Data Centre Technical and Operating Characterisics

1 Load Composition

	Req'd	Questions	Rationale
1.1	Gate 2	Please provide the Conceptual Electrical SLD with the breakdown of the data centre's load (refer to the Conceptual Electrical SLD section for an example). Specifically, include the percentage of the total load is used by the server racks, lighting, and cooling/heating systems? Clarify if this percentage changes during different seasons and time of the day. This information must be consistent with the Composite Load Model (CMLD) submitted along with this questionnaire.	This information helps the AESO accurately assign MWs of load in connection studies, planning studies, and operational studies by distributing the total data centre load among different components of the composite load model, each with distinct electrical characteristics. Additionally, it supports the evaluation of seasonal and time-dependent variations in load, which can impact load forecast assumptions.
1.2	Gate 2	Please provide the CMLD, consisting of different types of loads as per NERC CMLD representation (refer to the CMLD Representation section). The CMLD which is submitted must be consistent with the information provided in the rest of this questionnaire.	To evaluate the dynamic stability responses of the loads, data centres are represented by a Composite Load Model. This model comprises static ZIP loads, motor loads, and electronic loads. It provides a more accurate representation of the data centre for stability studies by having a combination of load components each with distinct electrical and dynamic characteristics, to provide a realistic load representation. NERC has also published a Reliability Guideline on developing load model composition data that can be used for dynamic stability studies.

2 UPS and Power Conditioning

	Req'd	Questions	Rationale
2.1	Gate 2	Is there any sort of Uninterruptible Power Supply (UPS) that would be on the customer site to be used as the back-up supply for any part of the load including server racks, cooling system, etc? This information must be consistent with the CMLD submitted along with this questionnaire.	This information helps validate the accuracy of the CMLD and ensures that the dynamic response of the data centre's load is properly captured, along with how it interacts with the grid. The data centre's power factor control capabilities, along with the UPS's role in addressing power quality issues and perhaps correcting the power factor, are essential in evaluating the data centre's impact on the power system.
2.2	Gate 2	What percentage of the total load is connected to UPS or power conditioning?	
2.3	Gate 2	What is the capacity of the largest UPS unit?	
2.4	Gate 2	Is the UPS online 24 X 7?	
2.5	Gate 2	Is the data centre capable of power factor control? If yes, what is the range?	
2.6	Gate 2	Describe the power conditioning functionality of the UPS. In other words, in the event of low power quality on the grid side, clarify whether UPS acts as a power conditioning device or it disconnects the load from the grid.	
2.7	Gate 2	What are the grid side power quality requirements for the data centre (e.g., harmonics, low voltage, and frequency deviation threshold)?	

3 Motors and Cooling			
	Req'd	**Questions**	**Rationale**
3.1	Gate 2	What is the equipment used for running the cooling loads? Provide a break-down between any type of variable speed drive and direct connected motors, if there are any. Provide a break-down of three-phase and single-phase cooling system.	This information allows the AESO to understand the response of loads to changes in voltages and frequency and how that response affects the utility grid voltage and frequency. This also can be used to validate the provided CMLD.
3.2	Gate 2	If the data centre has some form of forced cooling system, what is this comprised of? A. Computer Room Air Conditioners (CRACs) with internal compressors. B. Computer Room Air Handlers (CRAHs) supplied with chilled water. C. Air-Handling Units (AHUs) dedicated to the data centre space. D. Other?	
3.3	Gate 2	Are all motors controlled by variable frequency drives?	
3.4	Gate 2	Is any portion of the cooling system connected to UPS or battery?	
4 Heating			
	Req'd	**Questions**	**Rationale**
4.1	Gate 2	What is the heating source during winter? Is there any heat recovery system? If there are electric heaters, what is the maximum heater power?	This information helps assess potential seasonal variations in data centre load due to heating requirements. If electric heating is used, it may contribute to winter peak demand, impacting load forecasting and system adequacy studies.
5 Power Quality			
	Req'd	**Questions**	**Rationale**
5.1	Gate 2	Will there be any active filter to minimize the injected harmonics to the grid? If yes, indicate where the connection point of the filter is and confirm the percentage of harmonic penetration into the grid complies with the harmonic distortion criteria specified in IEEE Standard 519.	This information helps with pre-screening the need for harmonic studies.
5.2	Gate 1	Is there any harmonic threshold above which the data centre computer/server load may disconnect from the system?	This information helps determine whether a data centre's equipment includes protection mechanisms or if a Protection & Control Assessment is necessary. Additionally, it identifies whether harmonic thresholds exist that could trigger disconnection. It also assists in evaluating the need for additional studies to assess the potential impact of load disconnection on system reliability.
6 Back-Up Generation			
	Req'd	**Questions**	**Rationale**
6.1	Gate 1	Will the data centre have backup generators to supply power in the event of a grid disconnection? If so, please specify the type of generation used and the estimated duration for which the generators can sustain the data centre's load at both partial and full capacity.	This information helps assess interim mitigation measures for specific contingencies, ensuring that the data centre can maintain the required reliability and sustain operations during grid disconnections or other disruptions. This also helps the need for special facility design and functional spec requirement.
6.2	Gate 2	Clarify whether the backup generation is also intended to help minimize energy costs by self-supplying the load during high price hours.	This information helps determine whether the backup generators are intended solely for emergency situations or if they are also used for demand-side management to minimize energy costs by self-supplying the load during periods of high electricity prices.
6.3	Gate 2	If the answer to the previous question is yes, what is the load ramp rate observed by the grid during the transition between grid supply and self-supply, and vice versa?	

