD Bund. This may require additional conveyor belts to feed the dumper truck in a safe area. Once the de-grit is complete the mini-excavator and conveyor to be removed from the AD Process Tank. Continued...	Although from experience the grit built up inside the tank is quite stable, this cannot be guaranteed (requiring regular checks and reassessment) Potential hazards from the de-grit process are: • Methane • Hydrogen Sulphide • Ammonia • Movement of the grit sediment • Plus, carbon monoxide from the mini excavator. Continued...	Two ATEX rated forced air movers, with 4,000 m^3/hr minimum capacity running continuously. The original unit installed on the open "liquid relief" port on the AD Process Tank roof, pulling fresh air through continuously, with the second installed by the large opening created by the removed tank panels blowing fresh air inside the Tank.: NC1 confined space entry: • Forced air RPE to be worn (fresh filter cartridges installed each day during the de-grit), • Harness and lifeline to be worn • Personal Gas Monitors to be worn, and set to "RPE Mode", monitoring methane, ammonia, carbon monoxide (for excavator exhaust fumes), oxygen and hydrogen sulphide • All team trained in Confined Space Entry (NC1 & 2) • Continual assessment & monitoring of the confined space entry conditions, such as methane, oxygen, hydrogen sulphide, ammonia, carbon monoxide in the air, the temperature, and stability & nature of the grit. • Confined Space "Top Man" and "Runner" to be in attendance throughout the Confined Space Entry. • If either of these have to leave for any reason then the Confined Space Entry must stop, and the AD Process Tank evacuated immediately. • No other personnel allowed inside the AD Process Tank while the excavator is operating. Access around Tank and the conveyors cordoned off and controlled by the Central Operations De-Grit Team. Continued...	1	4	4	IMPORTANT – The Central Operations Team make a **continual, ongoing assessment of the grit** sediment, how it stacks, its stability, its wetness/dryness, **throughout** the de-grit operation. The temperature of any remaining material will have fallen below the conditions required for viable biological activity, plus the atmosphere inside the AD Process Tank is now aerobic. The sedimentation process is slow and gradual, making it unlikely for pockets of organic material or biogas, to be trapped within the grit. However, this is not taken for granted, hence the controls in place. Continued...

Step	Action	Hazard	Control	Residual Risk			Comments
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24 Part 2 of 2	Continued... Head of Central Operations, or deputy, controls this step. Default responsibility with Operations Director.	Continued... Potential sources of static charge from Telehandler, Vacuum Tanker & hose, and workwear. Haulage and disposal of unpasteurised, ex-AD Process Tank grit.	Continued... Confined space to be evacuated (with the ATEX Forced Air Movers left running) on sounding of any gas alarm Telehandler, Vacuum Tanker & hose, to be earthed to nearest Site earthing point, and anti-static safety footwear & workwear to be worn. A benefit of de-gritting the tank via excavator onto a conveyor belt, is that no jet wash water is required, therefore keeping the grit dry, and allowing it to be transferred directly into an approved HGV Bulker for transfer to the disposal site, rather than having to offload into the site's Reception Hall first to drain. Fully compliant disposal of grit to an authorised and correctly permitted receiving site, controlled by Duty of Care documentation managed by the Biogen Compliance & Commercial Teams. A compliant disposal site & hauliers to be identified and booked by the Compliance & Commercial Teams, with both haulier and disposal site correctly permitted to receive and carry EWC 19 02 03 waste & hold ABPR licence. Daily On-Site Meetings to manage these activities, with Biogen and Contractor staff present, with higher level management via Weekly Operations Meetings and Operations Projects Meetings overseeing progress & issues.	1	4	4	Continued... Covered in detail in the Permit to Work, workwear, disposable overalls, and safety gloves required to avoid contact with AD process material and grit. See COSHH assessment.

