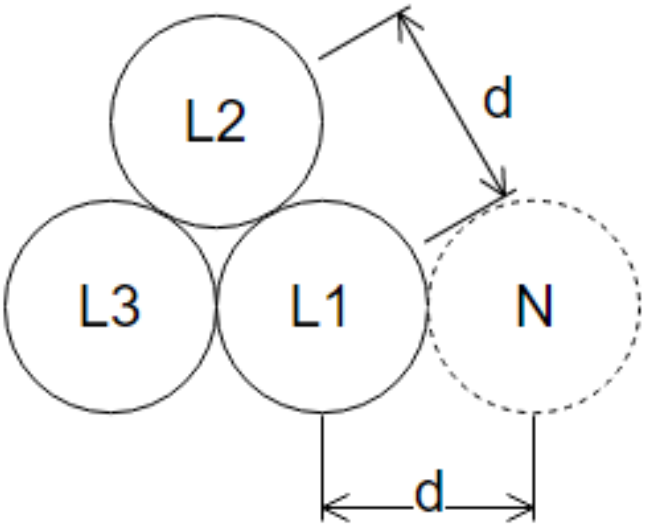
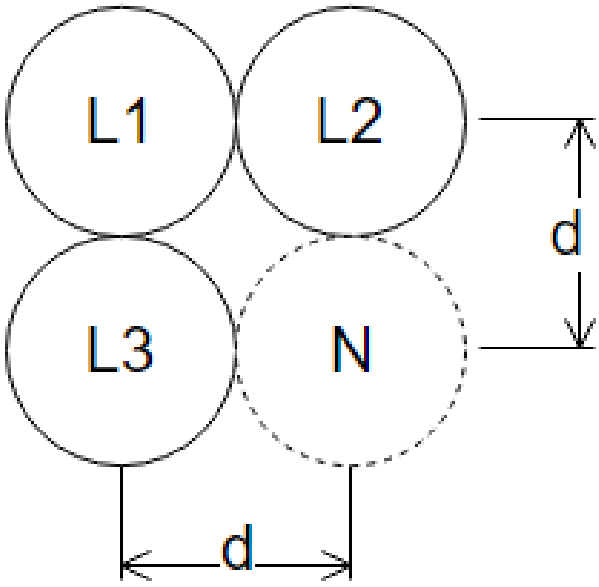
1.0 Appendices

Appendix 01 – Example Photos

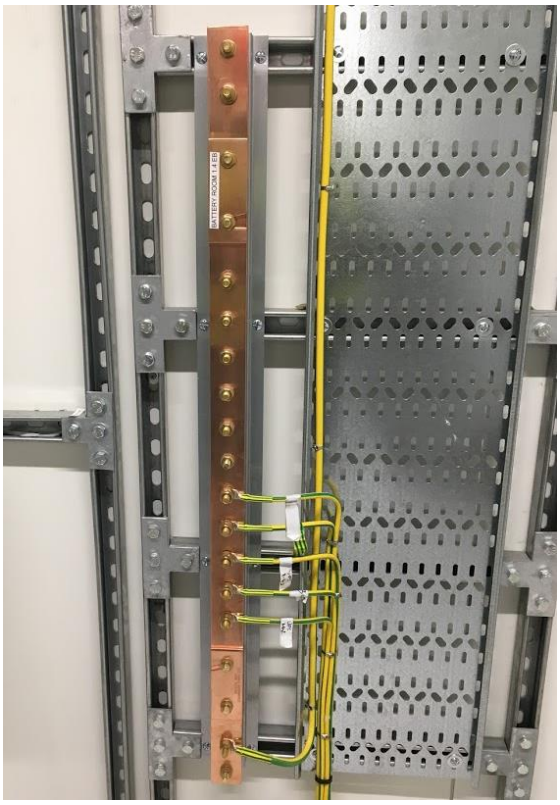
1.1.1 TriFoil Cable Arrangement – 3 core



