

Project UNION Block 4

pPUE & WUE Analysis Report

100% IT and partial loads

P.0740511
7th Jul 2023



PUBLIC



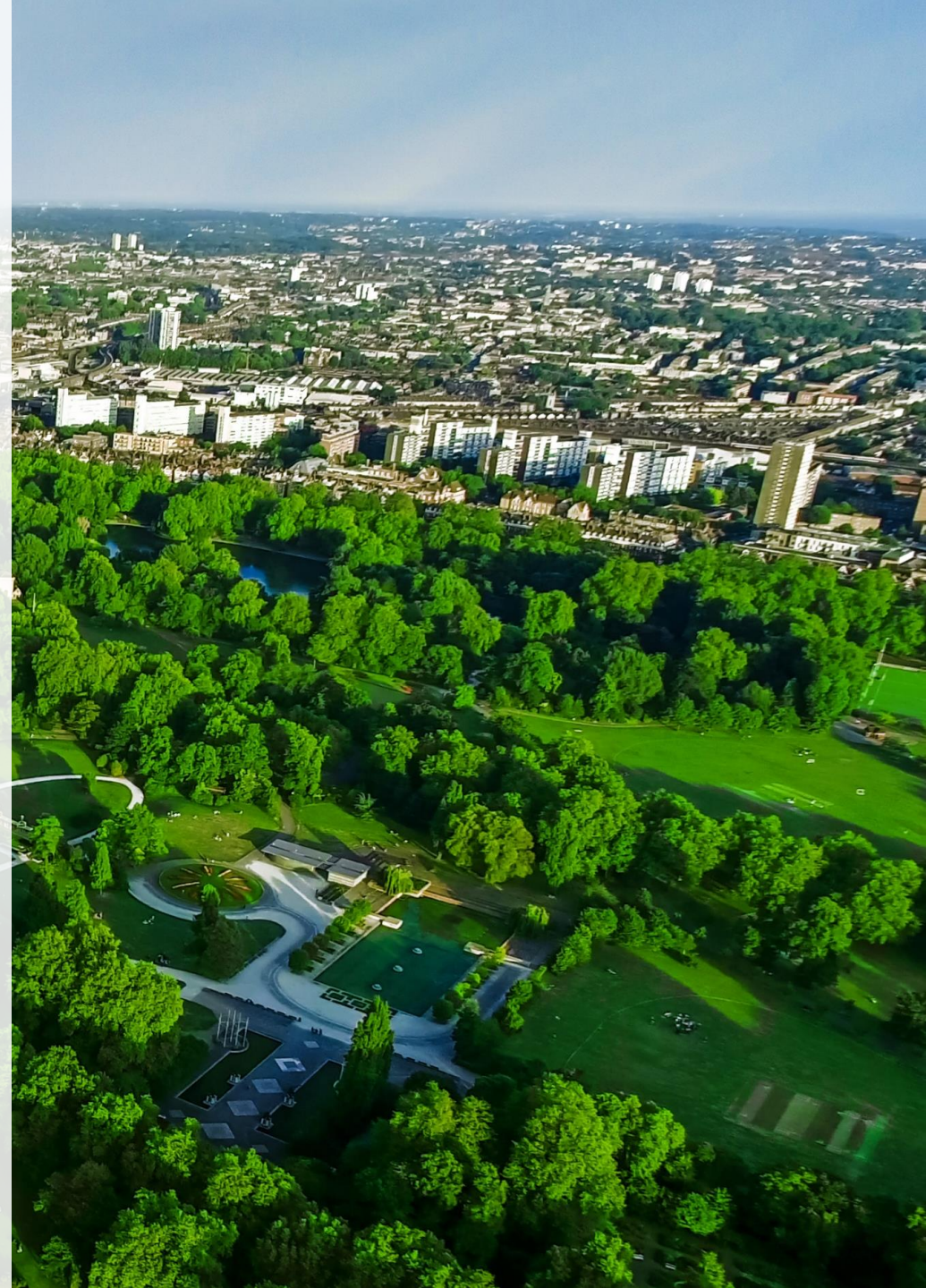
INTERNAL



RESTRICTED



CONFIDENTIAL



UNION – Block 4: pPUE

IT load	pPUE
26.676MW (100% IT)	1.08
21.340 MW (80% IT)	1.05
20.007MW (75% IT)	1.05
13.338MW (50% IT)	1.02
6.669MW (25% IT)	1.03

Calculation Notes:

- The pPUE figures are based on 26.676MW (100% IT) and, partial IT loads of 21.34MW (80% IT), 20.007MW (75% IT), 13.338MW (50% IT) and 6.669MW (25% IT).
- Direct Air Optimiser (DAO) cooling loads are considered proportional to the partial IT loads.
- pPUE considers mechanical components only i.e. fans, humidifier, BMS, AHF Cooling fan, Harmonic filter and Trace heating.
 - Harmonic filter 60A = 1.25KW (This feeds the DAO fans)
 - AHF Cooling fan = 0.14KW
 - Trace heating = 0.5KW; this has been assumed for usage during the winter period only, thus, only 3 months (2190 hrs) of power consumption is considered.
- pPUEs are based on an ideal situation where blanking is done properly. For these calculations, a Delta T for the IT equipment of 12 °C has been assumed.
- DAO setpoints considered:-
 - CP2: 18°C, 20% RH
 - CP3: 32°C, 40% RH
 - CP4: 32°C, 70% RH
- Weather data used: London Heathrow, UK (TRY2016).

