Revision of Environmental Protection of the AD Mona

For Environmental Permit

of AD Mona

Contents

1. Details of new drainage layout (see drawing 2341-PH2-6020.pdf)

The entire surface water system within the concrete loading apron will be rerouted and integrated into the leachate drainage system, thus preventing windblown or dropped substrate from being washed into the surface water system by mistake.

The manhole covers on the surface water system within this area will be replaced with sealed lids (shown at point H in drawing 2341-PH2-6020) thus allowing the retained surface water system to pass underneath the concrete loading apron, without risk of contamination.

In addition to give the flexibility to divert surface water, a new connection between the surface water system and the leachate system is proposed (see point 'F' on drawing 2341-PH2-6020). The alternative route giving a means to return surface water to the leachate system will be controlled by two supplementary valves.

2. Concrete Apron Area

I. <u>Ancillary Works</u>

1. There is a spare 150mm diameter duct (for possible future cabling requirements) which runs from the LV sub-station to the side of the chicken dung building. (It is visible coming through the concrete pavement of the apron area on the south side of the chicken dung building).
   This duct will be closed off with a bung, concreted and sealed to stop any ingress of rain water, possibly contaminated with leachate.

2. Across the entrance to the adjacent property from the concrete apron, a 1200mm wide (maximum) x 125mm high, concrete upstand will be constructed between the existing kerbs, to ensure rainwater falling on the apron is diverted in to the adjacent gullies, removing any possibility that leachate contaminated rainwater runs off the sloping entrance road on to the adjacent property.
   This bund will be formed by saw cutting a channel, 20mm deep in the existing concrete pavement and then constructing a "speed bump" shape approximately 1200mm wide by 125mm high.

3. The access road is considered only to be at risk of leachate contamination from blown silage during the delivery operations at harvest time in June/July (rye grass) and October (maize). Provision has been made in the additional drainage works to divert the entire surface water system in to the leachate tank during these times if necessary, but it is expected that good housekeeping – sweeping and vacuuming the access road – and the fact that silage will not be harvested during rainfall, will obviate the need for this to be used.

II. Slot Drains

Concern has been expressed that there are small gaps (<50mm wide) in the slot drain at either side of all the longitudinal side walls of the Silage Clamps which do not pick up all the leachate contaminated rainfall running off the silage clamps.
Although this is certainly the case at present – and is being addressed by the provision of temporary sandbag diversions – this will be resolved by the proposed changes to the leachate system as all the liquids running on to the concrete apron area, including the above, will be drained in to the leachate system leading to the leachate storage tank.

III. Sealing of minor cracks in the concrete apron

These are predominantly in the narrow concrete strip along the slot drain and have been caused by the long narrow shape of the concrete element.
It is proposed that these cracks are sawn out to 10mm wide by 50mm deep, and sealed with Fosroc Nitroseal MS600 sealant, to a minimum depth of 20mm, all in accordance with the detail on drawing 2341-PH2-1010.pdf (Appendix A)

3. SEQUENCE OF WORKS

The works will be carried out in the following sequence:-

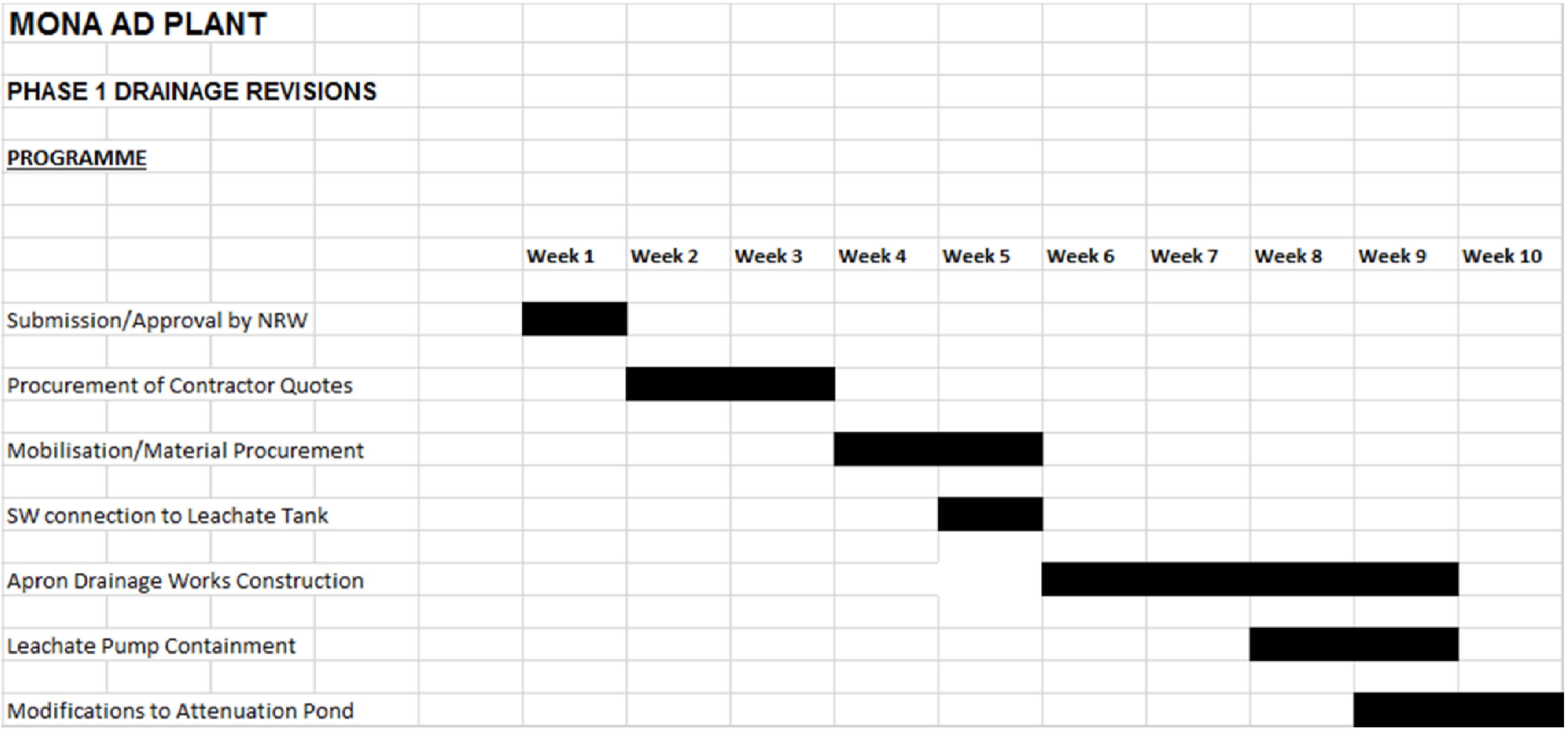
A. Additional Manhole and 2 valves on SW line downstream of petrol/oil interceptor tank, with new connection to leachate tank

B. New 150mm diameter discharge pipes from gullies G11, G12 and G13 to existing leachate system drain between manholes L4 and L6. The abandoned discharge pipes to the surface water system will be filled with non-shrink concrete grout. The abandoned valve chambers – with valves in fully closed positions – will also be filled with concrete.

C. Replacing the outlet pipes on gullies G14, G15 and G16 and the provision of a drainage channel across the access to the undeveloped field. The abandoned discharge pipes to the surface water system will be filled with non-shrink concrete grout. The abandoned valve chambers – with valves in fully closed positions – will also be filled with concrete.