1.1.2 TriFoil Cable Arrangement – 4 Core

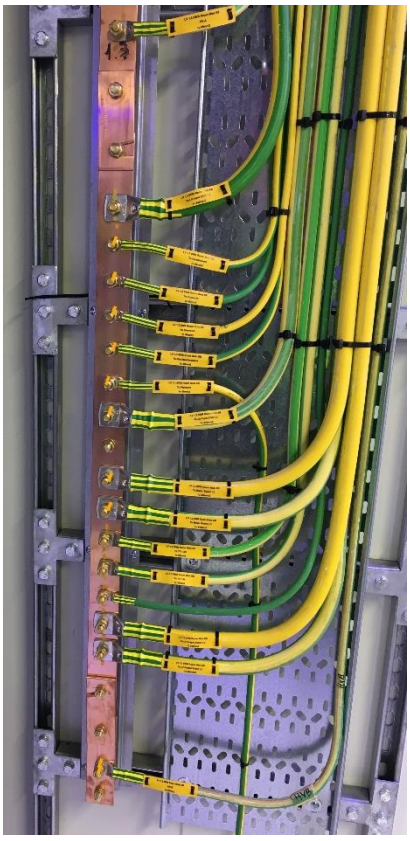


1.1.3 Earth Bar Torque markings and labelling – Bad example



Poor temporary Labelling, no torqued marks on the nuts

1.1.4 Earth Bar Torque markings and labelling – Good example



1.1.5 Breaker Label and Tagging

1.1.6 Transformer Cable Entry - Not Acceptable (No Glands)

1.1.7 HV/MV/LV Electrical Plant Rooms Drawing Mounting

1.1.8 HV Cleat Installation Example

BelleVille washer Application

EQUINIX

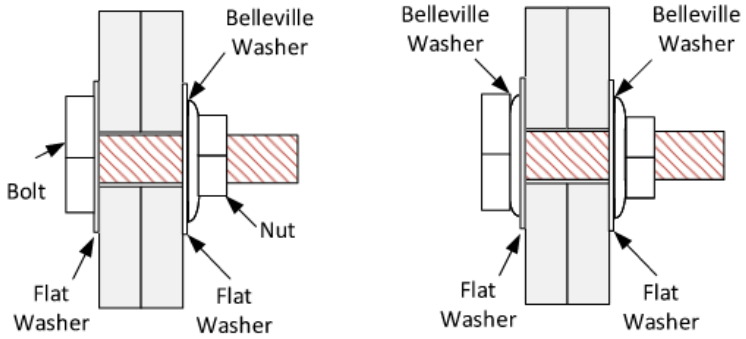
APPLICATION OF BELLEVILLE WASHERS

When making bolted electrical connections subject to high current loads and thermal cycling, Belleville washers can provide a more secure connection compared with spring washers.

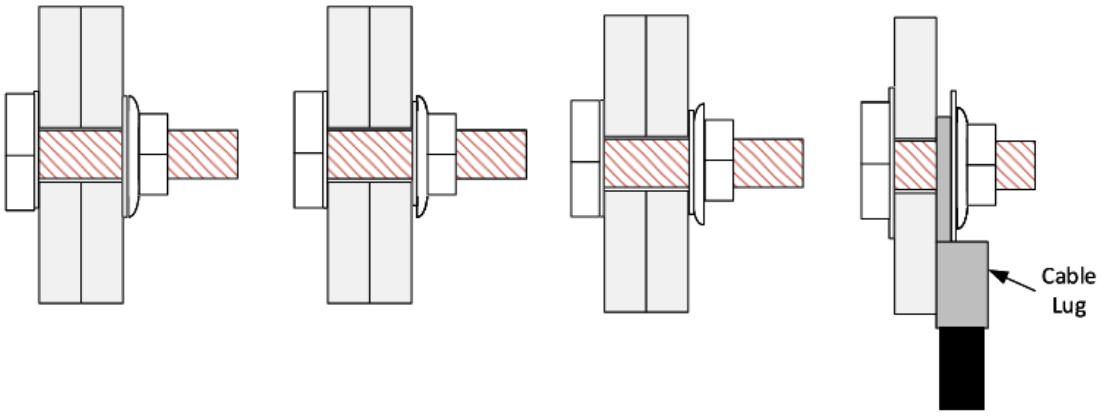
This is a guidance note and not an installation drawing. Manufactures guidelines should always be followed, common sense and engineering judgement should be applied. If a Belleville is not appropriate, then spring washers can be used. Where spring washers are used, they should be fitted in conjunction with a flat shake proof washer.

