ISHECON
CHEMICAL PROCESS SAFETY ENGINEERS

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Ms Sharleen Moodley
Environmental Consultant
Royal HaskoningDHV
Pinetown
082 5711 425

15 April 2014

Dear Madam,

RE: MAJOR HAZARD INSTALLATION CLASSIFICATION FOR THE UPGRADE OF THE SOUTHERN WASTE WATER TREATMENT WORKS (SWWTW)FACILITIES IN MEREWENT

INTRODUCTION

eThekwini Metro Water and Wastewater are responsible for the treatment of all municipal sewage in the greater eThekwini area. The SWWTW facilities process sewer effluent that is a combination of domestic and industrial in origin. It receives the majority of its raw sewage effluent through three large trunk sewers, with some lesser subsidiaries from local industry, as well as various smaller additional volumes of effluent discharged by road tankers.

The current practice is for all treated outflows to be discharged to sea. The aim of the proposed SWWTW upgrades is to reduce the quantity of suspended solids being disposed of to sea by affording primary treatment to the combined effluent discharges from two of the trunk sewers. This physical treatment process (through primary settling) will result in the organic load to sea being drastically reduced. The settled solids (referred to as primary (or raw) sludge) will then be removed and stabilised through a process of anaerobic digestion, before being dewatered.

SWWTW propose to refurbish and bring on-line a number of existing items of decommissioned processing equipment, as well as constructing new facilities. A layout of the existing and proposed new facilities on site can be found in **ATTACHMENT A** and a list of all facilities to be included in the proposed upgrade can be found in **ATTACHMENT B**.

SWWTW have requested an opinion on the classification the site as a Major Hazard Installation. At present in South Africa the classification of a facility as an MHI depends on firstly whether there is any notifiable substance on site hazardous substance that is listed in the General Machinery Regulations of the Occupational Health and Safety Act is processed, handled or stored, and the content exceeds the quantity stipulated. Pressurized methane is a listed material with a threshold quantity of 15t. The largest single storage unit of methane at the SWWTW site is less than 2 tons (5000 m^3 primary digester, 60% of volume methane with a SG of 0.55 kg/m^3). Therefore the site would not be a compulsory MHI by this criterion. However, there is a second clause in the definition of an MHI. This clause relates to the ability to cause a major incident or catastrophe. At present this is understood to mean the potential to fatally impact on public persons outside the site. If there are large explosions, fires or releases of toxic gases that, under abnormal accident conditions, could have major offsite impacts the facility should be classified as an MHI

HAZARD IDENTIFICATION

None of the existing operational facilities on site are expected to pose a major hazard, and thus only the facilities involved in the re-commissioning and upgrade project have been included in this classification study. SWWTW has supplied a list of buildings and processing equipment that will be involved in the upgrade (see **ATTACHMENT B**).

FLAMMABLE GASSES

The digestion process produces flammable biogas, consisting of roughly 40% carbon dioxide, and 60% methane (note there will be a small component of hydrogen disulphide and other contaminants). Thus there will be flammable gas present inside all the digesters (with volumes of between 4500 m^3 and 5000 m^3), as well as inside the gas holder and related piping. The sludge drying facility will possibly also be fuelled by

biogas, and thus a loss of containment scenario could result in the presence of biogas inside the drying building.

Once phase 2 of the upgrade is complete, and assuming all vessels/digesters are filled to capacity with only biogas, there could be a maximum possible inventory of 71500 m^3 i.e. ± 67 tons. If this site were in Europe or the UK, it would also be considered an MHI Site. Natural gas (methane) is a named substance as per Part 2 of Schedule 1 of the COMAH Regulations. A site would need to have more than 50 tons of natural gas to be considered a LOWER TIER COMAH site. Those sites having more than 200 tons of would be UPPER TIER COMAH sites. The SWWTW site with a maximum inventory of ± 67 tons of natural gas would be considered a LOWER TIER COMAH site by this criterion. This is relevant, as in South Africa the MHI regulations are under review, and we are expecting to follow the European system more closely in future.

LIQUEFIED GASES

There will be no large quantities of liquefied gasses on the site.

FLAMMABLE LIQUIDS

There will be no large quantities of flammable liquids on the site.

OXIDISERS, EXPLOSIVES AND OTHER

There will be no oxidisers, explosives, flammable solids etc. on site.

TOXIC MATERIALS

CO_2 is an asphixiant, and H_2S is extremely toxic, and both are present in biogas. However H_2S accounts for less than 1% of the gas' volume, and the asphyxiating effects of CO_2 do not extend very far from the point of release. In ISHECON's experience, a 5000m^3 release of biogas will only have toxic effects up to a maximum of 25 m from the point of origin, and thus due to the location of the facilities in relation to the site boundaries, the toxic hazards of biogas would not affect the site's MHI classification.

