Q. **C-11; Volume I, Tab 5: Upgrade Powerhouse Roofing – Holyrood**

Please provide a legible copy of Appendix A **Table 4 - Condition Summary and Risk Assessment**.

A. Please find attached as PUB-NLH-013 Attachment 1, a legible copy of Appendix A **Table 4 - Condition Summary and Risk Assessment**.

6.0 CONDITION AND RISK SUMMARY

The following table summarizes component level condition, and the technical and safety risk for the components addressed in the current report for Holyrood TGS. It is to be noted that the desired remaining life for the components assessed in this report is 30 years (to 2041).

The risk rankings and mitigating actions considered the 30 year life horizon. Risk is assessed relative to technical and economic (Techno-Eco) risk, and Safety risk. Techno-Eco risk includes repair and lost generation revenue (outage time). The likelihood ranking (and risk) is biased to the near term generating period.

Safety risk represents safety to site based personnel.

Where identified, asset designation is provided based on the asset register identified in the Phase 1 final report [R-1].

Asset Register

Asset Class:	BU 1296 Assets Generation
	BU 1297 Assets Commons
	BU 1325 Assets Holyrood Switchyard
Asset Level 2	7635 #2 (Unit 2), 6690 #1 (Unit 1)
	Buildings and Site – 7255
	Water Treatment and Environment – 9739
	Unit 3 Generator – 8193
Asset Level 3:	Buildings – 272255
	Waste Water Treatment System – 10038
	Drainage – 6781 #1, 7699 #2, 8257 #3
	Unit 3 Generator – 8194

Asset number beyond Level 3 is provided in Table 4. For each risk ranking, the expected failure event is described. Mitigating actions are also described. The actions are intended to reflect the component level recommendations in Section 7.

Table 4 Condition Summary and Risk Assessment

Asset # 3	Asset # 4	Asset # 5	Description	Component	Major Issues	Remaining Life Years[1] (Insufficient Info - Inspection Required)	Remaining Life Comments	TECHNO-ECO RISK ASSESSMENT MODEL			SAFETY RISK ASSESSMENT MODEL			Possible Failure Event	Mitigation
								Likeli-hood	Conse-quence	Risk Level	Likeli-hood	Conse-quence	Safety Risk		
Main Powerhouse Roof Assessment															
272255	7283	0	Roof A - BUR w/ aluminized coating	exposed to view roofing membrane	hairline cracks in aluminized coating	2	It is likely that cracks will spread and deepen to the extent that leaks will develop	3	A	LOW	2	C	MED	failure could include leaking and/or blow-off. Leaking could be detrimental to electrical equipment while flying debris could be injurious to persons and equipment.	immediate spot repairs recommended - annual inspection thereafter
272255	7283	0	Roof A1 - Inverted roofing system	roofing membrane below insulation and stone ballast - cannot be seen	minor damage to counter flashing - light fixture bolted through parapet	10	this roof should perform well as long as the minor issues indicated are addressed quickly	2	A	LOW	2	D	HIGH	failure could include leaking and/or blow-off. Leaking could be detrimental to electrical equipment while flying debris could be injurious to persons and equipment.	annual inspection to ensure adequate depth and spread of ballast + condition of penetrations