7 Data Centres Providing Global Services

	Req'd	Questions	Rationale
7.1	Gate 2	If the data centre is intended for global service, clarify whether there will be spatiotemporal coordination among data centres across different jurisdictions or geographical locations? For instance, in the event of a power supply interruption, will the load be transferred to another facility in a different location?	This information helps understand how energy market dynamics and load profiles in different jurisdictions might influence the overall load behavior of the data centre.

8 Configuration

	Req'd	Questions	Rationale
8.1	Gate 2	Provide a Schematic Diagram of the configuration of the UPS, server racks, cooling system, lighting system, and the connection transformer (please see an example of schematic diagram in the Electrical Distribution SLD section). This information must be consistent with the CMLD submitted along with this questionnaire.	The location of different equipment within the data centre determines how various loads interact with the UPS and the grid. This also provides insight into how the loads are connected to the grid and how the connections are configured on the low side of the connection transformer.
8.2	Gate 1	Provide the Conceptual Facilty SLD, including voltage levels at each stage from the point of interconnection (POI) to the server racks (refer to AESO's Single Line Diagram (SLD) Guideline for Projects on www.aeso.ca\connecting-to-the-grid\connection-process-templates).	The AESO requires a single line diagram (SLD) of the market participant and TFO's facilities in order to develop connection alternatives and the functional specification.

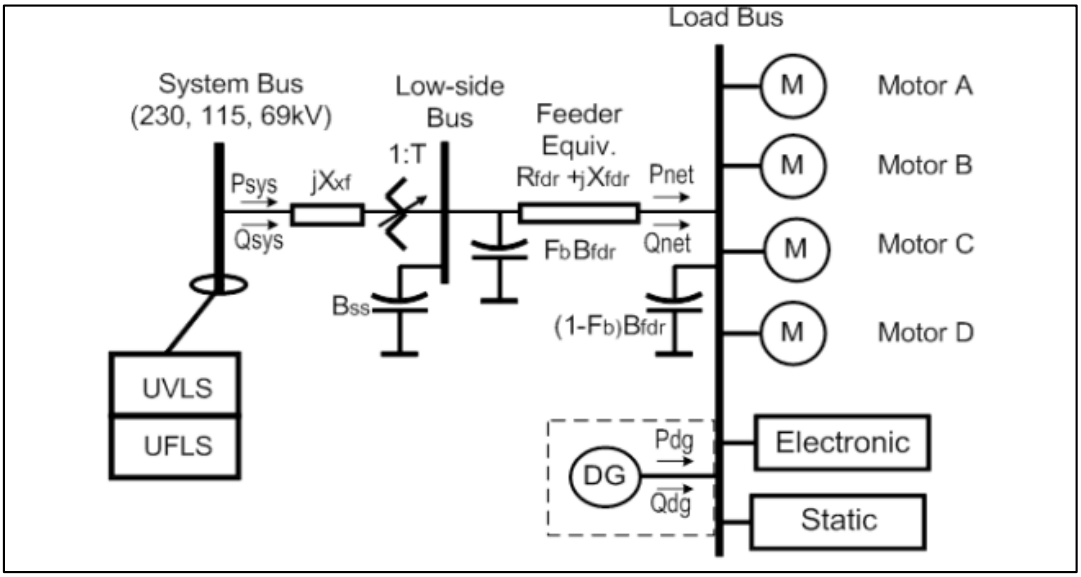
9 Redundancy

	Req'd	Questions	Rationale
9.1	Gate 1	Is there a specific transmission reliability requirement that necessitates a multi-circuit connection for the load? For instance, would a single radial transmission connection be sufficient?	This information helps identify the necessary level of reliability when evaluating connection alternatives.
9.2	Gate 1	What will be the Tier Classification based on Uptime Institute's Tier Standard?	