HAZARDOUS SCENARIOS

This is preliminary MHI screening study and therefore only 6 potential worse case events have been modelled to determine if there are possible offsite impacts. The scenarios are all related to biogas releases, or internal explosions inside the vessels.

1. Primary digester internal explosion (due, for example, to inadequate purging during maintenance and ignition of flammable vapours inside the vessel).
2. Secondary digester internal explosion (due, for example, to inadequate purging during maintenance and ignition of flammable vapours inside the vessel).
3. Biogas (gas) holder internal explosion (due, for example, to inadequate purging during maintenance and ignition of flammable vapours inside the vessel).
4. Sludge drying building internal explosion (due to loss of containment of biogas into building and subsequent ignition thereof).
5. Biogas transfer line rupture and explosion of flammable vapours.
6. Biogas gas holder catastrophic rupture and explosion of flammable vapours.

Note that events with substances that are not chemically hazardous, such as a dust explosion in dried compost silos are not considered in this MHI screening. These types of events are well known and protection against them should be incorporated in good design and operations of the facility.

CONSEQUENCE ANALYSIS

The possible fires and explosions resulting from the above failure events were modelled using PHAST 6.7.The table below indicates the distances to the MHI thresholds, i.e. the distance up to which there may be fatal impacts under worst case conditions. The table compares these to the distances to the site boundary.

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No	Failure	Possible Resultant Event	Distance to MHI Threshold	Distance to Site Boundary	MHI
1	Primary digester internal explosion (due for example to inadequate purging during maintenance).	Explosion	57	42	**Yes**
2	Secondary digester internal explosion (due for example to inadequate purging during maintenance).	Explosion	55	60	No
3	Biogas holder internal explosion (due for example to inadequate purging during maintenance).	Explosion	55	90	No
4	Sludge drying building internal explosion (due to loss of containment of biogas into building and subsequent ignition thereof).	Explosion	29	28	**Marginal**
5	Biogas transfer line rupture and explosion of flammable vapours.	Delayed explosion	42	65	No
6	Biogas gas holder catastrophic rupture and explosion of flammable vapours.	Delayed explosion	110	90	**Yes**
		Flash fire	60	90	No

From the above it is clear that only the catastrophic rupture of one of the gas holders, or an internal explosion inside the digesters that are situated within 60 m of the site boundary will lead to major offsite effects. As a result of these potential failure scenarios, the site must be classified as a Major Hazard Installation.

CONSEQUENCE AND RISK REDUCTION

SWWTW have provided a provisional site layout **(ATTACHMENT A)**. The placement of the new processing equipment and buildings to be erected on the SWWTW site should be carefully considered in light of the consequence analysis shown above. For the digesters it is suggested that, where possible, the new digesters be situated at least 60m from the site boundaries (limit of likely offsite fatalities), and that the new gas holders be situated at least 110 m from the site boundaries. Due to the fact that existing facilities such as the decommissioned digesters and gas holders are being re-commissioned, it is not plausible to suggest that they be moved, and while the consequences can therefore not be reduced, risk reduction methods such as hazardous area classifications to control ignition sources, maintenance and hot work procedures should be put into place.

FIGURE 1 –Primary Digester Internal Explosion

- Yellow = 70 kPa - Severe damage (22m radius)
- Green = 14kPa - MHI threshold, 1% lethality (57m radius) – extends beyond the site boundary
- Blue = 7 kPa - Maximum extent of minor injuries (90m radius)