UNION – Block 4: pPUE

Calculation Notes (continued):

- Annual DAO operation assumptions:
 - Filter conditions: Moderate filter pressure loss of 150Pa have been used to estimate the annual pPUE figure [Note: Clean filter = circa. 90 Pa (Based on test results), dirty filter = circa. 255Pa].
 - For partial IT loads, filter pressure losses were proportionally decreased based on the relationship (filter pressure vs volume flowrate) obtained from the test data for clean filter which was adjusted for moderate filter condition.
 - DAO mode of operations:
 - Full fresh air mode (100% fresh air and 100% exhaust air)
 - Adiabatic bypass dampers are fully open 50% of the time (linear approximation); annual operation hours = 35 hours (refer to table on page 3: zone 6 and 7 hours).
 - At mix operation mode (mixing of fresh air and return air)
 - In Zone 1: At this condition, the bypass dampers may be slightly closed depending on the mixing requirement. However, the zone 1 hours based on London Heathrow, UK (TRY2016) weather data is 39 hours only (refer to table on page 3) so this will not make a significant difference.
 - In Zone 3 and 4: the bypass dampers are fully open as no humidification is required.
- Total Fan pressure loss = DAO components pressure loss + external static pressure loss (based on CFD results for full fresh air mode and ductwork calculation for mix mode operation).
 - DAO pressure loss
 - Factory test results was used to determine the pressure loss of the DAO components at the following IT loads: 100%, 75%, 50% and 25%. Reference file: *'Bladeroom AO Factory Tests & Pressure Profiles Oct 2022'*
 - The volume flowrate of the DAO is directly proportional to the IT loads, since the delta T of the IT is constant.
 - Curve fitting method was applied to the factory test results to create relationship between total fan pressure loss and power consumption, which was used to determine the power consumption of the respective pressure loss at full fresh air mode and mix mode for the various floors and at the IT loads considered. Note: it is assumed that all the DAOs per floor have the same power consumption.
 - External static pressure loss
 - CFD results was used to determine the full fresh air mode pressure loss. Approximate external pressure loss per floor (at moderate filter condition) as per below [Fan law have been used to estimate the decrease in external static pressure loss at partial loads of the IT/DAO]:
 - Ground floor = 493 Pa
 - 1st floor = 593 Pa
 - 2nd floor = 653 Pa

Note: On either end of the building (DAO1 and DAO6), 50% of the air is exhausted from the DAOs. Therefore, an approximation has been made on the full fresh air mode chimney pressure loss. For all ambient conditions at fresh air mode operation, the power consumption figures are the same.
 - At mix mode, annual average weighted pressure loss at various DAO modes of operation of the chimney was determined based on ductwork calculation. Therefore, for all ambient conditions at mix mode operation, the power consumption figures are the same.
 - 10Pa pressure loss has been considered for façade pressure loss based on CFD results.
 - 30Pa pressure loss has been considered for bird mesh at design flowrate. The fan law has been used to estimate the pressure loss for partial IT loads.

Note: for 80% Partial IT load, fan square law has been used to estimate the pressure loss and the factory test data has been used to estimate the power consumption.

UNION – Block 4: pPUE

Zones of operation	
Zone	Hours
1	39
3	8637
4	49
6	35
7	0

Modes of operation

- Zone 1, 3 and 4: mixing of fresh air and return air
Note: In zone 1, adiabatic cooler is used to humidify the air.
- Zone 6 and 7: full fresh air mode, where adiabatic cooler is in operation.