10 Operational Aspects

	Req'd	Questions	Rationale
10.1	Gate 1	What is the operating philosophy for operating this data centre (i.e., application, hourly load profile, etc.)	This information helps in accurate forecasting and planning for needs, ensuring the system and generation mix can accommodate the load.
10.2	Gate 2	Would there be any automatic control to manage ramp up/down?	This information helps to understand the impact of load ramp on AESO control performance.
10.3	Gate 2	What are the voltage ride-through capabilities for this data centre?	Understanding the ride through that the load is capable of helps to assess the impact of load during a disturbance and ensuring system stability.
10.4	Gate 2	What are the frequency ride-through capabilities for this data centre?	
10.5	Gate 2	Confirm whether there is a limit on the number of ride-through events that the data centre can withstand within a specified duration.	
10.6	Gate 2	In the current design, if the loads disconnect due to frequency/voltage event, how do they reconnect back when the voltage and frequency returns to normal values? Would it be automatic or manual?	This information helps to understand the impact of the load disconnection and reconnection to system stability and control performance.

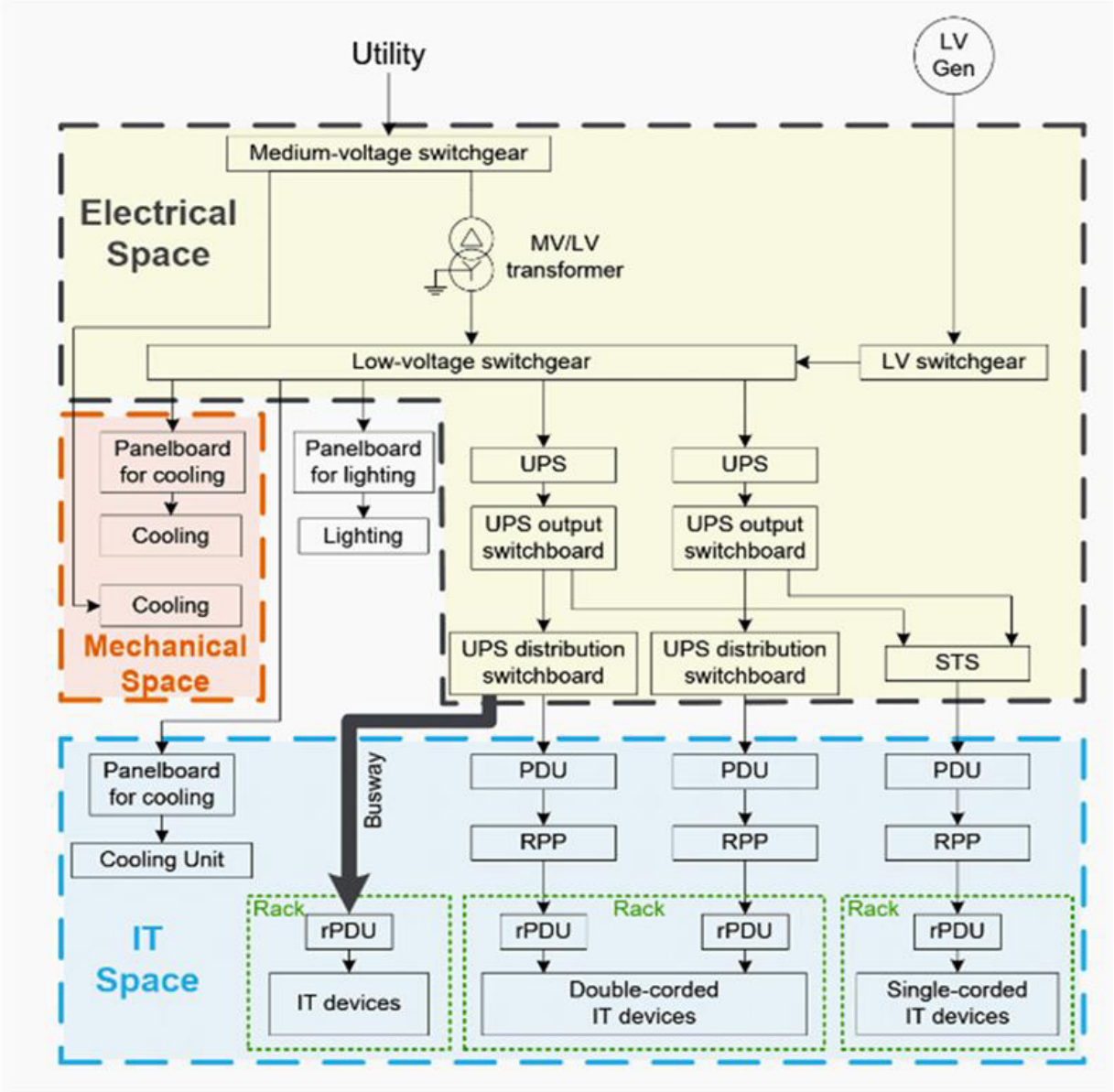
CMLD Representation



•Motor A: Low-inertia, constant-torque three-phase induction motors, commonly found in chiller compressors for centralized cooling.
•Motor B: High-inertia, quadratic-torque three-phase induction motors, used in air handling units and large ventilation fans.
•Motor C: Low-inertia, quadratic-torque three-phase induction motors, typically water circulation pumps in cooling systems.
•Motor D: Single-phase motors, mainly for small A/C units, relevant in smaller-scale data centers.
•Electronic Load: The dominant category, consisting of servers, routers, switches, UPS, and power conditioning systems

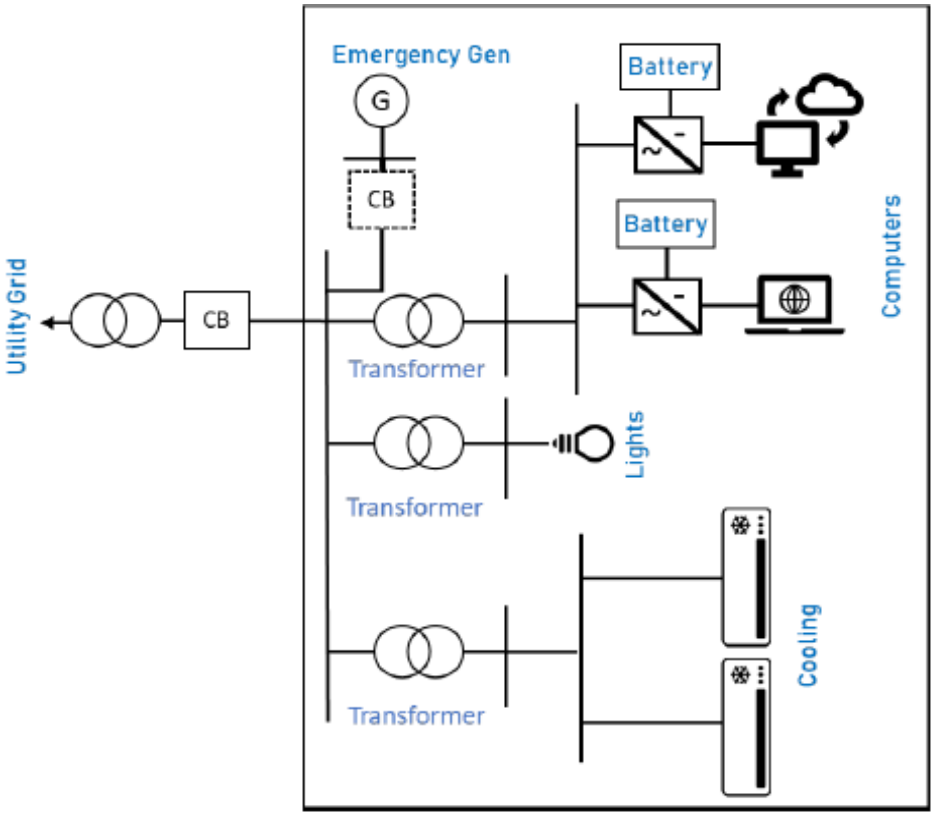
Ref: **NERC, Reliability Guideline: Load Model Composition, North American Electric Reliability Corporation, Feb. 28, 2017.**

Electrical Distribution SLD



Ref: **https://electrical-engineering-portal.com/substation-data-center**

Conceptual Electrical SLD



Specify the proportion of the total load allocated to the following categories:
- Lighting
- Cooling
- Heating
- Servers
- Single-Speed mortors
- Other loads (please specify)

Ref: **https://www.nerc.com/comm/RSTC/LMWG/Data%20Center%20Information%20Collection%20Questionnaire.pdf**