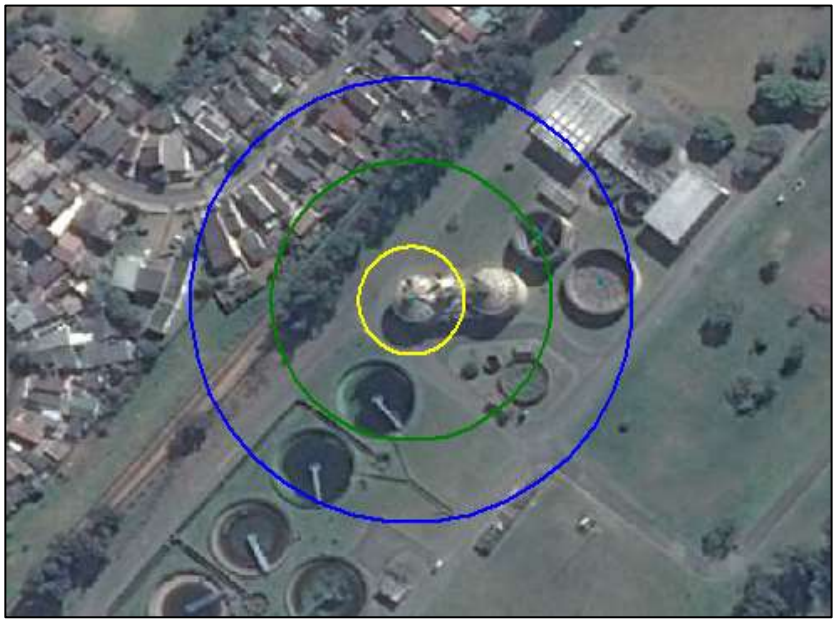


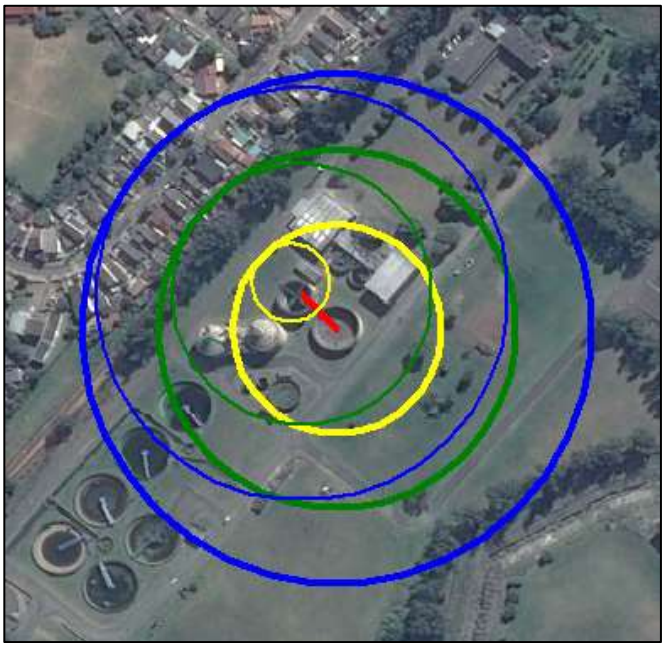
FIGURE 2 – Sludge Drying Room Internal Explosion

- Yellow = 70 kPa - Severe damage (10m radius)
- Green = 14kPa - MHI threshold, 1% lethality (29m radius) –extends just beyond the site boundary
- Blue = 7 kPa - Maximum extent of minor injuries (47m radius)

FIGURE 3 – Gas Holder Catastrophic Rupture and Delayed Ignition

Bold circles show maximum extent in any wind direction. Small faint circles are actual explosion for a SE wind.

- Yellow = 70 kPa - Severe damage (64m radius)
- Green = 14kPa - MHI threshold, 1% lethality (110m radius)
- Blue = 7 kPa - Maximum extent of minor injuries (155m radius)



If ignition of the gas cloud occurs early (i.e. the epicentre is close to the ruptured gas holder) the damage / fatalities should be limited to within the SWWTW site. Late ignition of the cloud could result in the damage and fatalities extending over 110m from the gas holder, i.e. affecting nearby houses.