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
25	**DE-GRIT COMPLETE; AD PROCESS TANK EMPTY & AVAILABLE FOR OTHER WORKS:** Once the de-grit works are complete, with tank now clean and empty, further works can be carried out on the AD Process Tank, such as: • Internal tank inspection • planned maintenance • improvement modifications (via the Control of Change system) If tank panels have been removed, they will stay out for this step, allowing all such works to be controlled by NC1 Confined Space Entry Permits However, if panels have not been removed, and access/egress is via the AD Process Tank's manway, then all the above works will be managed by NC2 Confined Space Entry Permits. Throughout this time, air mover(s) will remain running, continuously, keeping fresh air moving through the tank. The Head of Central Operations, or his nominated deputy, controls this step. Default responsibility lies with the Operations Director.	Adjacent AD tanks still online and operational, therefore potential risk of biogas release from them in the event of a process abnormality. Additional Hazards introduced by further works, such as inspections, maintenance, and improvement projects.	Two ATEX rated forced air movers, with 4,000 m^3/hr minimum capacity running continuously. The original unit installed on the open "liquid relief" port on the AD Process Tank roof, pulling fresh air through continuously, with the second installed by the large opening created by the removed tank panels blowing fresh air inside the AD Process Tank. Gas test of atmosphere within the AD Process Tank must be carried out prior to each proposed works, as required by the Confined Space Entry Permit, safeguarding against any other incident on site allowing flammable or harmful gasses to be pulled into the AD Process Tank from incidents elsewhere on site. Entry via the AD Process Tank's manway is NC2 Entry via the Tank's removed panel opening is NC1 Access to work area around the AD Process Tank cordoned off and controlled by the Central Operations De-Grit Team Full tank isolation remains in place. Control of Change to be raised and approved before any tank modifications can take place. All works covered by their own Permit to Work, Confined Space Entry Permit, and relevant supporting permits. Daily On-Site Meetings to manage these activities, with Biogen and Contractor staff present, with higher level management via Weekly Operations Meetings and Operations Projects Meetings overseeing progress & issues.	1	2	2	Note, specific hazards and controls for individual tasks carried out on or within the AD Process Tank to be managed via their own specific Permit to Work, supporting permits and RAMS.

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
26	**RECOMMISSIONING OF THE AD PROCESS TANK:** Once all works on the AD Process Tank are complete, and the tank has been inspected, checked, and confirmed empty, the tank can be "closed up", and prepared for recommissioning. If entry has only been through a manway, then this can be simply closed externally, resealed, and bolted. If entry had been through the removed panels, then these must be replaced and inspected by a competent AD tank construction contractor (such as Reliant), with the entry controlled by an NC2 Confined Space Entry as those inside the tank will be exiting via the reinstalled manway(s). The Head of Central Operations, or his nominated deputy, controls this step. Default responsibility lies with the Operations Director.	Adjacent AD tanks still online and operational, therefore potential risk of biogas release from them in the event of a process abnormality.	Two ATEX rated forced air movers, with 4,000 m^3/hr minimum capacity running continuously. The original unit installed on the open "liquid relief" port on the AD Process Tank roof, pulling fresh air through continuously, with the second installed by the large opening created by the removed tank panels blowing fresh air inside the AD Process Tank. However, once the panels are in place and manway doors closed, the second ATEX Air Mover will be redundant, and is no longer required. ATEX rated air mover on the AD Process Tank roof remains operational while the AD Process Tank ports are open. Entry to reinstate and inspect the removed tank panels is controlled by an NC2 Confined Space Entry, as those within the AD Process Tank will have to leave via the manway once the panels are back in place Personal gas monitors in use, as routine in the AD Process area, with all works stopped and the area vacated on sounding of any alarm, with the incident reported through to site management. Access to work area around the AD Process Tank cordoned off and controlled by the Central Operations De-Grit Team Daily On-Site Meetings to manage these activities, with Biogen and Contractor staff present, with higher level management via Weekly Operations Meetings and Operations Projects Meetings overseeing progress & issues.	1	3	3	Re-installation and inspection of the removed tank panels must only be undertaken by specialist AD Tank contractors, such as Reliant, following provision and approval of their RAMS and evidence of competence.