D. Replacement of manhole covers on manholes S8 and S9 with sealed manhole covers to prevent leachate intrusion to the surface water system.

E. The construction of a containment area around the leachate pump. The work will also include a 150mm diameter return pipe discharging by gravity back to Manhole L11 and thence in to the leachate tank.


MONA AD PLANT
PHASE 1 DRAINAGE REVISIONS
PROGRAMME
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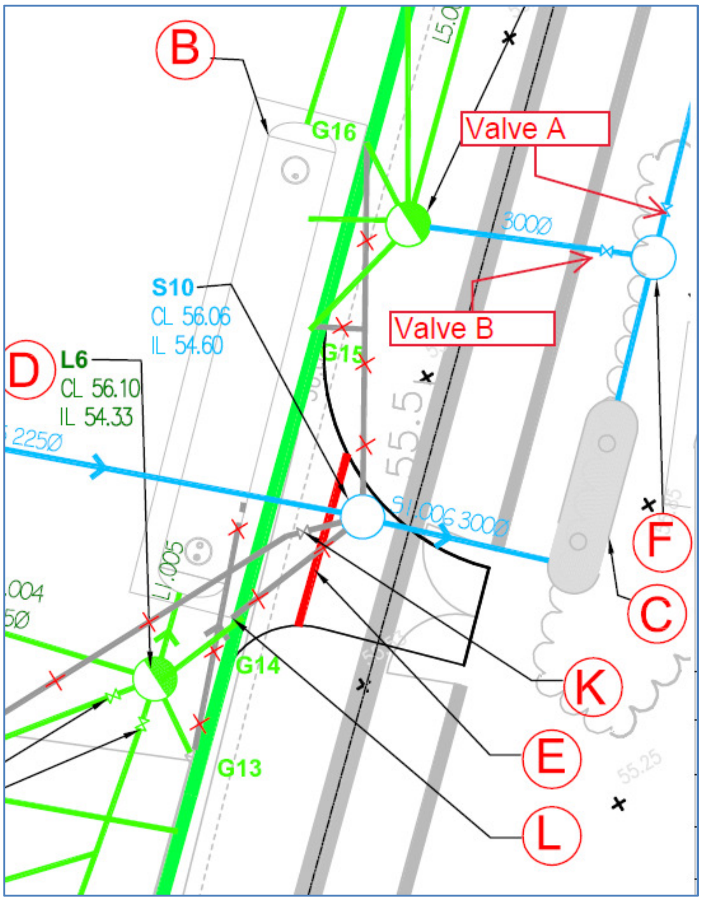
SW connection to Leachate Tank
Apron Drainage Works Construction
Leachate Pump Containment
Modifications to Attenuation Pond

4. Drainage setting during Harvesting

During the delivery to site of harvested silage there is an increased risk of wind-blown silage entering the surface water drainage system. To mitigate this risk the following actions shall be taken:

Daily inspecting and cleaning of all areas to prevent silage entering the drainage system.
In addition, all the surface water runoff from the site shall be temporarily diverted into the leachate holding tank during the period of the deliveries and until the water in the surface water system is proven to be of an acceptable standard. To achieve this, and referring to the extract below, Valve A shall be closed to prevent surface water passing downstream to the attenuation pond, and Valve B shall be opened to direct flow into the leachate tank.



Upon completion of the deliveries water sample(s) shall be collected for testing from chamber F, immediately upstream of Valves A and B, and the surface water system inspected for evidence of contaminants. If the test(s) proves the water is of acceptable standard, the valve controlling flow from the attenuation pond shall be closed as a precaution, Valve B shall be closed and Valve A opened. Any water held in the attenuation pond shall be inspected, and tested if necessary. Upon satisfactory inspection and testing the control valve shall be opened and allowing flow into the watercourse.
Should the testing and inspection prove water is not of an acceptable standard Valve A shall be retained closed and Valve B open, and the system cleaned into the leachate tank.

5. Assessment of the Leachate Tank Capacity for accepting apron area drain, and temporarily, access road and roof drainage

I. Scenario 1 (Silage, apron area)

Drained Area = 3300m²:
Scenario tested – permanently connect the gullies of the apron with the leachate system. Requires reconnection of all apron area gullies to leachate system as shown on drawing 2341-PH2-6020.pdf (Appendix A).

The leachate tank is emptied via a pump into the AD process. Assessing the tank capacity for the design rainfall considering the tank water level is the pump start level of 0.7m.
Source Control Filename : Scenario 1_Pump Start.RCRX

Return Period (1-year)	Critical Duration (mins)	Rainfall Intensity (mm/hr)	Maximum Volume in tank (m^3)	Overflow volume (m^3)
1	15	31.1	26.5	0
10	15	64.4	40.6	0
20	15	81.3	50.5	0
100	30	79.6	84.0	1.5
100 + 30% CC	30	103.5	84.0	30.52

From the above there is 1.5m^3 of overflow volume for the 1 in 100-year return period rainfall. This would be accommodated within the leachate pipe and chamber volume.

II. Scenario 2 (Silage, apron area, access road and roofs)

Drained Area = 5100m^2:
Scenario 2 is based on a temporary and precautionary condition, when silage is being delivered immediately following crop harvesting. In this scenario, in addition to the apron area drainage having been permanently connected to the leachate system, the access road and roof drainage is also directed into the leachate tank via newly installed chamber and valve arrangement. Although harvesting of silage and transporting to the site is not carried out in forecast heavy rain, the following assessment indicates the resilience in the system should forecast extreme rainfall occur.
The data is presented on the basis that the tank is full to a depth of 0.7m prior to the pump starting.

Source Control Filename: Scenario 2_Pump Start.SRCX

Return Period (1-year)	Critical Duration (mins)	Rainfall Intensity (mm/hr)	Maximum Volume in tank (m^3)	Overflow volume (m^3)
1	15	31.1	32.0	0
10	30	38.7	61.6	0
20	30	48.3	79.02	0
100	30	79.6	84.0	55.3
100 + 30% CC	30	103.5	84.0	103.4

From this table, it is evident that in the tank has capacity for rainfall in excess of 1 in 20 probability occurring at the same time as harvested silage is transported into the site with the surface water directed to the leachate system.

6. Details for watertight manholes

To ensure that no surface water, possibly contaminated with leachate, flows into manholes on the surface water system, it is proposed to replace the manhole covers with new water tight covers.

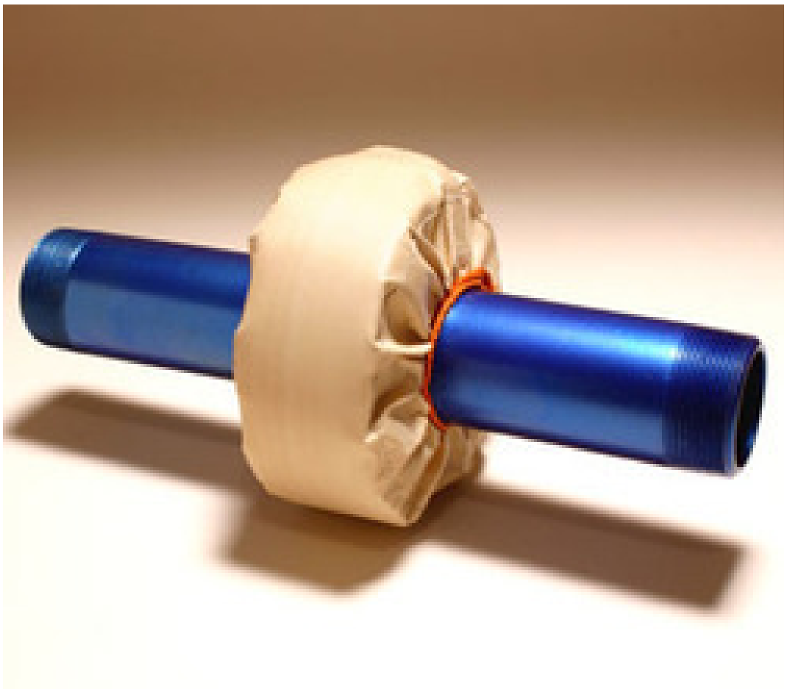
⇨ see drawing 2341-PH2-6022.pdf in Appendix A

7. Details for containment around leachate pump and its instrumentation

The Leachate Pump, located outside the main containment area will now be inside a concrete containment, with concrete walls and floor, designed to contain any leakage from the flanges/gaskets/valves/pump, on non-welded pipe section. Any leakage of leachate will be collected within this containment and transferred back into the underground leachate tank via a gravity pipeline.