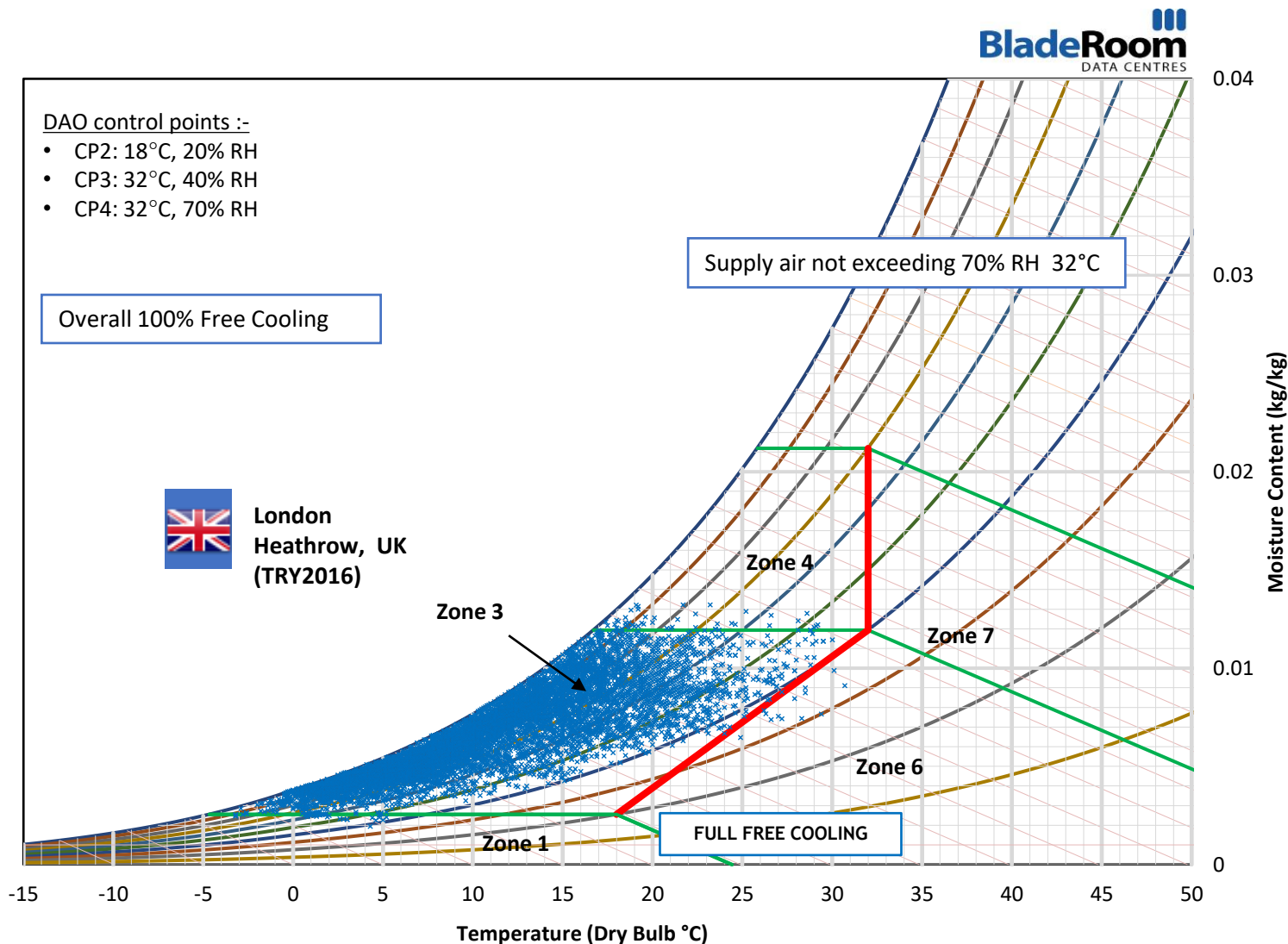


Figure 1: Table with zones of operation of DAOs and psychrometric chart of DAO operation based on London Heathrow, UK (TRY2016) weather data.

UNION – Block 4 : pPUE (100% IT)

Data Centre Annualised 100% pPUE Calculation

PROJECT NAME	Union Block 3
PROJECT NUMBER	P.0740511
DOCUMENT REFERENCE	P.0740511 - UP3 Annualised Energy Calcs Direct 12CdT 20230613
CALCULATION SHEET VERSION	v1



Revision	Description	Calculation By	Date	Reviewer	Date
A	26.676MW Annualised pPUE calculation - Internal review	NC	15.06.2023	STL	15.06.2023

Basis of Calculation:	Based on Factory test results, CFD results and average weighted approximated pressure drop
Assumptions:	See attached 'P.0740511 - UP3 pPUE & WUE report 20230615.pdf' for detailed review of the basis of the calculation.
Modifications of calculations:	Factory testing on 15.10.2022 by 'MECHANICAL VALIDATION SVS LTD' used where applicable. File ref: Bladeroom AO Factory Tests & Pressure Profiles Oct 2022.pdf

DBT = Dry Bulb Temperature, RH = Humidity, H = Hours
SAT Supply Air Temperature
NSCE = Net sensible cooling energy per half of the Block (3 datahalls)
pPUE = (NSCE+EC)/NSCE
TWC = Total water consumption (includes 25% for RO plant loss, dilution cycle and drainage)

