YUKON ENERGY CORPORATION

APPLICATION FOR AN ENERGY PROJECT CERTIFICATE
AND AN ENERGY OPERATION CERTIFICATE REGARDING THE
PROPOSED WHITEHORSE DIESEL-NATURAL GAS CONVERSION PROJECT

REVISED ROUND 1 INTERROGATORY RESPONSES FILED

March 14, 2014

TOPIC:

REFERENCE: Page 20

"In 16% of the 31 water years (i.e., five years, reflecting for this load scenario the worst drought conditions in five consecutive years from 1996 -2000), diesel generation at the Base Case 2016 forecast load is estimated to range from 52.8 GWh to 101.4 GWh (i.e., 2 to more than 4 times the long term average at this load level)."

PREAMBLE:

QUESTION:

a) For each of these five driest years please list the actual monthly and annual inflows of each of Whitehorse Rapids, Aishihik, and Mayo hydro plants as well as the monthly and annual long term averages for each of the three hydro plants.

b) For each of the three hydro plants please provide a table showing the net annual water volume and stored energy drawdown in each of these 5 years. If there is no net drawdown of stored water and energy (from Aishihik and Mayo Lakes in particular) incorporated into the diesel generation numbers quoted please explain why.

c) What is the maximum useable water and energy storage in Aishihik Lake permitted in the present water use license?

ANSWER:

(a) and **(b)**

Please see Attachment 1 to this response.

Please note that as the request was to provide the annual numbers for the water years from 1996 to 2000; therefore, long-term average generation is not provided.

As the table in Attachment 1 shows, there is hydro generation from Mayo and Aishihik generation stations for those drought years. The lake levels are affected by inflows, outflows and other factors (such as evaporation and ice build-up); therefore, YEC cannot provide net annual water levels for those years.

Revised Response

(a)

In addition to the information provided in the original response, Table 1 below provides long-term average Inflows Available for Outflow for Marsh Lake, Aishihik Lake and Mayo Lake.

Table 1: Long-term Average Inflows Available for Outflow

Month	Long-term Average Inflows Available for Outflow (IAO)		
	Marsh Lake - monthly average IAO (cms)	Aishihik Lake - monthly average IAO (cms)	Mayo Lake - monthly average IAO (cms)
Jan	84.7	3.1	3.7
Feb	68.4	2.2	3.0
Mar	54.0	2.0	2.4
Apr	37.8	3.4	3.4
May	148.6	14.1	39.6
Jun	495.4	19.6	46.5
Jul	561.0	19.7	22.2
Aug	513.5	16.2	17.3
Sep	411.7	12.3	17.8
Oct	278.8	6.7	12.0
Nov	162.8	3.9	6.1
Dec	110.2	3.9	5.9
Annual Average	243.9	8.9	15.0

Notes:

1. The monthly average inflows available for outflows are estimated based on weekly average numbers and subject to rounding. The monthly average numbers for some months may include the days in the weeks for the previous or next month.
2. Long-term average based on 1981-2011 water years.
3. The inflows available for outflow are estimated based on recorded outflows and change in lake levels for each lake. IAOs are affected by evaporation from a large reservoir and the magnitude of water lost from evaporation could exceed the amount gained by precipitation and inflow of the river that flows into the reservoir; and in the winter months due to ice build-up in shorelines [ice hung-up in shallow zones] which would prevent the water to be included as available storage to be released; and other factors.

(b)

Please see Table 2 below for the requested annual water levels and estimated energy associated with annual net drawdown for Marsh Lake, Aishihik Lake and Mayo Lake for 1996-2000 years. However, actual operation may not provide these benefits in practice due to licence constraints and due to the manner in which the system has to operate.

Water level data for Mayo Lake, Aishihik Lake and Marsh Lake are publicly available on the Water Survey of Canada website. Only the data for the beginning and end of year for the period starting in 1996 and ending in 2000 were considered (Table 2). Net drawdown (or increase) were calculated using water level information and corresponding volumes were obtained by assuming a constant surface area for each reservoir regardless of the lake elevation. Energy content corresponding to the net drawdown is calculated using generic plant performance.

It should be noted that the net drawdown is a simplistic representation of the system. It provides limited information on the inflows observed during the year (wet water year vs. average water year vs. dry water year) or the load distribution and its impact on water requirements to meet the demand. Yukon Energy operates its hydro facility in accordance with the terms outlined in the water license for each facility. The terms include minimum flow requirements during specific period of the year (e.g., minimum flows through Aishihik system or Mayo River), storage restrictions (e.g., Lewes Dam gate closing) or reservoir management (e.g., 10-year rolling average at Aishihik). Other assumptions made to determine the energy content of the net drawdown or increase pertain to but are not limited to the hydro unit efficiency, head losses through conveyance system and net water head between forebay and tailrace levels. Other factors such as rank of the hydro facility within the stacking order, water inflows, temporal variability of the demand throughout the year can impact the potential energy benefit Yukon Energy can obtain at its hydro stations.