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
27	**RECONNECTING PIPEWORK** Once side panels (if removed) & manway doors are all closed and secure, then: • Replace all the spool-piece pipework, removed as part of the decommissioning and confined space entry controls. HOWEVER, AT THIS STAGE **ALL** MANUAL VALVES ARE TO REMAIN **CLOSED**. • The air mover can be removed from the Tank roof, and the liquid relief flap closed after ensuring it re-seats correctly. • Replace removed weights & internal of the Pressure Relief Valve, returning it to the same set up as before the AD Process Tank was decommissioned. **IMPORTANT !** All tank instruments are to be replaced in their ports by a trained person (CompEx Ex01-Ex04 or equivalent), AND, they MUST REMAIN ELECTRICALLY ISOLATED WITHOUT POWER until the AD Process Tank gas space has been successfully taken back through its methane EXPLOSIVE LIMITS with the reintroduction of biogas. Head of Central Operations, or deputy, controls this step. Default responsibility with Operations Director.	Adjacent AD tanks still online and operational, therefore potential risk of biogas release from them in the event of a process abnormality.	ATEX rated forced air mover installed on the open "liquid relief" port on the AD Process Tank roof, can be removed during this Step. Working at Height Permit to be issued. All manual valves to remain locked closed after reinstating the removed spool piece All automated valves remain closed with their air disconnected. Check all seals/gaskets are in good order and replace as necessary. Reinstate the AD Process Tank's Pressure Relief Valve weights. ALL tank instruments and electrically powered items to remain fully isolated. Daily On-Site Meetings to manage these activities, with higher level management via Weekly Operations Meetings and Operations Projects Meetings overseeing progress & issues.	1	3	3	

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
28	**AD PROCESS TANK LEAK TEST:** Select a working and checked pressure and connect to the 1" gas sample point adjacent to the Tank's Pressure Relief Valve, then connect a compressed air line to a 1" port on a returned spool piece on the Tank. Closely monitor the pressure gauge and allow compressed air to enter the Tank. Fill the Tank with compressed air to 20 mbar and address any immediate leaks. Slowly increase the compressed air pressure within the AD Process Tank to check the Pressure Relief Valve correctly lifts at its designed setting of **25mbar**. If the PRV does not lift at the correct pressure, then check & adjust the weights. Once PRV has worked correctly, disconnect air supply. Leave the Tank just below 25mbar overnight. If still holding a positive pressure (at least 5mbar) the following morning, it has passed its leak test. If failed (<5mbar) the tank is repressurised to 25mbar & checked for leaks, repeating the above process until the Tank passes. Head of Central Operations, deputy, or Operations Director controls this step.	Adjacent AD tanks still online and operational, therefore potential risk of biogas release from them in the event of a process abnormality.	All manual valves to remain locked closed after reinstating the removed spool piece All automated valves remain closed with their air disconnected. ALL tank instruments and electrically powered items to remain fully isolated Working at Height Permit to be issued. The AD Process Tank roof area to be restricted to the key Central Operations Team staff. RPE to be worn (fresh filter cartridges installed each day during the "de-grit") "G7" Personal gas monitors to be worn. Daily On-Site Meetings to manage these activities, with higher level management via Weekly Operations Meetings and Operations Projects Meetings overseeing progress & issues.	1	3	3	

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
29	**REINTRODUCING BIOGAS – PREPARATION:** Access to the tank roof is barriered off and restricted to members of the Central Operations Team wearing RPE. Select and prepare a route between the Tank and an adjacent Process Tank, to allow balancing of the contents of the two tanks. Ideally this "balancing line" will be an existing common shared service, such as the Discharge Line, or Feed Line. NOTE – If no suitable balance pipeline route is available, then, under a Control of Change, a temporary balancing pipe to be installed under Central Operations control. Tank's connection to the Gas Collection / Balance System to **REMAIN CLOSED.** The site surplus gas flare checked to be fully functional. The site CHP engines are lowered to 50% load, and the Gasholder allowed to fill. The Head of Central Operations, or his nominated deputy, controls this step. Default responsibility lies with the Operations Director.	Adjacent AD tanks still online and operational, therefore potential risk of biogas release from them in the event of a process abnormality.	All manual valves to remain locked closed after reinstating the removed spool piece All automated valves remain closed with their air disconnected. ALL tank instruments and electrically powered items to remain fully isolated The AD Process Tank roof area to be restricted to the key Central Operations Team staff. RPE to be worn (fresh filter cartridges installed each day during the "de-grit") "G7" Personal gas monitors to be worn. Daily On-Site Meetings to manage these activities, with higher level management via Weekly Operations Meetings and Operations Projects Meetings overseeing progress & issues.	1	3	3	