⇨ see drawing 2341-PH2-3021.pdf in Appendix A

Any non-welded connections will be equipped with flange guards, which will ensure that no leaks would spray beyond the walls of the containment. (Example below)



8. Inspection of integrity and remedial works at attenuation pond

Remedial work is required here on the inspection chamber, located between the valve chamber and the hydro brake manhole, between the pond outlet and the ditch. Water has been observed entering this manhole between the walls and the benching, and it thus reasonable to assume that discharge water (conceivably leachate contaminated) could flow out of the manhole in the same way.

It is proposed that the concrete surround to this inspection chamber is excavated and exposed and an additional concrete surround is constructed to seal the chamber.
Also, the gate valve will be replaced with a butterfly valve downstream of the outlet headwall, to give further assurance that this valve will not be impacted by debris causing leakage past the valve.

At the same time, the pre-cast concrete outlet headwall will be excavated and investigated to confirm that the welded uPVC pond lining has been tied in to the concrete headwall. If the sealing of the lining to the headwall is found to be defective, this will be corrected before the area is backfilled.

9. Fencing in the vicinity of the attenuation pond area to stop trespassing

The extent and precise location of the security fencing will be determined following detailed site inspections and is shown indicatively on the drawing.

⇨ see drawing 2341-PH2-6021.pdf in Appendix A

10. Dryer Building Containment

I. Introduction

The risks identified in this area relate to a failure or leak in one of the tanks or from flanged pipe connections. There are two bigger tanks in the dryer building; one containing Sulphuric Acid and the other containing hygienised water. The sulphuric acid tank and system has been designed and constructed such that the risk of leakage into the Dryer Hall is sufficiently remote that it does not need to be considered in this assessment of containment. (see also chapter 11: Sulphuric Acid System)

The initial risk is from jetting liquid under pressure from a failed flange or tank. It is proposed that in respect of the flanges this is mitigated by the fitting of flange guards which will prevent jetting and contain a leek such that it drips into the proposed containment area. The jetting liquid from the hygienisation tank will be contained in one of two ways:

- By the constructing of screening in close proximity to the tank

- By positioning a new containment upstand so that it is beyond the range of jetting liquid.

Subsequently the task is to contain the volume of spilled liquid. A shallow upstand will be constructed around the building perimeter to tie in with the existing perimeter wall on one end of the building. Drawing 2341-PH2-6012 shows the proposals, and more detail is described below:

II. Liquid Jetting

Flange Guards.
These will comprise a proprietary guard that will be fitted to each flange that is within 2.5m of the building cladding. There are some hot water pipes, that contain pure water, which it is proposed will not be guarded.

Screening.
The Hygienisation tank will be partially screened to prevent jetting towards the doorway into the building, and the building cladding close to the tank.

III. Containment Volume

Inventory Volume
An assessment has been carried out of the pipes and tank system to determine the total inventory which could spill due to a failure of a pipe or tank. In addition to the tank volume, calculations have demonstrated that a maximum additional volume of 7m3 could spill in the worst case (see chapter 12: leak detection in dryer hall):

Hygienisation Tank Volume 16m^3
Maximum additional volume 7m^3
Total potential spill volume 23m^3

The total area of the dryer hall is 28.345 m x 13.886 m = 393.6 m^2.
Based on an upstand of 0.1m built around the edge of the area building the total containment volume of 39.4 m^3 is available.

The effective containment area is calculated by subtracting the volume of the equipment positioned inside the dryer hall from the total volume of the containment. The volume of the biggest tank is not considered as volume to be subtracted as the area will still be filled with the hygienised process water in event of a tank rupture. It is therefore marked red in the Figure below.
With the rest of the equipment the following effective containment volume is available:

dryer hall

length	28.345	m
width	13.886	m
area	393.60	m2
total volume with 0.1m high upstand	39.36	m3

Equipment inside	volume	diameter	length	width	area	volume for 0.1m height	comment
	m3	m		m	m2	m3	
buffer hyg tank	16	2.4	-	-	4.52	0.45	volume is part of the containment in case of tank leak
H2SO4 tank	15	2.82	-	-	6.25	0.62	diameter of tank hull
dryer buffer tank	2	1.25	-	-	1.23	0.12	
excentric screw pump at dryer buffer tank	-	-	-	-	-	-	(pump is standing on support legs)
excentric screw pump at buffer hyg tank	5.34	1.8	2.1		-	0.03	(pump is standing on 0.04m high support legs)
H2SO4 pump			0.2	0.1	0.02	0.002	approximate dimensions
belt dryer	-	-	17.965	5.4	97.01	0.97	is standing on support legs (assumption 10% of total volume)
air scrubber	-	-	-	-	-	-	air washer is standing on 0.1 high support legs
			0.05	5.88	0.29	0.18	6x small support legs
			0.4	5.88	2.35	0.47	2x broad support legs
evaporators (2x)	-	-	3	3	9	0.09	is standing on support legs (assumption 10% of total volume)
MKR ASL station	-	0.45	-	-	0.16	0.02	
MKR vacuum station	-	-	-	-	-	-	is standing on ca. 0.1m high support legs
MKR circulate tank	-	-	-	-	-	-	is standing on ca. 0.1m high support legs
MKR control cabinet	-	-	-	-	-	-	is standing on support legs
instrument air buffer tank	-	-	-	-	-	-	is standing on support legs
expansion vessel main heating	-	-	-	-	-	-	is standing on support legs
expansion vessel dryer heating	-	-	-	-	-	0.007	volume (-height of support legs)measured from model
expansion vessel evaporator heating (2x)	-	-	-	-	-	0.014	volume (-height of support legs)measured from model

sum of equipment volume (without buffer hyg tank)
2.52 m3

effective Containment volume inside dryer hall with 0.1m high upstand
36.84 m3

volume of biggest tank + 10%	17.6	m3
volume of pump overrun	7	m3
total leakage volume	24.6	m3

Figure: calculation of the effective containment area inside the dryer hall

The effective containment volume is 36.84 m^3, approximately 50 % greater than the maximum spillage volume of 23m^3.

There will be a note in the Operating Procedures that storing of any materials inside the dryer hall should be minimized and shall not cover more than 40m^2 of the ground.

IV. Containment Construction

Containment of a minimum of 0.1m will be provided close to the perimeter of the building. One gable end will be contained by the main containment bund wall. The opposite gable will be contained by the wall which will be formed as part of the external area containment. Along the elevations containment will be provided by the installation of square plastic section which will be bolted to the floor. These will be sealed against the building stanchions and at intermediate joints with a proprietary process water resistant sealant.
Across the doorway, the containment will be suitable for occasional vehicle crossing.