- Belleville washers provide their clamping force at their outer edge.
- Belleville washers should be used with a larger flat washer underneath, some may not require this. Consult manufactures guidance.
- Belleville washers have a slightly domed shape and should be installed in the correct orientation.
- Belleville washers should be torque tightened according to the torque values recommended.
- When making connections between different materials it is recommended contact grease is used.
- The bolt/ nut/ washer/ copper should be doubled marked with a paint pen for a visual assurance of connection quality.

Correct Applications



Inorrect Applications



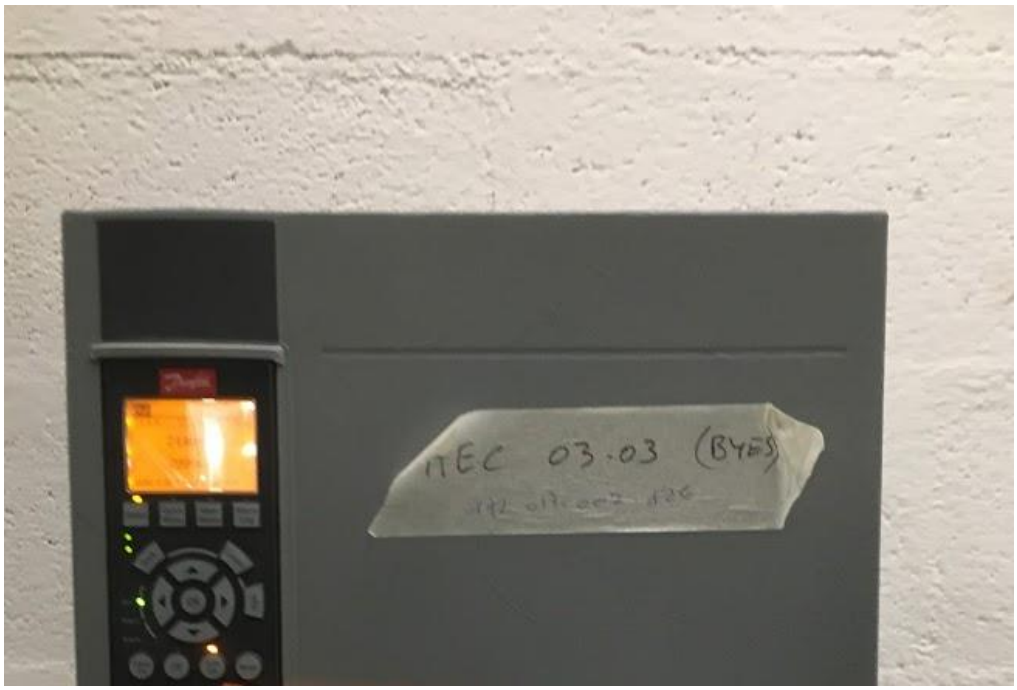
Flat washer same size as Belleville.
Under load the washer edges may slip over the flat washer, reducing clamping force

Flat washer smaller than Belleville
Washer is not providing any clamping force

Belleville is the wrong way round
Washer is not providing any clamping force

Belleville and flat washer are too big for this application.
If the edges of the Belleville overlap the clamping surface, it is not providing any clamping force