Weather data: London Heathrow, UK (TRY2016)						Note: Input power interpolated/extrapolated based on Manufacturer test results			26.676 MW block		
DBT [°C]	RH [%]	H [hrs]	SAT [°C]	NSCE [kWh]	Total of average IIF for 3Nos. 741 kW DAO of 3 floors [kWh]	Total input power for 18Nos. 741kW DAO Units in 3Dhls of 3 floors [kWh]	pPUE	Elec Load from DAOs per 13.338 MW [kWh]	Evaporated water 4.446MW DH (DAOs) [l/h]	Total Water consumption[m ³]	
3.70	95.00	1.00	21.2	43,200,000	179.0	1074.2	1.081	1074.2	0	0.00	
3.90	93.00	1.00	21.1	43,200,000	179.0	1074.2	1.081	1074.2	0	0.00	
4.00	92.00	1.00	21.1	43,200,000	179.0	1074.2	1.081	1074.2	0	0.00	
4.20	91.00	1.00	21.1	43,200,000	179.0	1074.2	1.081	1074.2	0	0.00	
4.30	90.00	1.00	21.1	43,200,000	179.0	1074.2	1.081	1074.2	0	0.00	
4.50	89.00	1.00	21.1	43,200,000	179.0	1074.2	1.081	1074.2	0	0.00	
4.60	88.00	1.00	21.1	43,200,000	179.0	1074.2	1.081	1074.2	0	0.00	
4.80	87.00	1.00	21.1	43,200,000	179.0	1074.2	1.081	1074.2	0	0.00	
4.90	87.00	1.00	21.2	43,200,000	179.0	1074.2	1.081	1074.2	0	0.00	
5.10	87.00	1.00	21.3	43,200,000	179.0	1074.2	1.081	1074.2	0	0.00	
5.30	87.00	1.00	21.4	43,200,000	179.0	1074.2	1.081	1074.2	0	0.00	
5.90	88.00	1.00	21.8	43,200,000	179.0	1074.2	1.081	1074.2	0	0.00	
6.70	88.00	1.00	22.2	43,200,000	179.0	1074.2	1.081	1074.2	0	0.00	
6.60	95.00	1.00	22.8	43,200,000	179.0	1074.2	1.081	1074.2	0	0.00	
7.10	92.00	1.00	22.8	43,200,000	179.0	1074.2	1.081	1074.2	0	0.00	
7.00	92.00	1.00	22.7	43,200,000	179.0	1074.2	1.081	1074.2	0	0.00	
6.40	93.00	1.00	22.5	43,200,000	179.0	1074.2	1.081	1074.2	0	0.00	
5.70	93.00	1.00	22.1	43,200,000	179.0	1074.2	1.081	1074.2	0	0.00	
5.50	89.00	1.00	21.6	43,200,000	179.0	1074.2	1.081	1074.2	0	0.00	
5.20	87.00	1.00	21.3	43,200,000	179.0	1074.2	1.081	1074.2	0	0.00	
5.00	86.00	1.00	21.1	43,200,000	179.0	1074.2	1.081	1074.2	0	0.00	

Figure 3: Page 1 of 155, see attached excel sheet: 'P.0740511 – UP4 Annualised Energy Calcs Direct 12CdT RED_20230706' for full calculation.

UNION – Block 4 : pPUE (80% IT)

Data Centre Annualised 80% pPUE Calculation

PROJECT NAME	Union Block 4
PROJECT NUMBER	P.0740511
DOCUMENT REFERENCE	P.0740511 - UP4 Annualised Energy Calcs Direct 12CdT 20230706
CALCULATION SHEET VERSION	v1



Revision	Description	Calculation By	Date	Reviewer	Date
A	21.34MW Annualised 80% IT pPUE calculation - Internal review	NC	06.07.2023	STL	06.07.2023

Basis of Calculation:	Based on Factory test results, CFD results and average weighted approximated pressure drop
Assumptions:	See attached 'P.0740511 - UP4 pPUE & WUE report 20230626.pdf' for detailed review of the basis of the calculation.
Modifications of calculations:	Factory testing on 15.10.2022 by 'MECHANICAL VALIDATION SVS LTD' used where applicable. File ref: Bladeroom AD Factory Tests & Pressure Profiles Oct 2022.pdf

DBT = Dry Bulb Temperature, RH = Humidity, H = Hours
SAT Supply Air Temperature
NSCE = Net sensible cooling energy per half of the block (3 datahalls)
pPUE = (NSCE+EC)/NSCE
TWC = Total water consumption (includes 25% for RO plant loss, dilution cycle and drainage)