⇨ Details on drawing 2341-PH2-6012

V. Dryer Building Drain

There is a single drain in the floor of the dryer building which is connected to the leachate system and draining to the leachate tank. The drain is required to provide an outfall for the automatic release of water from the evaporators. It is not proposed to amend the drain.

11. Sulphuric acid system

The sulphuric acid tank is positioned in one corner of the dryer hall, next to the evaporators and close to the air washer of the belt dryer.

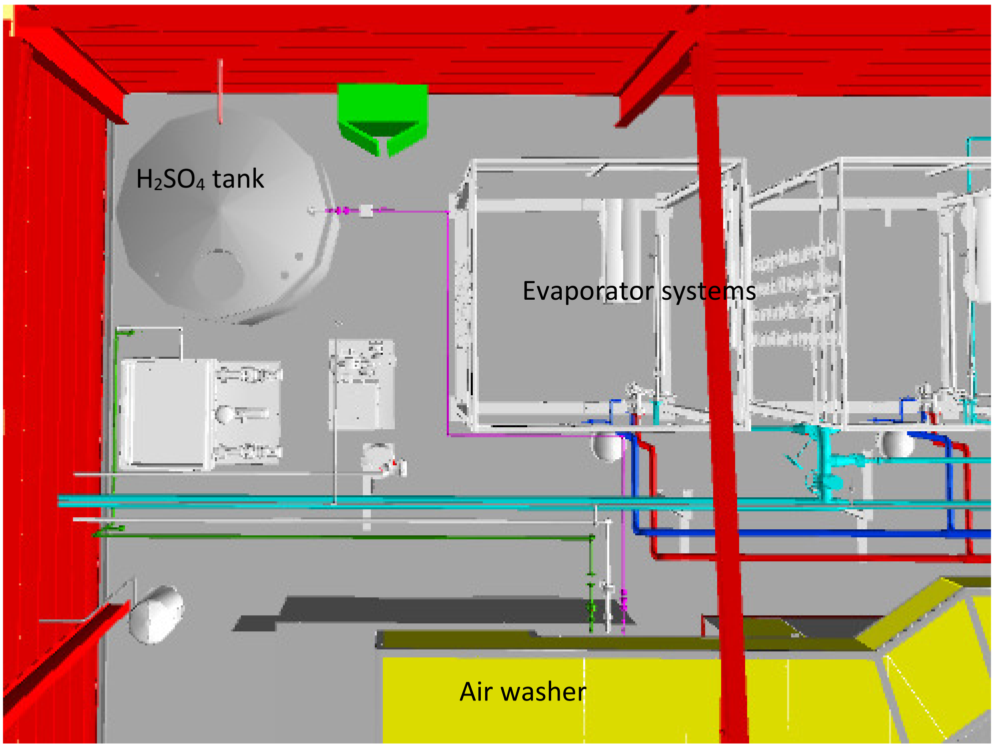


Figure: Position of sulphuric acid tank inside dryer hall

To define the measures for a safe and secure H_2SO_4 tank, a short risk evaluation was made:
Table 1: risk evaluation for sulphuric acid tank

risk	consequence	likelihood	Measure
Vehicle hitting the tank	Can cause a leak	none: Tank is standing on a position which is inaccessible for vehicles.	-
Medium inside the tank	Can cause a leak	Likely: pH 1-3	Use material resistant to 96% H_2SO_4, double walled system
Temperature	Can cause a leak	Highly unlikely: H_2SO_4 is not heated, ambient temperature inside tank	-
Pressure	Can cause a leak	Unlikely:	Aeration opening at the top of the tank to

		H_2SO_4 is not pressurised	ensure ambient pressure inside tank
Abrasion by any medium inside tank	Can cause a leak	None: No particles in medium	-
Abrasion from equipment outside the tank	Can cause a leak	Highly unlikely: No moving equipment is in proximity to the tank	Double walled tank

Resulting from this table, a tank made of PE-100-RC-WK-S-800 is used. Additionally, a catchment tank of the same material is mounted around the H_2SO_4 tank. The sulphuric acid tank has a DN100 aeration opening at the top.

To account for the harmfulness of the sulfuric acid, any risk of dropping sulfuric acid onto the alleyway in the dryer hall has to be eliminated. Additionally, any leakage of sulfuric acid throughout the dryer hall has to be avoided.

As a consequence, the sulphuric acid pipes to connect the tank with the supplier equipment are also double walled systems. This is to eliminate any possible spillage not only for environmental reasons but especially for health and safety reasons.

Independent of the safety measures described above, the pipes and the tank have to be visually checked every day. The system is described in the following chapters.

I. Sulphuric acid tank (SAT)

The sulphuric acid tank is provided as part of the package unit of the evaporator supplier. It is a PE-100-RC-WK-S-8000 (black) storage tank with a catchment tank of the same material. This catchment tank can hold 15 m^3, which is the net volume of the storage tank. Further tank details are given in the data sheet and the technical drawings.
The SAT contains a level gauge LI and a binary maximum level indicator L. In case the maximum level is reached, an alarm horn / light inside and outside the dryer hall is activated. Additionally, a leakage sensor is mounted between the inner tank and the catchment tank which triggers an alarm if sulfuric acid is detected.

- ⇨ See appendix B for specification of MKR (Technische Daten Säurebehälter und Füllschrank) and appendix A for drawing 160690e

II. Connections to belt dryer / evaporator

The pipes are connected to a PVC-U socket at the vacuum lifting station at the roof of the sulfuric acid tank. Details are given in the attached technical drawings.

The connection from the H_2SO_4 tank to the steam scrubber inside the evaporator units is part of the evaporator manufacturer's supply. The pipes connecting the tank and the two evaporator systems are secured with an outer protective pipe. The inner pipe is made of PVC-U, the outer pipe of 1.4401. This double walled piping is running at constant height and it is mounted at the back side of the evaporator systems, where access would be restricted to authorized persons only.

The H_2SO_4 tank is connected to the dryer system via a double walled PVC-U pipe with an inner diameter of DN15. The double walled pipe is then connected to the sulphuric acid pump (supplied by the dryer manufacturer). This pump is positioned directly next to the H_2SO_4 tank inside a stainless-steel drip tray. At the pressure side of the pump, the pipe rises to cross the alleyway at a height of 3m. Underneath this pipe crossing there will be a steel protection that could absorb potential impacts from outside.
A low point is created at the sulfuric acid pump. At the air scrubber, the pipe is led in at the roof of the pump cabin. This connection is made by the dryer manufacturer. Again, there is a low point at the end of the pressure pipe inside the air scrubber cabin. At each low point a transparent leak detection pipe will be mounted. In case of any leak of the inner pipe, the sulphuric acid is collected in this transparent pipe and will be noticed during the daily visual inspection.

III. Upstand and drain within dryer hall

Because of the extensive security measures explained above, the possibility that the sulphuric acid can spill into the dryer hall can be discounted. Therefore, the dryer hall containment does not need to be designed to resist 96% H_2SO_4.

The drain within the dryer hall should remain open, as it is needed for an undisturbed operation of the evaporator system. Furthermore, we have demonstrated above that no spilling of sulphuric acid will occur.

12. Leak detection and additional volume for biggest tank in dryer hall

In addition to any leak detection system, the tanks should be maintained and a daily visual inspection has to be conducted.