1.1.9 Labelling – Unacceptable Examples



1.1.10 Labelling – Good Examples

Appendix 02 – Critical Asset List template

1.1.11 PDU Asset Information template - Required 90 days prior to RFS.

Example Information included for reference only

					Gateway			BCPM Board					
Asset Description	**Number of Circuit Breakers**	**Panel Type**	**BCM Enabled**	Data Correct?	Manufacturer / Model	IP Address	Capable of multiple Modbus Masters	Manufacturer / Model	Addresses	Modbus Register Provided	**Layout Drawing Ref.**	**Install Type**	**Notes**
Electrical panel/RPD		Panel Type									(to be provided if not		
Panel Name											a current Layout)		
PA3-PDU-1.10	84	AC	N	Yes									no BCM
PA3-PDU-1.12	84	AC	N	Yes									no BCM
PA3-PDU-1.24	84	AC	Y	Yes	Schneider / EGX150	10.20.14.213	Yes	Schneider / A084S	1,2	Yes	S 84Way-42Pan	Retrofit	
PA3-PDU-1.25	84	AC	Y	Yes	Schneider / EGX150	10.20.14.216	Yes	Schneider / A084S	1,2	Yes	S 84Way-42Pan	Retrofit	
PA3-PDU-1.26	84	AC	N	No	Schneider / EGX150	10.20.14.172	Yes	Schneider / A084S	1,2	Yes	S 84Way-42Pan		Maximo needs changing
PA3-PDU-1.27	84	AC	N	No	Schneider / EGX150	10.20.14.174	Yes	Schneider / A084S	1,2	Yes	S 168Way-42Pan		Maximo needs changing
PA3-PDU-4.86	168	AC	Y	Yes	Schneider / EGX100	10.20.14.57	Yes	SCA2S	1,2,3,4	No	S 168Way-42Pan	Retrofit	

Excel template can be provided on request from Commissioning Authority or Central Ops Engineering team.

1.1.12 PDU layout drawing for circuit configuration

File: All Layouts Examples (PDU-BCM)

File can be provided on request from Commissioning Authority or Central Ops Engineering team.

Extract from document;

Below is an example of S 42Way-42Pan – (S = Sequential)

1	1	L1	8	L1	22
2	1	L2	8	L2	23
3	1	L3	8	L3	24
4	2	L1	9	L1	25
5	2	L2	9	L2	26
6	2	L3	9	L3	27
7	3	L1	10	L1	28
8	3	L2	10	L2	29
9	3	L3	10	L3	30
10	4	L1	11	L1	31
11	4	L2	11	L2	32
12	4	L3	11	L3	33
13	5	L1	12	L1	34
14	5	L2	12	L2	35
15	5	L3	12	L3	36
16	6	L1	13	L1	37
17	6	L2	13	L2	38
18	6	L3	13	L3	39
19	7	L1	14	L1	40
20	7	L2	14	L2	41
21	7	L3	14	L3	42

BCPM 1 CT 1A

1	1	L1	8	L1	22
2	1	L2	8	L2	23
3	1	L3	8	L3	24
4	2	L1	9	L1	25
5	2	L2	9	L2	26
6	2	L3	9	L3	27
7	3	L1	10	L1	28
8	3	L2	10	L2	29
9	3	L3	10	L3	30
10	4	L1	11	L1	31
11	4	L2	11	L2	32
12	4	L3	11	L3	33
13	5	L1	12	L1	34
14	5	L2	12	L2	35
15	5	L3	12	L3	36
16	6	L1	13	L1	37
17	6	L2	13	L2	38
18	6	L3	13	L3	39
19	7	L1	14	L1	40
20	7	L2	14	L2	41
21	7	L3	14	L3	42

BCPM 1 CT 1B

Appendix 03 – (Early Access) Soft Handover Pre-Requisites Check List

The Pre-Requisites must be undertaken on all strings feeding the White Space to be handed over including Mechanical strings and Redundant string.