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
30	**REINTRODUCING BIOGAS – OPERATION** Open the chosen "Balancing Line" to allow active, healthy process material to flow via gravity from the on-line AD Process Tank (typically operating between 85% to 93% full) into the empty, de-gritted, Tank. Balancing is to be constantly supervised by the Central Operations Team, with regular checks made around the receiving tank. As the two Tanks balance, the online, active Process Tank will pull biogas back into its gas space as the contents level slowly falls, via its Gas Collection / Gas Balance line. The active process material balancing under gravity into the empty Tank being recommissioned will displace that tank's air through the tank's pressure relief valve. As the material balancing into the Tank is active material, it will also be generating biogas., which will be continually mixing with the air, increasing the % methane content, and helping to displace the air through the Pressure Relief Valve. **THIS IS A CRITICAL STAGE as the Tank atmosphere is taken through its explosive limits.** The Head of Central Operations, or the Operations Director control this Step.	Extreme care is required as the tank internal atmosphere will pass through the Lower Explosive Limit (LEL) of 5%, then the Upper Explosive Limit (UEL) for methane of 17% in air. Adjacent AD tanks still online and operational, therefore potential risk of biogas release from them in the event of a process abnormality. Air, increasingly enriched with Biogas, deliberately allowed to escape via the AD Process Tank's Pressure Relief Valve. Therefore, potential for harmful exposure to personnel and potential ignition from a source of ignition.	PLC & SCADA process monitoring & alarms (of other AD process tanks) to limit any potential loss of containment. Overpressure relief valves – venting any released biogas in a controlled manner to a safe place. DSEAR Hazardous Area Zoning & controls. DSEAR risk assessment & controls. ATEX rated equipment installed. The AD Process Tank roof area to be restricted to the key Central Operations Team staff. RPE to be worn (fresh filter cartridges installed each day during the "de-grit") "G7" Personal gas monitors to be worn. All electrical instrumentation on the AD Process Tank roof remains fully isolated without power. All electrical equipment on the AD process area tank roofs is ATEX rated. No process tanks in the AD bund area have roof mounted agitators. All other non-routine operations on site suspended until this Step **and Step 31** are complete. Daily On-Site Meetings to manage these activities, with higher level management via Weekly Operations Meetings and Operations Projects Meetings overseeing progress & issues.	2	3	6	The lower explosive limit (LEL) for methane in air is 5%. The upper explosive limit (UEL) for methane in air is 17%. By balancing one tank into another we cannot overfill the tank being recommissioned, This is important as the receiving tank still have no level measurement (instruments still electrically isolated)

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
31	**ATMOSPHERE TESTING:** Once the level in the AD Process Tank being recommissioned has reached 30% full, the atmosphere escaping the tank is to be sampled hourly by a member of the Central Operations Team: • wearing RPE, • via the 1" sample point below the Pressure Relief Valve, • using a calibrated Geotech portable gas analyser. **GAS TEST PASS CRITERIA:** Once two successive hourly readings with a **methane content of at least 30%** have been obtained, the internal tank atmosphere is considered safely through its explosive limits. The balancing route between the two tanks can now be closed and secured. If a temporary balancing route had to be installed, then this must be closed, removed and its Control of Change cancelled. Head of Central Operations, or deputy, controls this step. Default responsibility with Operations Director.	Adjacent AD tanks still online and operational, therefore potential risk of biogas release from them in the event of a process abnormality. Sampling of biogas - potential for harmful exposure to personnel and potential ignition from a source of ignition.	PLC & SCADA process monitoring & alarms (of other AD process tanks) to limit any potential loss of containment. Overpressure relief valves – venting any released biogas in a controlled manner to a safe place. DSEAR Hazardous Area Zoning & controls. DSEAR risk assessment & controls. ATEX rated equipment installed. The AD Process Tank roof area to be restricted to the key Central Operations Team staff. Working at Height Permit to be issued. RPE to be worn (fresh filter cartridges installed each day during the "de-grit") "G7" Personal gas monitors to be worn. All electrical instrumentation on the AD Process Tank roof remains fully isolated without power. All electrical equipment on the AD process area tank roofs is ATEX rated. All other non-routine operations on site suspended until this Step is complete. Daily On-Site Meetings to manage these activities, with higher level management via Weekly Operations Meetings and Operations Projects Meetings overseeing progress & issues.	1	4	4	