272255	7283	0	Roof B - BUR w/ aluminized coating	exposed to view roofing membrane	insulation board shapes telegraphed through membrane - membrane cracking evident	2	it is likely that cracks will spread and deepen to the extent that leaks will develop	3	A	LOW	2	C	MED	failure could include leaking and/or blow-off. Leaking could be detrimental to electrical equipment while flying debris could be injurious to persons and equipment.	immediate spot repairs recommended - annual inspection thereafter
272255	7283	0	Roof B1 - BUR w/ aluminized coating	exposed to view roofing membrane	hairline cracks in aluminized coating	5	it is likely that cracks will spread and deepen to the extent that leaks will develop	2	A	LOW	2	C	MED	failure could include leaking and/or blow-off. Leaking could be detrimental to electrical equipment while flying debris could be injurious to persons and equipment.	immediate spot repairs recommended - annual inspection thereafter
272255	7283	0	Roof C - BUR w/ aluminized coating	exposed to view roofing membrane	large asphalt patch on roof - steam showing from centre of 3 roof drains	5	though this roof is in fair condition, it is likely to develop cracking in the relatively near future	2	A	LOW	2	C	MED	failure could include leaking and/or blow-off. Leaking could be detrimental to electrical equipment while flying debris could be injurious to persons and equipment.	service life could be extended by spot repairs and re-flooding/re-ballasting
272255	7283	0	Roof C1 - Inverted roofing system	roofing membrane below insulation and stone ballast - cannot be seen	filter fabric not evident - minor wind scowering one location	8	as the roof is missing filter fabric and there has been wind scouring of stone ballast, it is possible that this roof will fail prematurely	2	A	LOW	2	D	HIGH	failure could include leaking and/or blow-off. Leaking could be detrimental to electrical equipment while flying debris could be injurious to persons and equipment.	Inspect insulation and EPDM membrane and repair as necessary - check for and replace filter fabric. Add stone ballast to ensure required coverage and depth. Annual inspection thereafter.
272255	7283	0	Roof D - BUR w/ aluminized coating	exposed to view roofing membrane	Partial denuding -evidence of scowering prior to coating application - ridging and cracking evident	2	it is likely that cracks will spread and deepen to the extent that leaks will develop	3	A	LOW	2	C	MED	failure could include leaking and/or blow-off. Leaking could be detrimental to electrical equipment while flying debris could be injurious to persons and equipment.	immediate spot repairs recommended - annual inspection thereafter