Weather data: London Heathrow, UK (TRY2016)						Note: Input power interpolated/extrapolated based on Manufacturer test results			21.34 MW block		
DBT [°C]	RH [%]	H [hrs]	SAT [°C]	NSCE [kWh]	Total of average UIP for 3Nos.592.8kW DAO of 3 floors [kWh]	Total input power for 18Nos.592.8kW DAO Units in 3DHs of 3 floors [kWh]	pPUE	Elec Load from DAOs per 10.67MW [kWh]	Evaporated water 3.56MW DH (DAOs) [l/h]	TWC [m ³]	
								1.05	0.0002	29.4	
3.70	95.00	1.00	21.1	38,413,440	96.7	580.0	1.054	580.0	0	0.00	
3.90	93.00	1.00	21.0	38,413,440	96.7	580.0	1.054	580.0	0	0.00	
4.00	92.00	1.00	21.0	38,413,440	96.7	580.0	1.054	580.0	0	0.00	
4.20	91.00	1.00	21.0	38,413,440	96.7	580.0	1.054	580.0	0	0.00	
4.30	90.00	1.00	21.0	38,413,440	96.7	580.0	1.054	580.0	0	0.00	
4.50	89.00	1.00	21.0	38,413,440	96.7	580.0	1.054	580.0	0	0.00	
4.60	88.00	1.00	21.0	38,413,440	96.7	580.0	1.054	580.0	0	0.00	
4.80	87.00	1.00	21.0	38,413,440	96.7	580.0	1.054	580.0	0	0.00	
4.90	87.00	1.00	21.0	38,413,440	96.7	580.0	1.054	580.0	0	0.00	
5.10	87.00	1.00	21.1	38,413,440	96.7	580.0	1.054	580.0	0	0.00	
5.30	87.00	1.00	21.2	38,413,440	96.7	580.0	1.054	580.0	0	0.00	
5.90	88.00	1.00	21.6	38,413,440	96.7	580.0	1.054	580.0	0	0.00	
6.70	88.00	1.00	22.0	38,413,440	96.7	580.0	1.054	580.0	0	0.00	
6.60	95.00	1.00	22.4	38,413,440	96.7	580.0	1.054	580.0	0	0.00	
7.10	92.00	1.00	22.4	38,413,440	96.7	580.0	1.054	580.0	0	0.00	
7.00	92.00	1.00	22.5	38,413,440	96.7	580.0	1.054	580.0	0	0.00	
6.40	93.00	1.00	22.3	38,413,440	96.7	580.0	1.054	580.0	0	0.00	
5.70	93.00	1.00	21.9	38,413,440	96.7	580.0	1.054	580.0	0	0.00	
5.50	89.00	1.00	21.5	38,413,440	96.7	580.0	1.054	580.0	0	0.00	
5.20	87.00	1.00	21.2	38,413,440	96.7	580.0	1.054	580.0	0	0.00	
5.00	86.00	1.00	21.0	38,413,440	96.7	580.0	1.054	580.0	0	0.00	
4.70	86.00	1.00	20.9	38,413,440	96.7	580.0	1.054	580.0	0	0.00	
4.40	87.00	1.00	20.8	38,413,440	96.7	580.0	1.054	580.0	0	0.00	
4.10	88.00	1.00	20.7	38,413,440	96.7	580.0	1.054	580.0	0	0.00	
3.80	89.00	1.00	20.7	38,413,440	96.7	580.0	1.054	580.0	0	0.00	

Figure 4: Page 1 of 155, see attached excel sheet: 'P.0740511 – UP4 Annualised Energy Calcs Direct 12CdT RED_20230706' for full calculation.

UNION – Block 4 : pPUE (75% IT)

Data Centre Annualised 75% pPUE Calculation

PROJECT NAME	Union Block 3
PROJECT NUMBER	P.0740511
DOCUMENT REFERENCE	P.0740511 - UP3 Annualised Energy Calcs Direct 12CdT 20230613
CALCULATION SHEET VERSION	v1



Revision	Description	Calculation By	Date	Reviewer	Date
A	20.007MW Annualised 75% IT pPUE calculation - Internal review	NC	15.06.2023	STL	15.06.2023

Basis of Calculation:	Based on Factory test results, CFD results and average weighted approximated pressure drop
Assumptions:	See attached 'P.0740511 - UP3 pPUE & WUE report 20230615.pdf' for detailed review of the basis of the calculation.
Modifications of calculations:	Factory testing on 15.10.2022 by 'MECHANICAL VALIDATION SVS LTD' used where applicable. File ref: Bladroom AO Factory Tests & Pressure Profiles Oct 2022.pdf

DBT = Dry Bulb Temperature, RH = Humidity, H = Hours
SAT Supply Air Temperature
NSCE = Net sensible cooling energy per half of the Block (3 datahals)
pPUE = (NSCE+EC)/NSCE
TWC = Total water consumption (includes 25% for RO plant loss, dilution cycle and drainage)