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
32	**RECONNECTING THE TANK TO THE SITE GAS COLLECTION / BALANCE SYSTEM** After two successive >30% methane readings in Step 31, the Central Operations Team can **SLOWLY** open the closed manual valves isolating the Tank from the rest of the Biogas Collection / Balance System: • The CHPs remain on 50% load, with a member of the team, monitoring their performance, as another member slowly opens the manual gas valves in stages. • If there is evidence of the CHP engines labouring, due to the methane content reaching them being too lean, then the manual gas valve on the AD Process Tank being recommissioned will be closed partly or fully, until the engines recover. • Repeat the above process (as the active AD Process Tank material will continue to enrich the gas space) until the AD Process Tank's gas valves can be FULLY OPENED without any labouring of the CHP(s). At this point the CHP engine(s) can be returned to automatic control & allowed to run as required. The **FULLY OPEN** biogas valves will reseat Pressure Relief Valve. This must be checked. Head of Central Operations, deputy, or Operations Director controls this step.	AD tanks online and operational, therefore potential risk of biogas release from them in the event of a process abnormality.	PLC & SCADA process monitoring & alarms (of other AD process tanks) to limit any potential loss of containment. Overpressure relief valves – venting any released biogas in a controlled manner to a safe place. DSEAR Hazardous Area Zoning & controls. DSEAR risk assessment & controls. ATEX rated equipment installed. The AD Process Tank roof area to be restricted to the key Central Operations Team staff. Working at Height Permit to be issued. RPE to be worn (fresh filter cartridges installed each day during the "de-grit") "G7" Personal gas monitors to be worn. All electrical instrumentation on the AD Process Tank roof remains fully isolated without power. All electrical equipment on the AD process area tank roofs is ATEX rated. All other non-routine operations on site suspended until this Step is complete. Daily On-Site Meetings to manage these activities, with higher level management via Weekly Operations Meetings and Operations Projects Meetings overseeing progress & issues.	1	4	4	

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
33	**REINSTATE SERVICES:** With the AD Process Tank now safely passed through its explosive atmosphere limits, and fully connected back onto the Biogas Collection / Balance System, then all the other services on the tank can be reinstated • AD Process Tank Feeding Line(s) • AD Process Tank Heating Circulation • AD Process Tank Mixing • AD Process Tank Discharge **AND FINALLY :** • Power can be returned to all instrumentation on the AD Process Tank by a trained person (CompEx Ex01-Ex04 or equivalent), who must also check that their ATEX integrity has not been compromised and is still sound. If any are deemed unfit, they must be powered down and isolated immediately until they are replaced. The Head of Central Operations, or his nominated deputy, controls this step. Default responsibility lies with the Operations Director.	AD tanks online and operational, therefore potential risk of biogas release from them in the event of a process abnormality.	PLC & SCADA process monitoring & alarms to limit any potential loss of containment. Overpressure relief valves – venting any released biogas in a controlled manner to a safe place. DSEAR Hazardous Area Zoning & controls; DSEAR risk assessment & controls; ATEX rated equipment installed. Tank roof area to be restricted to the key Central Ops Team staff. Working at Height Permit to be issued; RPE to be worn; "G7" Personal gas monitors to be worn. All electrical equipment on the tank roof is ATEX rated. Reinstating the electrical instrumentation on the Tank, and resupplying power is be carried out by a trained person (CompEx Ex01-Ex04 or equivalent), who ensure their ATEX integrity has not been compromised and are still sound. **Reinstating the Mixing System:** Prior to restarting the Research Team and Operations Director must be consulted to guide the controlled reinstatement of mixing systems. • Once the contents are above the level of the mixing system, care must be taken reinstating the mixing of any tank containing process material, as build-up of trapped biogas could be suddenly released, and/or the sudden mixing together of AD process bacteria and organic feedstock could create a surge in biogas, both situations able to cause foaming and possible loss of containment. • A minimum 6-hours mixing must be allowed, carefully monitored, to assess any abnormalities, before any further movement of material into or out of the tank. • Once 6 clear hours of mixing have passed, the normal tank mixing regime and process operation can be fully reinstated.	1	3	3	Daily On-Site Meetings to manage these activities, with higher level management via Weekly Operations Meetings and Projects Meetings overseeing progress & issues.