To calculate the maximum spilling volume in the dryer hall, the biggest tank has to be defined. This is the buffer hygienisation tank, which has a filling volume of 16 m^3 and a diameter of 2.391 m.

This tank is filled with pasteurized process water (PPW) from the hygienisation unit:

feeding pump	pasteurisation discharge pump	
	45	m3/h
	7	m3 maximum amount during one pumping routine
	9.3	min duration of one pumping routine
	1.56	m level change in the tank after one pumping routine
	0.17	m level change in 1 minute

The leak detection system consists of two parts. Within the first part, leaks can be detected during the filling process. If the leak is quite small, the second part is needed. It is an automatic detection system with no need of assistance from the operator. In case of an alarm, the operator should of course check the situation inside the drier hall and find the cause of the alarm.

For both parts, various influences on the tank system have to be considered.

Influence	**Result for the detection system**
level fluctuations because of stirrer	The stirrer is turning with 8.3 revolutions per minute (at 50 Hz). This is quite slow and no high-level fluctuations are expected. Additionally, the stirrer is turned off during part 2.
demand for PPW from the evaporator	Volume flow is theoretically 800 l/h. The effective volume flow is measured and considered in the threshold value for the detection system.
discharge of the PPW to the storage tank	Discharge pump does not get signal to start during filling process and during part 2.
high level switch will be reached during filling routine	If the high-level switch is reached before the first 3 measurements could be made and therefore the condition to raise an alarm are not fulfilled, part 2 can still detect a leak.

IV. Leak detection system – part 1

The level change is measured every minute from starting the pump until it is stopped. After each minute, it is checked to see if the measurement is matching the expected value. The first measurement is done after 30 seconds to ensure a constant volume flow of the pump:

- If the level change (difference between starting level and level after 1.5, 2.5, 3.5, .. Minutes) is bigger than or equal to the expected value, everything is fine.
- If the level change (difference between starting level and level after 1.5, 2.5, 3.5, .. Minutes) is smaller than the expected value, a leak is possible.
- If 3 measurements in a row do not match the expected level rise, an alarm is given and the inlet pump is stopped.

With this procedure, it is taken into account, that the leak position can be higher than the starting level. In the best case the leak will be detected after 3 minutes. That results in an additional volume of 2.63 m^3. In the worst case the leak will be detected in the last 3 minutes. That results in an additional volume of 7 m^3. This is only likely to happen, if the leak is quite small and therefore the inflow is considerably bigger than the outflow.
Furthermore, these volumes are only valid for the assumption that the leak is at or below the liquid level when the filling starts.

The threshold for giving the "ok" signal is dependent on the inflow and the volume flow sucked in by the evaporators. The following table shows the values for a typical case. The effective demand from the evaporators is measured and changes the threshold value accordingly. That means that the threshold has to be calculated during filling:

maximum demand from the evaporators	0.8	m3/h
feeding volume flow	45	m3/h
threshold is resulting of the difference	44.2	m3/h
	0.74	m3/min
	0.16	m/min
considering the level fluctuations caused by the stirrer	0.12	m/min

In this example a level increase of at least 0.12 m can be detected after one minute, the internal test is passed. This value has to be adjustable for commissioning, in case the volume flow varies from the theoretical value.

V. Leak detection system – part 2

After the inlet pump has stopped, the system checks if PPW is transferred to the evaporators at this moment. If there is no demand for PPW from the evaporators, a testing period of 4 minutes starts. During this period, no PPW is allowed to be pumped to the final storage tank and no PPW is allowed to be sucked into the evaporator systems. (Pump and evaporator do NOT get clearance from the control system). Additionally, the stirrer is stopped.

➔ If the level is dropping during these 4 minutes, an alarm is given and the pump is stopped.

This procedure takes into account the scenario in which the inlet volume flow is much higher than the outflow and therefore the leak cannot be detected during filling. The reasons for a small outflow and therefore a small outflow velocity are either a small difference in height between the hole and the liquid level or a small size of the hole in the tank.

The duration of 4 minutes for the second detection level is chosen based on the following assumptions:

Leak hole is 10 cm below liquid level and has a diameter of 3 cm.

outflow velocity v:	sqr(2*g*h)		1.4	m/s
Volume flow V_dot:	v*A	A	0.00071	m2
		V_dot	0.00099	m3/s
			3.6	m3/h
level drop should be minimum 5cm for the level sensor to be securely able to detect it.				
Volume to flow out	0.22	m3		
Volume after .. minutes	2	0.119		
	2.5	0.149		
	3	0.178		
	3.5	0.208		
	4	0.238	>	0.22

VI. Conclusion:

If the second part of the detection system is necessary to trigger the alarm and stop the pump, a maximum volume of 7 m^3 would be released and therefore has to be added to the volume of the dryer hall containment.

13. Leak detection system for tanks in dryer hall

In addition to any leak detection system, the tanks should be maintained and a daily visual inspection has to be conducted. Inside the dryer hall 3 tanks are positioned that need to be discussed.

Buffer hyg tank:
The biggest tank in dryer hall. The leak detection system is explained in detail in Chapter 12.

Sulfuric acid tank:
The leak detection within the double walled system was described in Chapter 11.

Dryer buffer tank:
This tank is part of the belt dryer supply. The leak detection needs to be defined in this document:

The dryer buffer tank has a volume of 2 m^3 and will be filled with a volume flow 15 m^3/h. It is equipped with an overflow sensor and a level sensor. The level change inside the tank has to be compared to the difference of the filling volume and the discharge volume. Both volume flows are measured with a flow meter. The level is checked each time the feeding pump starts and again after the feeding pump has stopped. In case the measured level difference is less than 90% of the expected value, an alarm is given and the feeding pump is stopped. This measurement will only start if the expected level difference is bigger than 8 cm to avoid any error measurements.

Additionally to the leak detection system by Agraferm, the evaporator system is equipped with a leakage sensor. It is mounted at the bottom of the main control cabin of MKR, which is standing next to the evaporator columns. In case of a damage of any part of the evaporator system, the sensor will detect any liquid spreading on the ground. If it is activated, an alarm is triggered and the whole evaporator system stops.

Prevention of overtopping

Once one of these systems detects a leak, the pumping of medium to the relevant tank has to be stopped. The leak detection system immediately stops the pump / feeding mechanism, which is leading directly to the relevant tank. This results in stopping of all the pumps upstream of this pump. Because the pumping routines are all dependent on the level inside the tanks, the pumps upstream will automatically be blocked by the control system. It has to be noted, that the upstream systems will not be blocked immediately after the leak detection gave an alarm. These will only stop if the tank, which should be filled, is already full. Because of this time delay there is the chance to verify the alarm and keep the plant running as long as possible and at the same time avoid spilling of any more additional liquid. The shut of sequence will be in detail as described below (please see block flow diagram in appendix A for explanation):

Buffer hyg tank:

1. The tank is filled by the pasteurization discharge pump. If the pump is stopped, the pasteurization tank cannot be emptied.
2. Therefore the feeding pump for pasteurization will not start.
3. That means the process water tank cannot be emptied, as this is done by the pasteurization feeding pump.
4. If the process water tank is full, the separation will stop.
5. If the separation stops, the discharge of digestate from the post digester to the separation stops.
6. Because of less demand of digestate, the level inside the post digester rises and eventually, the feeding of the digesters will be stopped.

Sulfuric acid tank:

The only way to pump H_2SO_4 into the tank is via the filling cabinet. As the filling is a manual process and has to be supervised, as well as the level has to be checked during filling, no feeding pumps have to be stopped automatically.