Weather data: London Heathrow, UK (TRY2016)						Note: Input power Interpolated/extrapolated based on Manufacturer test results		20.007 MW block		
DBT [°C]	RH [%]	H [hrs]	SAT [°C]	NSCE [kWh]	Total of average UIP for 3Nos.555.75kW DAO of 3 floors [kW]	Total Input power for 18Nos.555.75kW DAO Units in 3DHs of 3 floors [kW]	pPUE	Elec Load from DAOs per 10.004MW [kWh]	Evaporated water 3.3334MW DH (DAOs) [l/h]	Total Water consumption[m ³]
								1.05	0.0002	27.6
3.70	95.00	1.00	21.1	32,400,000	72.8	437.0	1.049	437.0	0	0.00
3.90	93.00	1.00	21.0	32,400,000	72.8	437.0	1.049	437.0	0	0.00
4.00	92.00	1.00	21.0	32,400,000	72.8	437.0	1.049	437.0	0	0.00
4.20	91.00	1.00	21.0	32,400,000	72.8	437.0	1.049	437.0	0	0.00
4.30	90.00	1.00	21.0	32,400,000	72.8	437.0	1.049	437.0	0	0.00
4.50	89.00	1.00	21.0	32,400,000	72.8	437.0	1.049	437.0	0	0.00
4.60	88.00	1.00	21.0	32,400,000	72.8	437.0	1.049	437.0	0	0.00
4.80	87.00	1.00	21.0	32,400,000	72.8	437.0	1.049	437.0	0	0.00
4.90	87.00	1.00	21.0	32,400,000	72.8	437.0	1.049	437.0	0	0.00
5.10	87.00	1.00	21.1	32,400,000	72.8	437.0	1.049	437.0	0	0.00
5.30	87.00	1.00	21.2	32,400,000	72.8	437.0	1.049	437.0	0	0.00
5.90	88.00	1.00	21.6	32,400,000	72.8	437.0	1.049	437.0	0	0.00
6.70	88.00	1.00	22.0	32,400,000	72.8	437.0	1.049	437.0	0	0.00
6.60	95.00	1.00	22.6	32,400,000	72.8	437.0	1.049	437.0	0	0.00
7.10	92.00	1.00	22.6	32,400,000	72.8	437.0	1.049	437.0	0	0.00
7.00	92.00	1.00	22.5	32,400,000	72.8	437.0	1.049	437.0	0	0.00
6.40	93.00	1.00	22.3	32,400,000	72.8	437.0	1.049	437.0	0	0.00
5.70	93.00	1.00	21.9	32,400,000	72.8	437.0	1.049	437.0	0	0.00
5.50	89.00	1.00	21.5	32,400,000	72.8	437.0	1.049	437.0	0	0.00
5.20	87.00	1.00	21.2	32,400,000	72.8	437.0	1.049	437.0	0	0.00
5.00	86.00	1.00	21.0	32,400,000	72.8	437.0	1.049	437.0	0	0.00
4.70	86.00	1.00	20.9	32,400,000	72.8	437.0	1.049	437.0	0	0.00
4.40	87.00	1.00	20.8	32,400,000	72.8	437.0	1.049	437.0	0	0.00
4.10	88.00	1.00	20.7	32,400,000	72.8	437.0	1.049	437.0	0	0.00

Figure 5: Page 1 of 150, see attached excel sheet: 'P.0740511 – UP4 Annualised Energy Calcs Direct 12CdT RED_20230706' for full calculation.

UNION – Block 4 : pPUE (50% IT)

Data Centre Annualised 50% pPUE Calculation

PROJECT NAME	Union Block 3
PROJECT NUMBER	P.0740511
DOCUMENT REFERENCE	P.0740511 - UP3 Annualised Energy Calcs Direct 12CdT 20230613
CALCULATION SHEET VERSION	v1



Revision	Description	Calculation By	Date	Reviewer	Date
A	13.338MW Annualised 50% IT pPUE calculation - Internal review	NC	15.06.2023	STL	15.06.2023

Basis of Calculation:	Based on Factory test results, CFD results and average weighted approximated pressure drop
Assumptions:	See attached 'P.0740511 - UP3 pPUE & WUE report 20230615.pdf' for detailed review of the basis of the calculation.
Modifications of calculations:	Factory testing on 15.10.2022 by 'MECHANICAL VALIDATION SVS LTD' used where applicable. File ref: Bladroom AO Factory Tests & Pressure Profiles Oct 2022.pdf

DBT = Dry Bulb Temperature, RH = Humidity, N = Hours
SAT Supply Air Temperature
NSCE = Net sensible cooling energy per half of the Block (3 datahalls)
pPUE = (NSCE+EC)/NSCE
TWC = Total water consumption (includes 25% for RO plant loss, dilution cycle and drainage)