Step	Action	Hazard	Control	Residual Risk			Comments
				L	S	R	
34	**AD PROCESS TANK RETURNED TO ROUTINE OPERATION** The AD Process Tank is now fully recommissioned and can be handed back to the Site Operating Team, with feeding and other operations reintroduced as normal. AD Process Tank operations fully returned to Site management.		PLC & SCADA process monitoring & alarms to limit any potential loss of containment. Overpressure relief valves – venting any released biogas in a controlled manner to a safe place. DSEAR Hazardous Area Zoning & controls. DSEAR risk assessment & controls. ATEX rated equipment installed. Site Manager or his deputy, and the Central Operations Team to walk around the AD Process Tank for formal handover of the tank from Central Operations to Site Management. When all are in agreement, the Control of Change document covering the AD Process Tank's removal from routine operations can be cancelled. AD Process Tank returns to routine Operations Site Management, and routine performance monitoring, including, but not limited to, the Weekly Operations Meetings.	1	2	2	

*****NOTE: Periodic inspections and/or audits will be undertaken by members of the Compliance Team to assess adherence to this methodology, the findings of such inspections/audits will be recorded*****

END OF THE PROCEDURE

Planned Responses to Deviations:

Potential Deviation	ACTIONS TO BE TAKEN
Methane readings remain above 0.5% during decommissioning	• Continue purging with air • Recheck all isolations are in place and effective. • Retest after 12 hours
Process material released from partly opened manway	• Vacuum Tanker hose to collect released material • If safe to do so, close the door so the rate of removal by the Vacuum Tanker outmatches the rate of release. IF IT IS DEEMED THERE IS NO SAFE METHOD OF ACCESSING THE DOOR TO CLOSE IT, THEN THE AD PROCESS TANK IS TO BE LEFT DRAINING INTO THE SITE'S PURPOSE MADE CONCRETE BUND AND THE AREA EVACUATED. If it has been possible to safely close the door then the team must reassess the situation, and again attempt to remove material using the Vacuum Tank reattached to various valved ports around the tank. After which the slow and controlled opening of the manway door an recommence. *(Note: An uncontrollable release has never been experienced after following this method of decommissioning a AD Process Tank, but we approach each De-Grit as this being a possible hazardous event to manage).*
Methane ALARM (10% LEL), sounds within the AD Process Tank	• Work must stop and the AD Process Tank evacuated immediately. • ATEX Rated air movers left to run to continue purging the tank with fresh air. • The tank atmosphere to be monitored clear of methane before reassessing the situation, and the de-grit method before recommencing any entry. (*Note: This has never been experienced after following this method of decommissioning of a AD Process Tank, but we approach each De-Grit as this being a possible hazardous event to manage).*