[1] It is assumed the units have and will continue to be operated within limits (temperatures and pressures) specified by operating procedures.

Asset # 3	Asset # 4	Asset # 5	Description	Component	Major Issues	Remaining Life Years[1] (Insufficient Info - Inspection Required)	Remaining Life Comments	TECHNO-ECO RISK ASSESSMENT MODEL			SAFETY RISK ASSESSMENT MODEL			Possible Failure Event	Mitigation
								Likeli-hood	Conse-quence	Risk Level	Likeli-hood	Conse-quence	Safety Risk		
272255	7283	0	Roof D1 - Inverted roofing system	roofing membrane below insulation and stone ballast - cannot be seen	roof drain - grassed over -several protruding building column caps evident - filter fabric needs replacement in areas - stone ballast required to be raked level - damage evident to filter fabric - pitch pockets at steps form interior of building to roof	10	this roof is in fair condition and should perform well with suggested mitigation	2	A	LOW	2	D	HIGH	failure could include leaking and/or blow-off. Leaking could be detrimental to electrical equipment while flying debris could be injurious to persons and equipment.	rake existing stone ballast and add additional ballast to ensure required coverage and depth - annual inspection there
272255	7283	0	Roof E - BUR w/ aluminized coating	exposed to view roofing membrane	some ridging and denuding - - broken light fixture not well secured - steam from one roof drain	5	it is likely that cracks will spread and deepen to the extent that leaks will develop	2	A	LOW	2	C	MED	failure could include leaking and/or blow-off. Leaking could be detrimental to electrical equipment while flying debris could be injurious to persons and equipment.	immediate spot repairs recommended - annual inspection thereafter
272255	7283	0	Roof E1 - Inverted roofing system	roofing membrane below insulation and stone ballast - cannot be seen	minor denuding - varying thickness patio slabs - stone ballast requires raking	10	this roof should perform well as long as the minor issues indicated are addressed quickly	2	A	LOW	2	D	HIGH	failure could include leaking and/or blow-off. Leaking could be detrimental to electrical equipment while flying debris could be injurious to persons and equipment.	rake existing stone ballast and add additional ballast to ensure required coverage and depth - annual inspection there
272255	7283	0	Roof F - BUR w/ aluminized coating	exposed to view roofing membrane	10 m x 13 m patch of unknown material - 1 x 3 metre asphaltic patch at east roof divider - minor membrane cracking evident - insulation board shapes telegraphed through membrane	2	it is likely that cracks will spread and deepen to the extent that leaks will develop	3	A	LOW	2	C	MED	failure could include leaking and/or blow-off. Leaking could be detrimental to electrical equipment while flying debris could be injurious to persons and equipment.	immediate spot repairs recommended - annual inspection thereafter
272255	7283	0	Roof F1 - unknown fully adhered membrane w/ aluminized coating	exposed to view roofing membrane	50% of roof is unknown membrane, 50 % of roof is BUR w/o coating - there is standing water at parapet	2	membrane (other than the portion which is BUR) is very soft and susceptible to penetration by slight impact - both membranes in poor condition.	3	A	LOW	2	C	MED	failure could include leaking and/or blow-off. Leaking could be detrimental to electrical equipment while flying debris could be injurious to persons and equipment.	immediate assessment recommended - remedial action to be based on outcome of assessment - annual inspection thereafter
272255	7283	0	Roof G - unknown fully adhered membrane w/ aluminized coating	exposed to view roofing membrane - 5 traffic pads secured to membrane	unknown membrane type - soft - susceptible to puncturing	2	unknown membrane type - soft - susceptible to puncturing	3	A	LOW	2	C	MED	failure could include leaking and/or blow-off. Leaking could be detrimental to electrical equipment while flying debris could be injurious to persons and equipment.	immediate assessment recommended remedial action to be based on outcome of assessment - annual inspection thereafter
272255	7283	0	Roof G1 - unknown fully adhered membrane w/ aluminized coating	exposed to view roofing membrane	unknown membrane type - soft - susceptible to puncturing	2	unknown membrane type - soft - susceptible to puncturing	3	A	LOW	2	C	MED	failure could include leaking and/or blow-off. Leaking could be detrimental to electrical equipment while flying debris could be injurious to persons and equipment.	immediate assessment recommended remedial action to be based on outcome of assessment - annual inspection thereafter
272255	7283	0	Roof G2 - unknown fully adhered membrane w/ aluminized coating		50% of roof is unknown membrane, 50 % of roof is BUR w/o coating - there is standing water at parapet	2	membrane (other than the portion which is BUR) is very soft and susceptible to penetration by slight impact - both membranes in poor condition.	3	A	LOW	2	C	MED	failure could include leaking and/or blow-off. Leaking could be detrimental to electrical equipment while flying debris could be injurious to persons and equipment.	immediate assessment recommended - remedial action to be based on outcome of assessment - annual inspection thereafter
272255	7283	0	Roof H - unknown fully adhered membrane w/ aluminized coating	exposed to view roofing membrane - 5 traffic pads secured to membrane	unknown membrane type - soft - susceptible to puncturing	2	unknown membrane type - soft - susceptible to puncturing	3	A	LOW	2	C	MED	failure could include leaking and/or blow-off. Leaking could be detrimental to electrical equipment while flying debris could be injurious to persons and equipment.	immediate assessment recommended remedial action to be based on outcome of assessment - annual inspection thereafter