13.338 MW block		
pPUE	WUE [l/kWh]	Total Water consumption[m ³]
1.02	0.0002	18.4

Weather data: London Heathrow, UK (TRY2016)					Note: Input power interpolated/extrapolated based on Manufacturer test results					
DBT [°C]	RH [%]	H [hrs]	SAT [°C]	NSCE [kWh]	Total of average UIF for 3Nos. 370.5KW DAO of 3 floors [kW]	Total Input power for 18Nos. 370.5KW DAO Units in 3DH of 3 floors [kW]	pPUE	Elec Load from DAOs per 6.669MW [kWh]	Evaporated water 2.223MW DH (DAOs) [l/h]	TWC [m ³] With +25% for Dilution, drainage and RO
3.70	95.00	1.00	21.1	21,600,000	20.8	124.5	1.021	124.5	0	0.00
3.90	93.00	1.00	21.0	21,600,000	20.8	124.5	1.021	124.5	0	0.00
4.00	92.00	1.00	21.0	21,600,000	20.8	124.5	1.021	124.5	0	0.00
4.20	91.00	1.00	21.0	21,600,000	20.8	124.5	1.021	124.5	0	0.00
4.30	90.00	1.00	21.0	21,600,000	20.8	124.5	1.021	124.5	0	0.00
4.50	89.00	1.00	21.0	21,600,000	20.8	124.5	1.021	124.5	0	0.00
4.60	88.00	1.00	21.0	21,600,000	20.8	124.5	1.021	124.5	0	0.00
4.80	87.00	1.00	21.0	21,600,000	20.8	124.5	1.021	124.5	0	0.00
4.90	87.00	1.00	21.0	21,600,000	20.8	124.5	1.021	124.5	0	0.00
5.10	87.00	1.00	21.1	21,600,000	20.8	124.5	1.021	124.5	0	0.00
5.30	87.00	1.00	21.2	21,600,000	20.8	124.5	1.021	124.5	0	0.00
5.90	88.00	1.00	21.6	21,600,000	20.8	124.5	1.021	124.5	0	0.00
6.70	88.00	1.00	22.0	21,600,000	20.8	124.5	1.021	124.5	0	0.00
6.60	95.00	1.00	22.6	21,600,000	20.8	124.5	1.021	124.5	0	0.00
7.10	92.00	1.00	22.6	21,600,000	20.8	124.5	1.021	124.5	0	0.00
7.00	92.00	1.00	22.5	21,600,000	20.8	124.5	1.021	124.5	0	0.00
6.40	93.00	1.00	22.3	21,600,000	20.8	124.5	1.021	124.5	0	0.00
5.70	93.00	1.00	21.9	21,600,000	20.8	124.5	1.021	124.5	0	0.00
5.50	89.00	1.00	21.5	21,600,000	20.8	124.5	1.021	124.5	0	0.00
5.20	87.00	1.00	21.2	21,600,000	20.8	124.5	1.021	124.5	0	0.00
5.00	86.00	1.00	21.0	21,600,000	20.8	124.5	1.021	124.5	0	0.00

Figure 6: Page 1 of 158, see attached excel sheet: 'P.0740511 – UP4 Annualised Energy Calcs Direct 12CdT RED_20230706' for full calculation.

UNION – Block 4 : pPUE (25% IT)

Data Centre Annualised 25% pPUE Calculation

PROJECT NAME	Union Block 3
PROJECT NUMBER	P.0740511
DOCUMENT REFERENCE	P.0740511 - UP3 Annualised Energy Calcs Direct 12CdT 20230613
CALCULATION SHEET VERSION	V1



Revision	Description	Calculation By	Date	Reviewer	Date
A	6.669MW Annualised 25% IT pPUE calculation - Internal review	NC	15.06.2023	STL	15.06.2023

Basis of Calculation:	Based on Factory test results, CFD results and average weighted approximated pressure drop
Assumptions:	See attached 'P.0740511 - UP3 pPUE & WUE report 20230615.pdf' for detailed review of the basis of the calculation.
Modifications of calculations:	Factory testing on 15.10.2022 by 'MECHANICAL VALIDATION SVS LTD' used where applicable. File ref: Bladroom AO Factory Tests & Pressure Profiles Oct 2022.pdf

DBT = Dry Bulb Temperature, RH = Humidity, H = Hours
SAT Supply Air Temperature
NSCE = Net sensible cooling energy per half of the block (3 datahalls)
pPUE = (NSCE+EC)/NSCE
TWC = Total water consumption (includes 25% for RO plant loss, dilution cycle and drainage)