Dryer buffer tank:

1. The tank is demanding medium from the collecting and mixing tank.
2. If the connecting pump is stopped by the leakage alarm, the collecting and mixing tank will not be emptied.
3. If the collecting and mixing tank is full, no medium from the evaporators and from the post digester is allowed to be pumped to this tank. As both pumps have an alternative pumping routes, these will be used:
4. The evaporators will pump the pasteurized and thickened process water (PtPW) into the final storage tank.
5. The pump at the post digester will pump the digestate to the separation.
6. The resulting process water will be pumped from the separation to the process water tank and then to the pasteurization.

7. The pasteurized process water will be pumped to the buffer hyg tank, from there to the evaporators.
8. From here the medium will be pumped to the final storage tank (see point 4).

In case a leak is detected in the dryer buffer tank, the AD plant can run in normal operation. A bypass of the belt dryer will be created by pumping the material directly to the final storage tank.

Hydraulically linked tanks

There are no hydraulically linked tanks inside the dryer hall. On each filling/emptying pipe connected to the tanks, a pump and an automatically controlled valve is installed, which divide the system into hydraulically separate tanks.

14. Containment - Process Tank Separator Area

I. Introduction

The risks identified in this area relate to a failure or leak in one of the tanks, or from flanged pipe connections.
The initial risk is from jetting liquid under pressure from a failed flange or tank. It is proposed that in respect of the flanges this is mitigated by the fitting of flange guards which will prevent jetting and contain a leak such that it drips into the proposed containment area. The jetting liquid from a tank will be contained in one of two ways:

- By the constructing of screening in close proximity to the tanks
- By positioning a new reinforced concrete containment wall so that it is beyond the range of jetting liquid, or so that jetted liquid strikes an existing building cladding and drips into the contained area.

Subsequently the task is to contain the volume of spilled liquid. It is proposed that the spill volume, plus that of rainfall will be conveyed to a new below ground tank formed from insitu reinforced concrete or a pre-fabricated tank formed from a suitable material.

⇨ Drawing 2341-PH2-6011 shows the proposals, and more detail is described below:

II. Liquid Jetting

Flange Guards.
These will comprise a proprietary guard that will be fitted to each flange.

Screening.
The Coll+Mix tank will be partially screened to prevent jetting towards the perimeter of the contained area. The adjacent hygienisation tanks are insulated, which provides a second skin and prevents jetting. Therefore, it is not proposed to further screen those. The PW tank and the separation tanks will not be screened as the perimeter wall will be positioned beyond the jetting distance.

III. Containment Volume

Inventory Volume

An assessment has been carried out of the pipes and tank system to determine the total inventory which could spill due to a failure of a pipe or tank.

Tank Volumes are:

	tank volume m3	no	total vol m3
7m3 (pasteurization)	7	2	14
16m3 (PW tank)	16	1	16
26 m3 (coll+mix tank)	26	1	26
3m3 (tanks of separation)	3	2	6
			62

In addition, an assessment of further consequential spillage from connected pipes has calculated a maximum potential additional inventory volume of 2m3. (see chapter 14. Leak detection)

The total stored inventory volume is 64m3. 25% of this is 16m3
The total volume that could spill in a single failure comprises the Coll+Mix tank (26m3) plus the additional spill volume (2m3). 110% of this is 30.8m3
Inventory containment will therefore be provided for 30.8m3

Rainfall Depth

In addition to the inventory containment storage will be provided to accommodate one day duration design rainfall. Assessing the 1 in 10 Annual Event Probability (10% AEP) 1 day duration depth of rainfall using the Flood Estimate Handbook, a depth of 60.3mm mm has been determined.
Including the area of the open topped tank the total area is:
Contained area 360m2
Tank Area 33m2
Total 399m2
The volume of rainfall to be stored is therefore 399m2 x 60.3mm = 25.1m3
The total volume of inventory and rainfall to be stored is 30.8m3 + 25.1m3 = **55.9m3.**

Containment Storage

It is proposed that the total volume is stored below the slab level. Given the existing site constraints the tank dimensions will therefore be 10m x 3.3m x 1.7m deep. The tank wall will extend to the top of the adjacent perimeter wall, at 0.3m above the slab level. A small sump will be formed in the base of the tank to provide a point for pumping.
A guardrail will be provided around the perimeter of the tank.

Height, position and form of perimeter wall

The proposed height and position of the perimeter wall varies depending on location and function.

- Where its function is only to convey liquid to the containment tank it is a minimum of 0.3m high above the slab. This is in the vicinity of the separators.
- Where the position and height is affecting by jetting in the vicinity of the tanks it is 0.8m high.
- Along the Dryer Hall perimeter, it is also 0.8m high to tie in with Dryer Hall sheeting rail height.

The wall will be constructed from reinforced concrete and tied and sealed into the existing slab or proposed slab extensions. Locally, steps with guardrails will be constructed to allow access.
The gaps between the separator slab and process tanks slab will be sealed with a connecting concrete slab. Services penetrate the separator slab through an opening, and it is proposed the space around the services is sealed with a non-shrink grout to prevent liquid ingress. All joints in the slab will be sealed against liquid ingress.

IV. <u>Tank Emptying</u>

The tank will fill naturally by rainfall and will be emptied by pumping. Prior to emptying the liquid in the tank will be assessed, and if it meets the acceptability criteria will be pumped into the surface water system. If it fails to meet the criteria a decision will be made as to its suitability for pumping into the leachate system, or otherwise collected and disposed off site at a suitably licensed facility.

15. Leak detection and additional volume of largest tank on pasteurization slab

In addition to any leak detection system, the tanks should be maintained and a daily visual inspection has to be conducted.

To calculate the maximum spilling volume in the dryer hall, the biggest tank has to be defined. This is the coll+mix tank (CMT), which has a filling volume of 26 m^3 and a diameter of 2.391 m.

This tank is filled with pasteurized and thickened process water (PtPW) from the evaporator units and with digestate from the post digester. The CMT needs to be filled with 12 t/d of PtPW and 13 t/d of digestate. This results in a ratio of 0.92.
As the starting of the PtPW discharge from the evaporators is depending on its own control system the digestate pump is aligned to this discharge process. The volume transferred from the evaporators to the CMT is measured by the evaporators’ control system.

The leak detection system consists of two parts. Within the first part, leaks can be detected during the filling process. If the leak is quite small, the second part is needed. It is an automatic detection system with no need of assistance from the operator. In case of an alarm, the operator should of course check the tank and find the cause of the alarm.

For both parts, various influences on the tank system have to be considered.

Influence	Result for the detection system
level fluctuations because of stirrer	The stirrer is turning with 8.3 revolutions per minute (at 50 Hz). This is quite slow and no high-level fluctuations are expected. Additionally, the stirrer is turned off during part 2.
belt dryer demands for medium	The demand from the belt dryer is only small and can be stored in the dryer buffer tank during measuring.
discharge of the PtPW from the evaporators to the CMT during measuring	Discharge pump can use the alternative pumping route to the final storage tank during measuring period.
high level switch will be reached during filling routine	If the high-level switch is reached before the full amount of digestate is pumped to the CMT, the measuring is not valid. A leak can still be detected with the second part of the system.