1.1.13 White Space Power

	Power Path
1. Check and verify labelling of all cables from Incoming Transformers/Generators to Main Switchgear to UPS/DC rectifier to SMDB's to PDU's (AC/DC).	
2. DC Rectifier operation and distribution checked and verified.	
3. Visual inspection and thermo graphic survey of all customers connected final distribution boards (PDU- AC/DC)	
4. Visual inspection and thermo graphic survey of all Sub Main Distribution Boards (SMDB) feeding item 1	
5. Load tested must be complete on UPS's & STS's (to be completed by Emerson).	
6. Isolation and physical check and clean of all ATS's.	
7. Isolation, physical check and clean of all Main Switchgear& Busbar (MSB,UDP,MDSB thermal graphic survey under load to be carried out and report issued.	
8. Generator and fuel system functional operation (Needs to be proven with generator under full load to prove the fuel system can maintain the demand for each generator).	
9. All critical deficiency's and SOR related items to be resolved (See section I for definition of deficiency's).	
10. Mains failure test to be carried out for each electrical system/generator to prove the automatic and safe transfer to generator during a utility failure and automatic recovery when mains supply is restored. Expectation would be a minimum of 60 minutes proving time to ensure the utility supply is stable (Hz & V are within normal limits) before reverting back to utility.	
11. On completion of the individual utility tests, a building utility test is to be carried out to prove the site in its entirety during a power failure to transfer automatically to generators but all critical systems such as chillers, pumps, CRACs etc. will restart. UPS Systems should unaffected and capable to maintain load during the safe transfer to generator and, after the 60-minute proving time, back to utility.	
12. All generators before being run-up or tested shall have the alternator termination section visually inspected to check for foreign objects, swarf, cable terminations etc.	
13. Where breakers have been identified as being under specified for the rated fault current of the electrical system, these must be replaced with breakers of the correct rating. The existing breakers in operation (live) are a H&S Risk and need to be replaced with the correct rating for the system to ensure they can operate safely in accordance with their design and to ensure compliance with Statutory Regulations and Equinix's Duty of Care (DC PDU breakers issue to be resolved with replacement).	
14. Electrical Installation Certificates to be provided for all Distribution Boards and Electrical Systems. NB – Earth Loop Impedance needs to be checked and verified on the certificates with the physical readings on site to prove the integrity of the earthing system. Previous certificates issued in the past have not had this information. Similarly, cabling to the earth rods were not mechanically protected prior to being buried and we have provided records of earth cabling being physically damaged during construction.	
15. Internal visual inspection and Installation Test Certificates to be provided of the MV Switchgear and Transformers.	

16. SAT approval from ENGINEER OF RECORD for all above (to include signed-off test sheets for each SAT- signatures from M+W and ENGINEER OF RECORD along with dates).	

1.1.14 Cooling Systems

1. SAT approval from ENGINEER OF RECORD for 2 of the Chillers and associated pump sets /controls.	
2. Network CRAC control to be removed and interdependencies (No CRAC controls to affect other CRAC's operations).	
3. Chilled Water Flow Rates to all CRAC' s and chillers to be verified and signed off by ENGINEER OF RECORD	
4. All critical deficiency's and SOR related items to be resolved (See section I for definition of deficiency's).	
5. SAT approval from ENGINEER OF RECORD for FAHU and fresh Air systems including humidifiers.	
6. SAT approval from ENGINEER OF RECORD for CRAC systems (white space and plant room areas).	
7. Prove one chiller can maintain cooling with the current building load for 48hrs.	
8. All chillers and pumps supporting the agreed critical areas must be tested to ensure auto change-over of standby pumps, or pumps ramp-up to maintain duty of the affected system.	
9. Leak Detection for operational areas to be put into service and tested to ensure alarms are back onto the BMS.	
10. Handover documents required for the Cooling Towers and closed loop systems under our control. Please see attached e-mail of expected requirement (NB- No information has been provided to date on the current condition of the system), we will also need to setup an immediate regime for the regular monitoring and management of the cooling towers (under ACOP L8 for guidance).	