Table 2: Historical Water Level at YEC Hydro Facilities

Date	Mayo Lake					Aishihik Lake					Marsh Lake				
	Level		Drawdown	Volume	Energy	Level		Drawdown	Volume	Energy	Level		Drawdown	Volume	Energy
	[m]	[masl]	[m]	[hm3]	[GWh]	[m]	[masl]	[m]	[hm3]	[GWh]	[m]	[masl]	[m]	[hm3]	[GWh]
1/1/1996	2.714	665.051	0.03	3.1	0.4	2.381	913.946	-0.8	-111.5	-49.1	2.222	655.579	-0.1	-11.5	-0.5
12/31/1996	2.745	665.082				1.627	913.192				2.107	655.464			
1/1/1997	*N/A*	*N/A*	0.11	11.0	1.4	1.619	913.184	0.6	88.0	38.7	2.084	655.441	0.5	45.5	2.0
12/31/1997	2.855	665.192				2.214	913.779				2.539	655.896			
1/1/1998	2.840	665.177	-0.20	-20.3	-2.6	2.215	913.780	-0.5	-79.4	-34.9	2.513	655.870	-0.2	-21.2	-0.9
12/31/1998	2.636	664.973				1.678	913.243				2.301	655.658			
1/1/1999	2.633	664.970	0.13	13.4	1.7	1.675	913.240	0.6	95.6	42.1	2.291	655.648	0.1	14.1	0.6
12/31/1999	2.767	665.104				2.322	913.887				2.432	655.789			
1/1/2000	2.763	665.100	-0.18	-18.0	-2.3	2.322	913.887	1.0	140.4	61.8	2.425	655.782	0.1	8.0	0.3
12/31/2000	2.582	664.919				3.272	914.837				2.505	655.862			

Source: Water Survey of Canada.

Notes:

1. In absence of accurate bathymetry data, surface area of the lakes was assumed constant regardless of lake level.
2. N/A - Data not available.
3. Data for Mayo Lake not available for 1-1-1997. As such, data for 31-12-1996 was used for calculation of drawdown.
   - 9,963 ha area of Mayo Lake
   - 14,783 ha area of Aishihik Lake
   - 9,609 ha area of Marsh Lake.

(c)

Based on the current license, which expires on December 31, 2019, the mean daily water level on Aishihik Lake should be maintained between a controlled minimum of 913 metres and a controlled maximum of 915.16 metres. The lake operation is also subject to minimum water flow rates as well as maintaining water levels in spring based on a 10-year rolling averages.

Revised Response

In addition to the above, it is noted that the energy associated with the controlled storage in Aishihik Lake between the minimum of 913 metres and a controlled maximum of 915.16 metres is estimated to be 141 GW.h.

Assuming a lake area of 146 km^2 and a drawdown of 2.16 metres (FSL of 915.16 metres ASL – LSL of 913 metres ASL), the volume of water contained within the operating range is approximately 319.31 hm^3. This assumes the lake would have vertical shore.

However, in addition to roughly estimating the lake volume, this calculation does not take into account other factors such as head loss through the conveyance system, any reduction in overall head as a result of higher tailrace level or turbine efficiency. It should be noted that the calculation above represents an oversimplification of a complex system. All hydrologic cycles have some inflow component. Even the driest year on record, approximately 87 hm^3 of water flowed into Aishihik Lake from rain, snowmelt, and groundwater sources. Given water licenses, operating constraints, location of the Aishihik plant within the stacking order, distribution of the load throughout the year, and inflow into the lake, the full range cannot be utilized in a year.