Weather data: London Heathrow, UK (TRY2016)						Note: Input power interpolated/extrapolated based on Manufacturer test results		6.669 MW block			
DBT [°C]	RH [%]	H [hrs]	SAT [°C]	NSCE [kWh]	Total of average IUP for 3Nos. 167 KW DAO of 3 floors [kW]	Total Input power for 18Nos. 185.25kW DAO Units in 3DH of 3 floors [kW]	pPUE	1.03	0.0002	9.2	Total Water consumption[m ³]
								Elec Load from DACs per 3.335MW [kWh]	Evaporated water 1.112MW DH (DACs) [l/h]		TWC [m ³] With +25% for Dilution, drainage and RO
3.70	95.00	1.00	21.1	10,800,000	14.0	84.0	1.028	84.0	0	0.00	
3.90	93.00	1.00	21.0	10,800,000	14.0	84.0	1.028	84.0	0	0.00	
4.00	92.00	1.00	21.0	10,800,000	14.0	84.0	1.028	84.0	0	0.00	
4.20	91.00	1.00	21.0	10,800,000	14.0	84.0	1.028	84.0	0	0.00	
4.30	90.00	1.00	21.0	10,800,000	14.0	84.0	1.028	84.0	0	0.00	
4.50	89.00	1.00	21.0	10,800,000	14.0	84.0	1.028	84.0	0	0.00	
4.60	88.00	1.00	21.0	10,800,000	14.0	84.0	1.028	84.0	0	0.00	
4.80	87.00	1.00	21.0	10,800,000	14.0	84.0	1.028	84.0	0	0.00	
4.90	87.00	1.00	21.0	10,800,000	14.0	84.0	1.028	84.0	0	0.00	
5.10	87.00	1.00	21.1	10,800,000	14.0	84.0	1.028	84.0	0	0.00	
5.30	87.00	1.00	21.2	10,800,000	14.0	84.0	1.028	84.0	0	0.00	
5.90	88.00	1.00	21.6	10,800,000	14.0	84.0	1.028	84.0	0	0.00	
6.70	88.00	1.00	22.0	10,800,000	14.0	84.0	1.028	84.0	0	0.00	
6.60	95.00	1.00	22.6	10,800,000	14.0	84.0	1.028	84.0	0	0.00	
7.10	92.00	1.00	22.6	10,800,000	14.0	84.0	1.028	84.0	0	0.00	
7.00	92.00	1.00	22.5	10,800,000	14.0	84.0	1.028	84.0	0	0.00	
6.40	93.00	1.00	22.3	10,800,000	14.0	84.0	1.028	84.0	0	0.00	
5.70	93.00	1.00	21.9	10,800,000	14.0	84.0	1.028	84.0	0	0.00	
5.50	89.00	1.00	21.5	10,800,000	14.0	84.0	1.028	84.0	0	0.00	
5.20	87.00	1.00	21.2	10,800,000	14.0	84.0	1.028	84.0	0	0.00	
5.00	86.00	1.00	21.0	10,800,000	14.0	84.0	1.028	84.0	0	0.00	
4.70	86.00	1.00	20.9	10,800,000	14.0	84.0	1.028	84.0	0	0.00	
4.40	87.00	1.00	20.8	10,800,000	14.0	84.0	1.028	84.0	0	0.00	
4.10	88.00	1.00	20.7	10,800,000	14.0	84.0	1.028	84.0	0	0.00	
3.80	89.00	1.00	20.7	10,800,000	14.0	84.0	1.028	84.0	0	0.00	

Figure 7: Page 1 of 155, see attached excel sheet: 'P.0740511 – UP4 Annualised Energy Calcs Direct 12CdT RED_20230613' for full calculation.

UNION – Block 4: WUE

Control Setpoint	Temperature	Humidity
CP2	18 °C	20%
CP3	32 °C	40%
CP4	32 °C	70%

DAO Qty	6		<i>(per Data hall)</i>
IT Load	4446	kW	
Supply Flowrate	319.68	m3/s	

Weather Data	London Heathrow TRY2016
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Annual Water Evaporation	5889.6	kg	<i>(Adiabatic Inhibitor at 29.5 °C) (include 20% safety factor)</i>
Water Consumption	7362	kg	<i>(include additional 25% RO plant and dilution cycle water usage)</i>

WUE	0.0002	l/kWh
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Calculation notes:

- IT delta T considered = 12°C
- 20% Safety margin has been assumed for the evaporation figures of the DAO.
- Additional 25% loss assumed which constitutes of 20% RO loss of and, 5% for dilution cycle and drainage.



Prepared by


Nicolas Cheng


Shesehang Tawa Limbu


e: Nicolas.Cheng@red-eng.com

e: shesehang.tawalimbu@red-eng.com

Dubai	dubai@red-eng.com	+971 4 450 3873
Hong Kong	hongkong@red-eng.com	+852 3960 6511
Istanbul	istanbul@red-eng.com	+90 212 211 9914
London	london@red-eng.com	+44 20 7299 8260
Manila	manila@red-eng.com	+63 2 7950 90 16/7
Newcastle	newcastle@red-eng.com	+44 191 500 3140
Oxford	oxford@red-eng.com	+44 1869 355 600
Singapore	singapore@red-eng.com	+65 6226 3106

 www.red-eng.com

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