Potential Deviation	ACTIONS TO BE TAKEN
Sudden Movement of Grit Sediment	• AD Process Tank to be immediately evacuated. Harness and Lifeline to be utilised if necessary • The disturbed grit to be removed as much as possible from outside of the AD Process Tank by means of a Vacuum Tanker and its hose. When all movement has stopped and as much of the disturbed grit removed as possible without Entry, then the Central Operations Team must reassess the remaining grit and its safe removal. (*Note: This has never been experienced after following this method of decommissioning a AD Process Tank, but we approach each De-Grit as this being a possible hazardous event to manage).*
Pocket of Trapped Biogas Released	• As above, upon sounding of any Methane alarm, work must stop, and the AD Process Tank evacuated immediately. • ATEX Rated air movers left to run to continue purging the tank with fresh air. • The tank atmosphere to be monitored clear of methane before reassessing the situation, and the de-grit method before recommencing any entry, considering the likelihood of any further pockets. (*Note: This has never been experienced after following this method of decommissioning a AD Process Tank, and bearing in mind the nature of how the grit sediment forms, but we approach each De-Grit as this being a possible hazardous event to manage).*
Hydrogen Sulphide ALARM (either the 5ppm WEL, or 8ppm STEL Alarm), sounds within the AD Process Tank	• Work must stop and the AD Process Tank evacuated immediately. • ATEX Rated air movers left to run to continue purging the tank with fresh air. • The tank atmosphere to be monitored clear of hydrogen sulphide before reassessing the situation, and the de-grit method before recommencing any entry. (*Note: This has never been experienced after following this method of decommissioning a AD Process Tank, but we approach each De-Grit as this being a possible hazardous event to manage).*

Potential Deviation	ACTIONS TO BE TAKEN
Ammonia ALARM (with monitor set to “RPE Mode”) sounds within the AD Process Tank	*Note – unlike methane and H2S, experience shows that ammonia is main issue to deal with during these entries. Ammonia is present in varying amounts at different stages of the AD process.* *When de-gritting a AD Process Tank we often find ammonia levels above the 25ppm WEL and 35ppm STEL, but very rarely see it reaching 100ppm.* *Therefore, to avoid repeated alarms, the gas monitors worn by those inside the AD Process Tank during the actual grit removal process is set to “RPE Mode”.* Therefore, should any gas monitor worn inside the AD Process Tank alarm with ammonia readings while in RPE Mode: • Work must stop and the AD Process Tank evacuated immediately. • ATEX Rated air movers left to run to continue purging the tank with fresh air. • The tank atmosphere to be monitored clear of hydrogen sulphide before reassessing the situation, and the de-grit method before recommencing any entry. (*Note: Ammonia alarms while in RPE Mode have never been experienced after following this method of decommissioning a AD Process Tank, but we approach each De-Grit as this being a possible hazardous event to manage).*
Carbon Monoxide ALARM (either the 20ppm WEL, or 100ppm STEL Alarm), Sounds within the AD Process Tank	• Work must stop and the mini-excavator switched off, with the AD Process Tank evacuated immediately. • ATEX Rated air movers left to run to continue purging the tank with fresh air. • The tank atmosphere to be monitored clear of Carbon Monoxide before reassessing the situation, and the de-grit method before recommencing any entry. Mini-excavator to be inspected for any faults. (*Note: This has never been experienced, with the forced air movers overwhelming the exhaust emissions from the excavator. However, as above, we approach each De-Grit as this being a possible hazardous event to manage).*

Biogen Continuous Improvement – Ideas for Improving This Methodology:

1. Consider “double block and bleed” as an improvement to the current “removable spool piece”.

2. Record future gas measurements at the various stages, to build a body of evidence to support Biogen’s experience from its previous 20 AD Process Tank de-grits, AND/OR to inform Biogen of areas to improve this Safe System of Work.

3. Confirm with vacuum tanker contractors (currently Clearwater, GEWS and Millers) the earthing and anti-static provisions which come with their equipment, in addition to our own earthing controls.

4. All sites to develop in conjunction with the Central Operations Team a register of the necessary isolations required for each named process tank.

5. In conjunction with #4, consider clearly identifying on site the actual isolations required, for example by painting or clearly tagging the valves and pipework involved.

6. Following discussion with the HSE at Millerhill on 1st July 2022, we shall not be trialling the use of nitrogen purging on future De-Grits. Although nitrogen purging may be beneficial in safely taking the AD Process Tank through its explosive methane limits, it presents its own significant dangers of asphyxiation to personnel involved with handling the nitrogen purging equipment and process, and those undertaking subsequent entry into the AD Process Tank.

7. Review any issues or proposals raised in the ongoing DSEAR reviews.

8. Continue to investigate new technologies and/or work methods to continue to reduce the hazards and risks involved in these activities.