CONCLUSIONS

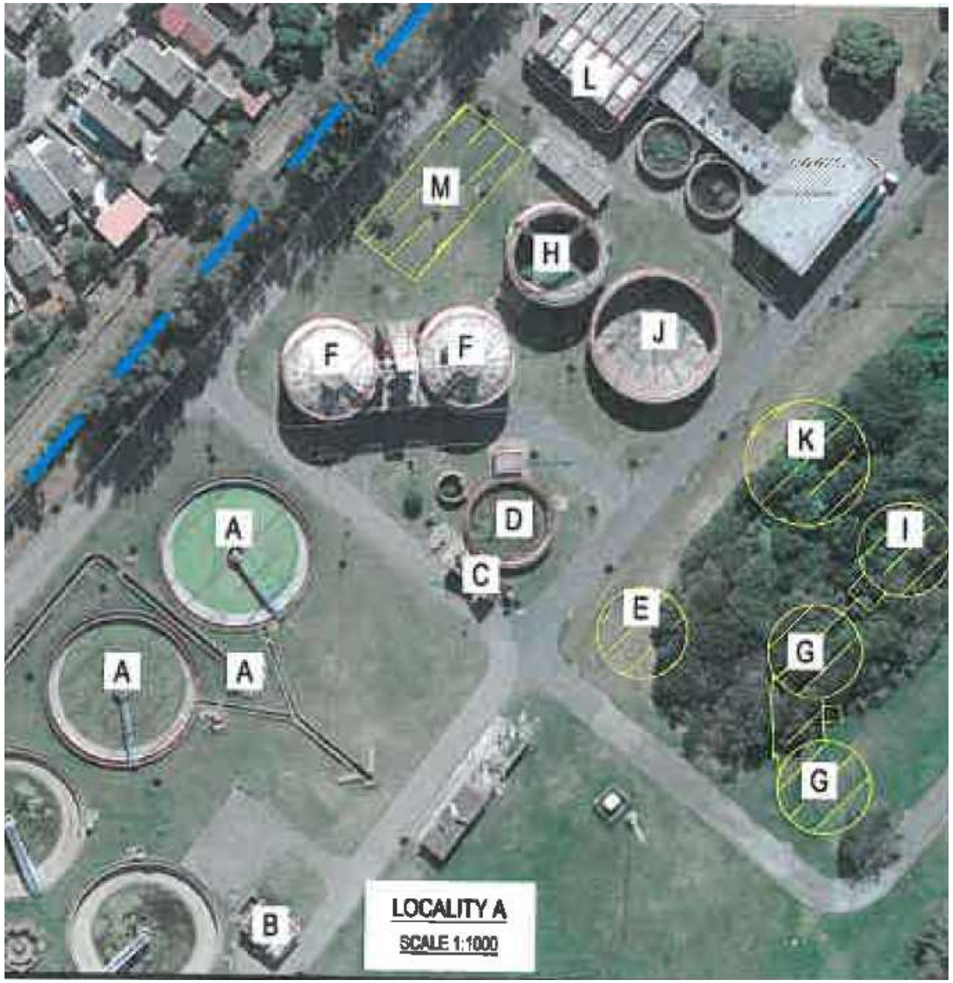
The re-commissioned and the new facilities to be constructed during the proposed upgrade of the SWWTW facilities should be classified as an MHI and a full risk assessment will be required. For new facilities this risk assessment should be conducted in parallel with the environmental impact assessment and basic engineering design. In addition all the notifications to relevant MHI authorities should be completed prior to construction of the facility (usually a 6 – 7 month process). Given the relatively small nature of the MHI risks posed by the facility, the MHI notification process is unlikely to halt the project.

Please note that the classification of the site will change if the MHI regulations are revised at some point in the future, and the site will likely no longer be considered an MHI.

Yours Sincerely

Debra Mitchell Pr.Eng
ISHECON Risk Assessor
(See AIA certificate **ATTACHMENT C**)

ATTACHMENT A – Proposed Site Layout



SCOPE OF WORKS			
ZONE	PROCESS		DESCRIPTION
A	PRIMARY TREATMENT	UPGRADE TO ETHEKWINI SOUTHERN WASTEWATER TREATMENT WORKS	REFURBISHMENT OF 2x 30ML/d PRIMARY SEDIMENTATION TANKS, EFFLUENT CHANNEL & SPLITTER BOX.
B	PRIMARY TREATMENT		UPGRADE & REFURBISHMENT OF EXISTING PRIMARY SLUDGE PUMP STATION.
C	SLUDGE THICKENING		INSTALLATION OF SLUDGE DEGRITTING FACILITY.
D	SLUDGE THICKENING		REFURBISHMENT OF EXISTING SLUDGE THICKENER & PUMP STATION.
E	SLUDGE THICKENING		CONSTRUCTION OF A NEW SLUDGE THICKENER & PUMP STATION.
F	SLUDGE DIGESTION		REFURBISHMENT OF EXISTING 2x PRIMARY DIGESTERS & ASSOCIATED HEATING & MIXING FACILITY.
G	SLUDGE DIGESTION		CONSTRUCTION OF 2x NEW PRIMARY DIGESTERS & ASSOCIATED HEATING & MIXING FACILITY.
H	SLUDGE DIGESTION		REFURBISHMENT OF EXISTING SECONDARY DIGESTER & PUMP STATION.
I	SLUDGE DIGESTION		CONSTRUCTION OF A NEW SECONDARY DIGESTER & PUMP STATION.
J	BIO-GAS STORAGE		REFURBISHMENT OF EXISTING GAS HOLDER.
K	BIO-GAS STORAGE		CONSTRUCTION OF A NEW GAS HOLDER.
L	SLUDGE DEWATERING		CONSTRUCTION OF A NEW INLINE DEWATERING FACILITY.
M	SLUDGE DRYING		CONSTRUCTION OF A NEW SLUDGE DRYING FACILITY.
N	GENERAL WORKS		CONSTRUCTION OF A NEW TANKER BAY FACILITY AND ACCESS ROAD.
O	FINAL EFFLUENT DISCHARGE		CONSTRUCTION OF A NEW 2 ML RAW SEWAGE STORAGE BASIN.
P	FINAL EFFLUENT DISCHARGE		UPGRADE OF EXISTING LOW-LIFT PUMP EFFLUENT PUMP STATION.
Q	FINAL EFFLUENT DISCHARGE		70m PORTION OF LAND BASED SEA-OUTFALL TO BE REPLACED. 2X1m diam