I. <u>Leak detection system – part 1</u>

The volume of PtPW is registered and added every time the evaporators discharge to the CMT. After a total volume of 700 l is counted, the digestate pump will transfer medium to the CMT to ensure a homogeneous feeding material for the belt dryer. If the value of 700l is reached during a discharge process, it is waited until the routine is completed. Directly after the digestate pump started, the counter of the volume flow of PtPW into the CMT is reset and starts to count again. The amount of digestate transferred to the CMT is calculated as follows:

$$V_{digestate} = V_{PtPW} / 0.92 \qquad (1)$$

For control, the volume flow of digestate is measured with a flow meter. The calculated resulting level change from this value is then compared to the measured level change inside the CMT. Therefore, the level is registered when the digestate pump starts and again directly after it has stopped.

- If the level change correlates to the measured volume flow, everything is fine.
- If the level change is smaller than the expected value, a leak is possible.

With this procedure, it is taken into account, that the leak position can be higher than the starting level. If the leak is quite small and therefore the inflow is considerably bigger than the outflow, the leak will probably not be detected until the second part of the detection system has been completed.

The threshold for giving the "ok" signal is dependent on the inflow and the effect of the stirrer on the level. The following table shows the values for a typical case. As the effective amount of digestate to be transferred to the CMT is dependent on the PtPW discharge routine the threshold value changes accordingly. That means that the threshold has to be calculated for each measurement:

threshold value to trigger an alarm and stopp the pump:					
amount of PtPW transferred to CMT	0.7	m3	(assuming minimum value for this example)		
level change correspondent to 700l	0.16	m			
consider level fluctuations caused by the stirrer	0.12	m			

In this example a level increase of at least 0.12 m has to be detected. If the measured value is below the threshold, an alarm is triggered. Additionally, the pneumatic valves in both inlet pipes (coming from the evaporator system and the post digester) are being closed. As the digestate pump, as well as the evaporators, has alternative pumping routes, the pumps are not shut down, but only the feeding option to the CMT is blocked.

II. <u>Leak detection system – part 2</u>

If there was no alarm in the first part, and after the digestate pump has stopped feeding, the system checks if the dryer buffer tank demands for medium. In any case the dryer buffer tank is filled with until maximum filling level is reached to prevent any process interruption because of the testing period of 6 minutes. During this period, no material is allowed to be pumped to or discharged from the CTM. The evaporator system has to use the alternative pumping route to the final storage tank if PtPW needs to be discharged from the columns. Additionally, the stirrer inside the CTM is stopped.

This procedure takes into account the scenario, in which the inlet volume flow is much higher than the outflow and therefore the leak cannot be detected during filling. The reasons for a small outflow and therefore a small outflow velocity are either a small difference in height between the hole and the liquid level or a small size of the hole in the tank.

The duration of 6 minutes for the second detection level is chosen based on the following assumptions:

Leak hole is 10 cm below liquid level and has a diameter of 3 cm.

level drop should be minimum 5cm for the level sensor to be securely able to detect it.								
Volume to flow out	0.22	m3						
	minutes	volume change / m3			level change / m			
Volume after .. min	2	0.119						
	2.5	0.149						
	3	0.178						
	3.5	0.208						
	4	0.238	>	0.22 m3				
	4.5	0.267						
	5	0.297						
	5.5	0.327						
	6	0.356			0.08	m		
To take into account the level fluctuations due to the discharge of medium with 15 m3/h directly before the testing started,								
the minimum level drop is increased to 8 cm. Because of the dryer buffer tank, an prolonged testing period will not interrupt the drying process.								
This results in a testing period of 6 minutes.								

➔ If the level inside the CMT is dropping during this period, an alarm is triggered. Additionally, the pneumatic valves in both inlet pipes (coming from the evaporator system and the post digester) are being closed. As the digestate pump, as well as the evaporators, has alternative pumping routes, the pumps are not shut down, but only the feeding of the CMT is blocked.

If no alarm is raised, the evaporators are allowed to discharge into the CMT again, as long as the maximum filling level is not already reached. The stirrer has to run for at least 4 minutes to mix any possible inhomogeneity that might have been building up during the measuring process.

III. Conclusion:

The additional volume released to the bunded area has to be calculated based on the assumption that the evaporators discharge every 10 minutes (assumption given by MKR). As the evaporators might add PtPW to the CTM during the first part of the testing period, this volume has to be included in the containment design:

total discharge from MKR		15	m3/d		
		0.63	m3/h		
		0.10	m3/10 min		
starting condition:		0.7	m3	PtPW is discharged to the CMT	
worst case assumption, that 0.7m3 is reached at the beginning of one discharge routine.					
->	0.80	m3	have to be considered as starting additional volume		
volume of digestate to be added					
->	0.87	m3			
time needed to pump 0.7 m3 digestate into CMT				2.1	min
time needed to fill dryer buffer tank (2 m3)				8	min
time needed from starting until the testing period of 6 minutes in part 2:				10.1	min
-> volume of PtPW discharged into CTM during this time				0.11	m3
total additional volume inside bunded area:				1.78	m3

The additional volume that needs to be considered is about 1.78 m^3. As this value is based on the assumption of a constant PtPW discharge every 10 minutes, which in reality can only be verified during normal operation of the evaporators, a safety measure of 10% should be added. Therefore, an additional volume of 2 m^3 should be taken into account.

16. Leak detection system for tanks on process water slab

In addition to any leak detection system, the tanks should be maintained and a daily visual inspection has to be conducted. On the pasteurisation slab 6 tanks are positioned that need to be discussed.

Coll.+mix tank:
the biggest tank on the process water slab. The leak detection system is explained in detail in

Chapter 15.

PW tank:
The tank has a volume of 16 m^3 and will be filled with a volume flow 20 m^3/h. It is equipped with an overflow sensor and a level sensor. The level change inside the tank has to be compared to the difference of the filling volume and the discharge volume. Both volume flows are measured with a flow meter. The level is checked each time the feeding pump starts and again after the feeding pump has stopped. Additionally the discharge pump, which is filling the pasteurization tanks must not work during the measuring period. In case the measured level difference is less than 90% of the expected value, an alarm is given and the feeding pump is stopped. This measurement will only start if the expected level difference is bigger than 8 cm to avoid any error measurements.

2 Pasteurization tanks:
If the maximum filling time is exceeded, an alarm is triggered and the system is stopped.

Separation buffer tank / Separation PW tank:
Both tanks have each a volume of 3 m^3 and are equipped with a level sensor. The maximum filling volume flow of the separation buffer tank is approximately 20 m^3/h and the digestate is transferred from the post digester.
The separators are fed with two pumps, both transferring digestate from the separation buffer tank to the screw presses. Here the process water is separated from the solid material. This process water is then flowing constantly to the separation PW tank. The PW discharge pump (EYS) is now transferring the process water to the PW buffer tank. During normal operation, the ratio of input material to process water is constant as long as the same feedstock quality and composition is used in the fermenters. As starting value the ratio is 0.6 used in the control system. This has to be adjustable for verification during commissioning and in case of feedstock variation.
The leak detection is based on the measurement of the level change inside the tanks. First, the level drop in the separator buffer tank caused by transferring the digestate to the screw presses is measured. This value is compared to the level rise in the separation PW tank. As the ratio of input to process water is constant, the level change has to show the same ratio.

$$\frac{\Delta L_{separation\ PW\ tank}}{\Delta L_{separation\ buffer\ tank}} = 0.6$$

These measurements are only conducted, when the digestate pump at the post digester as well as the PW discharge pump (EYS), are not running. The first measuring point is recorded 1.5 minutes after the digestate pump has been stopped. Thereafter every 1.5 minutes the next measuring is made.

If the separation buffer tank has a leak, the level will drop faster than process water is produced and therefore faster than the separation PW tank is filled.

➔ The ratio is smaller as defined.