Average Inflows Available for Outflow (IAO) and Average Generation

		Whitehorse Rapid GS		Aishihik GS		Mayo GS	
		Marsh Lake - monthly average IAO (cms)	Average generation (GW.h)	Aishihik Lake - monthly average IAO (cms)	Average generation (GW.h)	Mayo Lake - monthly average IAO (cms)	Average generation (GW.h)
1996	Jan	60.9	18.2	1.5	3.2	2.3	8.5
	Feb	58.9	16.4	2.8	6.6	2.1	5.4
	Mar	51.3	17.0	2.0	4.8	1.2	2.4
	Apr	39.9	11.8	4.6	7.0	2.6	1.5
	May	101.7	16.3	8.5	5.9	19.8	5.8
	Jun	343.8	20.9	4.0	2.5	44.0	6.3
	Jul	486.1	23.2	15.1	2.5	15.7	3.6
	Aug	413.3	24.5	13.1	2.5	10.2	3.4
	Sep	340.2	26.9	5.8	3.1	17.6	3.0
	Oct	198.0	26.6	1.9	4.3	7.7	5.6
	Nov	110.7	18.1	5.2	14.4	4.1	8.2
	Dec	74.1	17.7	2.9	17.7	4.9	8.2
Annual Average IAO and total annual generation		**189.9**	**237.6**	**5.6**	**74.7**	**11.0**	**61.9**
1997	Jan	51.0	18.2	4.4	11.1	3.7	8.5
	Feb	46.4	12.3	2.3	6.1	2.7	5.9
	Mar	30.3	10.1	1.2	3.9	1.8	3.0
	Apr	36.0	9.9	2.8	5.2	4.9	2.3
	May	160.6	14.7	15.4	5.7	51.1	8.8
	Jun	440.6	19.7	19.9	2.8	49.2	7.2
	Jul	566.9	19.6	16.3	2.5	28.9	7.2
	Aug	549.2	20.4	19.6	2.6	26.8	7.5
	Sep	464.7	23.3	10.9	2.7	16.3	7.0
	Oct	261.4	25.5	3.8	4.4	10.7	6.7
	Nov	151.9	18.1	4.5	14.4	4.3	8.2
	Dec	102.3	17.7	6.1	17.1	4.9	8.2
Annual Average IAO and total annual generation		**238.5**	**209.5**	**8.9**	**78.6**	**17.1**	**80.4**
1998	Jan	69.0	18.2	6.0	16.6	4.3	8.5
	Feb	58.4	16.4	1.0	9.3	2.8	6.7
	Mar	32.8	17.2	1.5	6.6	3.5	3.8
	Apr	32.3	10.8	3.7	7.2	3.5	2.1
	May	95.0	15.8	8.3	4.6	25.5	6.9
	Jun	557.6	22.9	13.5	2.6	27.1	4.3
	Jul	446.4	23.5	2.9	2.5	8.0	3.4
	Aug	414.0	24.6	-0.6	2.5	4.2	3.4
	Sep	328.8	27.1	2.0	2.8	6.4	2.8
	Oct	222.5	26.5	0.3	3.4	4.7	5.7
	Nov	164.1	18.1	-0.6	5.1	2.4	6.3
	Dec	85.7	17.7	0.5	3.9	2.5	1.4
Annual Average IAO and total annual generation		**208.9**	**238.9**	**3.2**	**67.1**	**7.9**	**55.3**

Average Inflows Available for Outflow (IAO) and Average Generation

		Whitehorse Rapid GS		Aishihik GS		Mayo GS	
		Marsh Lake - monthly average IAO (cms)	Average generation (GW.h)	Aishihik Lake - monthly average IAO (cms)	Average generation (GW.h)	Mayo Lake - monthly average IAO (cms)	Average generation (GW.h)
1999	Jan	66.3	18.2	2.6	3.2	3.5	1.3
	Feb	55.3	16.4	0.4	3.0	2.1	1.8
	Mar	33.8	13.7	0.0	3.2	2.0	1.3
	Apr	22.6	9.9	0.9	3.1	3.7	1.5
	May	90.6	14.8	8.6	2.6	33.1	8.0
	Jun	455.6	19.8	23.0	3.8	44.1	6.0
	Jul	498.0	23.3	20.3	2.5	14.5	3.6
	Aug	464.9	24.0	9.5	2.5	14.7	3.9
	Sep	343.9	22.3	5.1	2.7	23.6	8.0
	Oct	222.1	25.0	3.1	4.1	13.7	7.2
	Nov	152.9	18.1	3.0	11.8	4.3	8.2
	Dec	115.4	17.7	3.3	11.2	4.1	8.2
Annual Average IAO and total annual generation		**210.1**	**223.2**	**6.6**	**53.7**	**13.6**	**58.9**
2000	Jan	107.2	18.2	1.3	5.8	2.1	8.5
	Feb	70.3	16.4	2.7	6.8	3.7	6.6
	Mar	43.2	18.3	1.9	5.8	2.2	3.4
	Apr	35.8	18.0	2.8	5.7	1.8	1.6
	May	96.8	15.5	10.8	4.3	30.4	7.9
	Jun	461.6	19.0	29.6	3.9	59.8	6.8
	Jul	662.5	16.8	43.2	7.1	26.4	5.5
	Aug	522.2	15.0	53.6	9.7	29.8	5.7
	Sep	407.2	16.0	50.4	11.1	25.3	5.9
	Oct	318.4	18.0	20.8	13.4	19.3	5.1
	Nov	178.3	18.0	9.0	14.5	10.3	7.8
	Dec	118.7	17.7	6.0	16.3	4.2	8.2
Annual Average IAO and total annual generation		**251.9**	**206.9**	**19.3**	**104.5**	**17.9**	**73.1**

Notes:

1. The monthly average inflows available for outflows are estimated based on weekly average numbers and subject to rounding.

2. The inflows available for outflow are estimated based on recorded outflows and change in lake levels for each lake. IAOs are affected by evaporation from a large reservoir and the magnitude of water lost from evaporation could exceed the amount gained by precipitation and inflow of the river that flows into the reservoir; and in the winter months due to ice build-up in shorelines [ice hung-up in shallow zones] which would prevent the water to be included as available storage to be released; and other factors.

3. The generation estimates are based on Base Case no Alexco load forecast for 2016 at 437.3 GW.h.