Asset # 3	Asset # 4	Asset # 5	Description	Component	Major Issues	Remaining Life Years[1] (Insufficient Info - Inspection Required)	Remaining Life Comments	TECHNO-ECO RISK ASSESSMENT MODEL			SAFETY RISK ASSESSMENT MODEL			Possible Failure Event	Mitigation
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272255	7283	0	Roof I - BUR - no coating	exposed to view roofing membrane	roof does not drain well - standing water - ridging evident - partial denuding	5	it is likely that denuding will spread over time thus exposing more of the felt roofing membrane to UV rays and therefore degradation	2	A	LOW	2	C	MED	failure could include leaking and/or blow-off. Leaking could be detrimental to electrical equipment while flying debris could be injurious to persons and equipment.	immediate spot repairs recommended - annual inspection thereafter
272255	7283	0	Roof J - BUR - no coating	exposed to view roofing membrane	minor denuding - 14 concrete safety fence supports laid on roofing membrane - standing water - ridging	5	it is likely that denuding will spread over time, thus exposing more of the felt roofing membrane to UV rays and therefore degradation	2	A	LOW	2	C	MED	failure could include leaking and/or blow-off. Leaking could be detrimental to electrical equipment while flying debris could be injurious to persons and equipment.	immediate spot repairs recommended - annual inspection thereafter
272255	7283	0	Roof J1 - BUR - no coating	exposed to view roofing membrane	Roof generally in poor condition – roof sloped to one pipe scupper – does not drain well	4	the roof is likely to have its life extended if minor upgrading is carried out to it	2	A	LOW	2	C	MED	failure could include leaking and/or blow-off. Leaking could be detrimental to electrical equipment while flying debris could be injurious to persons and equipment.	
272255	7283	0	Roof K - BUR - no coating	exposed to view roofing membrane	1 x 1.2 x 1.2 m high hydrogen piping penetration enclosures - minor denuding, ridging and scouring - sleepers for 2 cooling units - penetrations for hydrogen gas pipes	5	it is likely that denuding and scouring will spread over time, thus exposing more of the felt roofing membrane to UV rays and therefore degradation - sleeper and penetration flashing to be checked	2	A	LOW	2	C	MED	failure could include leaking and/or blow-off. Leaking could be detrimental to electrical equipment while flying debris could be injurious to persons and equipment.	immediate spot repairs recommended - annual inspection thereafter
272255	7283	0	Roof L - BUR - no coating	Exposed to view roofing membrane	1 x 1.2 x 1.2 m high hydrogen piping penetration enclosures - minor denuding, ridging and scouring - sleepers for 2 cooling units - penetrations for hydrogen gas pipes	5	it is likely that denuding and scouring will spread over time, thus exposing more of the felt roofing membrane to UV rays and therefore degradation - sleeper and penetration flashing to be checked	2	A	LOW	2	C	MED	failure could include leaking and/or blow-off. Leaking could be detrimental to electrical equipment while flying debris could be injurious to persons and equipment.	immediate spot repairs recommended - annual inspection thereafter
272255	7283	0	Roof M - Inverted roofing system	roofing membrane below insulation and stone ballast - cannot be seen	ballast depth questionable - minor denuding - filter fabric and insulation visible	10	this roof should perform well as long as the minor issues indicated are addressed quickly	2	A	LOW	2	D	HIGH	failure could include leaking and/or blow-off. Leaking could be detrimental to electrical equipment while flying debris could be injurious to persons and equipment.	Inspect insulation and EPDM membrane and repair as necessary - check for and replace filter fabric. Add stone ballast to ensure required coverage and depth. Annual inspection thereafter.
272255	7283	0	Roof N - BUR - no coating	Exposed to view roofing membrane	minor denuding - roof sloped to gravel stop roof edge to drain through 2 scuppers	10	this roof should perform well as long as the minor issues indicated are addressed quickly	2	A	LOW	2	C	MED	failure could include leaking and/or blow-off. Leaking could be detrimental to electrical equipment while flying debris could be injurious to persons and equipment.	immediate spot repairs recommended - annual inspection thereafter
272255	7283	0	Roof O - standing seam metal roof	exposed to view steel roof with visible standing seams at 600 mm o.c.	evidence of fluid applied repair on small portion of roof - some paint missing from roof panels - evidence of rust in some locations	10	this roof should perform well as long as the minor issues indicated are addressed quickly	2	A	LOW	2	D	HIGH	failure could include leaking and/or blow-off. Leaking could be detrimental to electrical equipment while flying debris could be injurious to persons and equipment.	address rusting of steel roof panels and apply protective coating or paint