If the separation PW tank has a leak, it will counteract the level rise due to separated process water. Therefore the absolute level change after 1.5 minutes in the PW tank is smaller than normal.

➔ The ratio is smaller as defined.

Based on this ratio it is decided, if there could be a leak in one of the tanks. In case the level change ratio of two measurements in a row is smaller than 10% from the expected value, an alarm is triggered. Additionally the feeding of the separation by the digestate pump is blocked. The operator has to check immediately if one of the tanks has a leak. The separation and composting process will not be stopped immediately, as fluctuations can also be caused by variation of feedstock. In this case the level drop ratio has to be measured and defined again.

Prevention of overtopping

Once one of these systems detects a leak, the pumping of medium to the relevant tank has to be stopped. The leak detection system immediately stops the pump / feeding mechanism, which is leading directly to the relevant tank. This results in stopping of all the pumps upstream of this pump. Because the pumping routines are all dependent on the level inside the tanks, the pumps upstream will automatically be blocked by the control system. It has to be noted, that the upstream systems will not be blocked immediately after the leak detection gave an alarm. These will only stop if the tank, which should be filled, is already full. Because of this time delay there is the chance to verify the alarm and keep the plant running as long as possible and at the same time avoid spilling any more additional liquid. The shut of sequence will be in detail as described below (please see block flow diagram in appendix A for explanation):

Coll+mix tank:

1. The tank is filled by the digestate pump at the post digester and with the pasteurized and thickened process (PTPW) water from the evaporators.
2. If a leak is detected, the digestate pump will not stop, because it also has to deliver digestate to the separation. That means the inlet pipe of the coll+mix tank will be closed by a pneumatic valve. The separation and the processes downstream will run in normal operation until the evaporator is reached.
3. The evaporator does not get clearance to pump to the coll+mix tank. Therefore, the alternative pumping route is used and all the PTPW will be pumped to the final storage tank.

In case a leak is detected inside the coll+mix tank, the AD plant can run in normal operation. A bypass of the belt dryer and the coll+mix tank will be created by pumping the material directly to the final storage tank.

PW tank:

1. The process water tank is filled with the separated process water produced in the separator.
2. If this water cannot be pumped to the PW tank, the separation has to stop.
3. If the separation stops, the digestate pump at the post digester is only pumping material to the coll+mix tank as long as PTPW is still available for mixing.
4. The level inside the post digester will rise because of less demand for digestate and eventually the feeding of the digesters will be stopped.

Pasteurization tanks:

1. The pasteurization tanks are filled with process water from the PW tank.
2. If this pump is stopped, the PW tank cannot be emptied.
3. Therefore, the production of process water in the separator has to be stopped.
4. If the separation is stopped, the digestate pump at the post digester is only pumping material to the coll+mix tank as long as PTPW is still available for mixing.
5. The level inside the post digester will rise because of less demand for digestate and eventually the feeding of the digesters will be stopped.

Separation buffer tank / separation PW tank:

1. The separation buffer tank is filled with digestate from the post digester.
2. If the pump does not get clearance to fill the separation buffer tank, it will pump the digestate to the coll+mix tank as long as PTPW is still available for mixing.
3. The level inside the post digester will rise because of less demand for digestate and eventually the feeding of the digesters will be stopped.

Hydraulically linked tanks

There are no hydraulically linked tanks on the pasteurization slab. On each filling/emptying pipe connected to the tanks, a pump and an automatically controlled valve is installed, which divide the system into hydraulically separate tanks.

17. Overfill protection

Each tank supplied by Agraferm is equipped with an analogue level sensor and a digital overfill protection. The switch points will be active in the same sequence as listed below, starting with the lowest level.

The level sensor has two high switch points:

- At the first (SH) switch point, the feeding pump for the corresponding tank is stopped.
- At the second (ASHH) switch point, the pneumatic valve in the inlet pipe is closed. Additionally, it is checked again if the feeding pump is stopped and an alarm is given.

As second line of defence the overfill sensor is mounted. In case of failure of the level sensor, the overfill sensor will prevent any overtopping of the tank. The switch point of this sensor is active at a higher level than the analogue level sensor:

- At the ASH switch point, the feeding pump is stopped, the pneumatic valve in the inlet pipe is closed and an alarm is raised.

The analogue level sensor is measuring the hydrostatic pressure in the tank. The level is

calculated based on the measuring value. The sensor probe is mounted 200mm above the tank bottom.
The digital overfill sensor is a swing sensor, which detects the vibrations when the liquid medium is reaching the sensor head. The sensor is mounted below the lower edge of the inlet pipe to prevent any backflow into the pipe.

18. Surface Water Lagoon

I. Specification of Attenuation Pond

Copy of Drawing 2341-PH2-6003 is attached showing the layout of the attenuation pond, and details of the lining installed.
Copy of drawing 2341-PH2-6002 is attached showing details of the drainage works associated with the pond:

a. The inlet and outlet headwalls. During the construction phase the Contractor proposed using pre-cast concrete headwalls and this was accepted
b. The hydro brake chamber
c. Inspection Chamber
d. Valve and Chamber

II. Inspection and Remedial works

Remedial work is required on the inspection chamber, located between the valve chamber and the hydro brake manhole, between the pond outlet and the ditch. Water has been observed entering this manhole between the walls and the benching, and it thus reasonable to assume that discharge water (conceivably leachate contaminated) could flow out of the manhole in the same way.
It is proposed that the concrete surround to this inspection chamber is excavated and exposed and an additional concrete surround is constructed to seal the chamber.
Also, the gate valve will be replaced with a butterfly valve downstream of the outlet headwall, to give further assurance that this valve will not be impacted by debris causing leakage past the valve.
At the same time, the pre-cast concrete outlet headwall will be excavated and investigated to confirm that the welded uPVC pond lining has been tied in to the concrete headwall. If the sealing of the lining to the headwall is found to be defective, this will be corrected before the area is backfilled.

III. DRAINAGE REVISIONS

1. All surface water flowing normally into the attenuation pond is being diverted into the leachate storage tank until the Phase 1 Remedial Works have been completed and the pond lining has been cleaned out (see below).

2. Initially this is done by pumping water from the oil/water interceptor tank directly in to manhole L10 from where it will flow by gravity in to the underground leachate storage tank. Then the first operation on the Phase 1 Remedial Works will be to construct the new manhole downstream of the interceptor tank, valves and the new connection to the leachate tank. As soon as this is commissioned, pumping will cease and the entire surface water system will be diverted by gravity in to the leachate storage tank.

3. Other than localised rainfall, the attenuation pond will be kept empty during this period of the Remedial Works.

4. The bird netting over the pond will be removed, to be replaced later.

5. Contaminated stones on top of the pond lining will be removed and disposed of.

6. The geotextile fabric layer will be removed and disposed of.

7. The pond lining will be cleaned and checked for damage.

8. If any defects are found, the lining will be repaired.

9. Geotextile layer, slate protection layer and bird netting will be replaced.

19. Appendix A – Drawings

- **drawing 2341-PH2-6020**
- **drawing 2341-PH2-6021**
- **drawing 2341-PH2-6022**
- **drawing 2341-PH2-3021**
- **drawing 2341-PH2-1010**
- **drawing 2341-PH2-6012**
- **drawing 2341-PH2-6011**
- **drawing 2341-PH2-6003**
- **drawing 2341-PH2-6002**
- **A2529UK_MONA-block flow diagram**
- **160690e**

20.Appendix B – Data sheets

- **Technische Daten Säurebehälter und Füllschrank**