CO-ORDINATES		
POINT	Y	X
A	-2959.225	3315281.274
A	-2998.303	3315314.502
A	-2999.227	3315314.184
B	-2909.302	3315372.874
C	-2912.942	3315291.103
D	-2558.229	[illegible]
E	-2575.817	[illegible]
F	-2947.402	3315044.278
F	-2148.083	[illegible]
G	-2932.982	3316334.377
G	-2546.309	[illegible]
H	-2587.060	3315211.030
I	-2615.387	[illegible]
J	-2573.998	[illegible]
K	-2638.494	[illegible]
L	-2588.043	[illegible]
M	-2916.190	[illegible]
N	-2381.304	[illegible]
O	-2278.279	3315054.436
P	-2575.105	[illegible]
Q	-3015.497	[illegible]

ATTACHMENT B – List of processing equipment and buildings involved in the proposed upgrade to SWWTW

The work to be completed under each phase is proposed as follows:

Phase 1:

a) Refurbish and bring back on line two out of six existing primary settling tanks
b) Refurbish and bring back on line existing two anaerobic primary digesters and secondary digester and construct two new primary digesters and one secondary digester, all of same capacity as existing.
c) Refurbish and bring back on line existing raw sludge gravity thickener and construct a new gravity thickener of the same capacity
d) Refurbish and bring back on line existing gas holder and construct a new gas holder of the same capacity.
e) Refurbish and bring back on line various existing (unused) electrical substation buildings and small pumping stations.
f) Establishing a new mechanical sludge dewatering facility on site and 2 x 150 000 litres fully enclosed steel sludge storage silos.
g) Establishment a new mechanical sludge thermal drying facility on site.
h) Provide additional effluent storage capacity of 23 000 000 litres at existing low level pumping station and install two new 350 kilowatt pumps.
i) Replace the last 70 m of the landline section of the sea outfall pipeline with new 2x 1000 m diameter pipe.
j) Construct new road tanker effluent discharge bays in close proximity to the entrance of the Works.
k) Install new medium voltage and low voltage electrical cables and equipment.
l) Minor road works and a new access road
m) The installation of a standby generator.

Phase 2:

a) Refurbish and bring back on line remaining four of the existing six primary settling tanks and construct two new primary settling tanks of the same capacity as existing.
b) Construct four new anaerobic primary digesters and two new secondary digesters, all of the same capacity as existing.
c) Construct a new raw sludge gravity thickener, of the same capacity as existing.
d) Construct a new gas holder.
e) Install additional mechanical sludge dewatering equipment.

ATTACHMENT 3 – AIA Certificate

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South African National Accreditation System

CERTIFICATE OF ACCREDITATION

In terms of section 22(2) (b) of the Accreditation for Conformity Assessment, Calibration and Good Laboratory Practice Act, 2006 (Act 19 of 2006), read with sections 23(1), (2) and (3) of the said Act, I hereby certify that:-

ISHECON CC
Co. Reg. No.: 1999/029022/23
MODDERFONTEIN

Facility Accreditation Number: **MHI0008**

is a South African National Accreditation System accredited Inspection Body to undertake **TYPE A** inspection provided that all SANAS conditions and requirements are complied with

This certificate is valid as per the scope as stated in the accompanying schedule of accreditation, Annexure "A", bearing the above accreditation number for

THE ASSESSMENT OF RISK ON MAJOR HAZARD INSTALLATIONS

The facility is accredited in accordance with the recognised International Standard

ISO/IEC 17020:1998

The accreditation demonstrates technical competency for a defined scope and the operation of a quality management system

While this certificate remains valid, the Accredited Facility named above is authorised to use the relevant SANAS accreditation symbol to issue facility reports and/or certificates

Mr R Josias
Chief Executive Officer

Effective Date: 13 June 2013
Certificate Expires: 12 June 2017

This certificate does not, on its own confer authority to act as an Approved Inspection Authority as contemplated in the Major Hazard Installation Regulations. Approval to inspect within the regulatory domain is granted by the Department of Labour.