Asset # 3	Asset # 4	Asset # 5	Description	Component	Major Issues	Remaining Life Years[1] (Insufficient Info - Inspection Required)	Remaining Life Comments	TECHNO-ECO RISK ASSESSMENT MODEL			SAFETY RISK ASSESSMENT MODEL			Possible Failure Event	Mitigation
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272255	7283	0	Roof Q - standing seam metal roof	exposed to view steel roof with visible standing seams at 600 mm o.c.	some paint missing from roof panels - evidence of rust in some locations - multi penetrations through this roof	10	this roof should perform well as long as the minor issues indicated are addressed quickly	2	A	LOW	2	D	HIGH	failure could include leaking and/or blow-off. Leaking could be detrimental to electrical equipment while flying debris could be injurious to persons and equipment.	address rusting of steel roof panels and apply protective coating or paint
Overhead Doors Assessment															
272255	357449	357958	Door # 1	insulated multi-blade - power operated - auxiliary chain operation - safety feature	auxiliary chain mechanism inoperable - chain not tethered - significant rust to door panels- weather-stripping requires replacement - door remains open 150 mm at the bottom	15	rust may increase - inoperable chain hoist will render door out of service during power outage - draft and rain / snow drift through door perimeter where weather-stripping is defective	1	A	LOW	2	D	HIGH	door failure could result in: open door free falling onto persons or equipment - un-tethered chain could entangle a person while the door is operating - door jamming in partial or full open position causing inclement weather to affect the interior of the plant	annual inspection to ensure proper operation - including lubrication, tension adjustments, motor, control and safety feature inspection and paint/rust assessment.
272255	357449	357959	Door # 2	insulated multi-blade - power operated - auxiliary chain operation - safety feature	noisy / erratic operation - significant rust to door panels - no weather-stripping - water ingress at door bottom - significant rust to door panels and steel frame	10	rust may increase - draft and rain / snow drift through door perimeter where weather-stripping is defective - door may jam open or closed	2	A	LOW	2	D	HIGH	door failure could result in: open door free falling onto persons or equipment - door jamming in partial or full open position causing inclement weather to affect the interior of the plant	immediate attention required to address identified issues - annual inspection thereafter to ensure proper operation - including lubrication, tension adjustments, motor, control and safety feature inspection and paint/rust assessment.
272255	357449	359342	Door # 2A	insulated sectional overhead door - power operated - auxiliary chain operation - safety bottom	door failed during visual testing and required technician to adjust - minor rust to door panels - door was never painted	15	rust may increase - door may jam partially open or closed.	1	A	LOW	2	D	HIGH	door failure could result in: open door free falling onto persons or equipment - door jamming in partial or full open position causing inclement weather to affect the interior of the plant	annual inspection to ensure proper operation - including lubrication, tension adjustments, motor, control and safety feature inspection and paint/rust assessment.
272255	357449	357960	door # 3	un-insulated steel roll-up door - manual chain operation only - no safety features	exterior and interior door surfaces exceedingly rusty - door bows inwards in strong wind - door excessively difficult to operate – weather-stripping in poor condition	3	rust may increase - draft and rain / snow drift through door perimeter where weather-stripping is defective - door may jam open or closed	2	A	MED	2	D	HIGH	door failure could result in: open door free falling onto persons or equipment - door jamming in partial or full open position causing inclement weather to affect the interior of the plant	immediate attention required to address identified issues - annual inspection thereafter to ensure proper operation - including lubrication, tension adjustments, motor, control and safety feature inspection and paint/rust assessment.
272255	357449	357961	Door # 4	insulated multi-blade - power operated - auxiliary chain operation - safety bottom	door failed during visual testing and required technician to adjust. - surface rust to outside of door panels - no weather-stripping	15	rust may increase - draft and rain / snow drift through door perimeter where weather-stripping is defective - door may jam open or closed	1	A	LOW	2	D	HIGH	door failure could result in: open door free falling onto persons or equipment - door jamming in partial or full open position causing inclement weather to affect the interior of the plant	annual inspection to ensure proper operation - including lubrication, tension adjustments, motor, control and safety feature inspection and