1.1.15 Fire Safety/Security

1. SAT approval for all Fire Detection system from ENGINEER OF RECORD.	
2. SAT approval for Fire Suppression systems from ENGINEER OF RECORD.	
3. Air Integrity Test Certificate for rooms with Gas Suppression.	
4. Pressure test certificate for testing the integrity of the pipework for water suppression systems.	
5. Cause and effect test and sign-off from ENGINEER OF RECORD.	
6. All critical deficiency's and SOR related items to be resolved (See section I for definition of deficiency's).	
7. SAT approval for Security system from ENGINEER OF RECORD.	

1.1.16 BMS/CMS/EMS

1. For systems coming under the remit for early handover we will require accurate visibility of all readings, set points and their operation proven to be monitored/controlled via the BMS/CMS/EMS.	
2. Alarming on the BMS plus Remote Alarming is a requirement to ensure the site team have a fighting chance to proactively react to the early signs of a failure or fault.	

1.1.17 Testing

1. Successful Blackout test of all Transformers feeding IT services.	
2. Successful Blackout test of all Transformers feeding Mechanical services.	
3. Testing and signoff from ENGINEER OF RECORD for CMS/BMS/EMS systems relating to above.	
4. ISAT completed for all above systems.	

1.1.18 Training

1. Prior to early handover of the expected areas, the site team will need to have appropriate training of each system	
2. Training should cover; ➢ First level fault investigation and diagnosis ➢ Immediate actions to recover a system or piece of equipment in the event of a failure ➢ Sequence required to make equipment available for maintenance and the maintenance activities to be carried out.	
3. Prior to training below documentation should be issue to each trainee; ➢ A detailed schematic of the overall system ➢ Detailed schematic of the section of the system being trained on ➢ Description covering the method of operation under normal conditions as well as under various failure scenarios	

1.1.19 Water Analysis

We would expect for each of the closed and open water systems on site to ensure these systems are within normal operating parameters prior to taking ownership. Water samples should be taken at least 1 week prior to handover to allow time for test results to be returned in time for the Soft Launch dates.	

Conditions for sampling: ➢ Each sample must be collected in a sterile container. Samples must be stored at a temperature between 6-8˚C and must be tested within 24 hours of being removed from the system. Tests should be performed by an accredited laboratory. Test results must be interpreted making allowance for the accuracy of test procedures. Any variation in results from samples taken at different points around the system should be investigated and, if necessary, further samples taken.	
Items for analysis; ➢ Total alkalinity (ppm CaCO3) ➢ Molybdate (ppm MoO4) ➢ Nitrite (ppm NaNO2) ➢ Conductivity (µS/cm) ➢ Total dissolved solids (TDS) ➢ Suspended solids (mg/l) ➢ pH ➢ Soluble Iron (mg/l) ➢ Total Iron (mg/l) ➢ Total Copper (mg/l) ➢ Soluble Copper (mg/l) ➢ Glycol (%) – Where Applicable ➢ Bacteriological Analysis (to include test for pseudomonas)	

Appendix 04 – Go-Live Checklist

Below is current version of the Go-Live checklist. An excel template can be provided on request from Commissioning Authority or Central Ops Engineering team

1.1.20 CONSTRUCTION CHECKLIST

Project:

31/05/2018 **Construction Manager:**

-60 DAYS PRE RFS				**DATE:**			
Item	**Description**	**Target Date**	**Actual Comp.**	**Comments**	**Handover Checklist**	**GC Deliverables**	**Reference**
1.1.1	Agree to Operations acceptance signoff participants and criteria					X	
1.1.2	Provide site safety orientation to Operation personnel					X	
1.1.3	Approve alarms, set points, and alarms to be paged with Operations					X	
1.1.4	Confirm all alarm and set points to be paged are included for commissioning, testing pre-IST and IST.					X	
1.1.5	Agree to punch list process and participants					X	
1.1.6	Complete roof and flood tests (if applicable)					X	
1.1.7	Log fuel fills per environmental jurisdiction standards and collect individual tickets.					X	
1.1.8	Confirm all IT equipment (computers, phones, BMS servers, etc.) is purchased and track delivery					X	
1.1.9	Ensure environmental jurisdiction (i.e. Department of Environmental Quality or local environmental Protection Agency) are satisfied including generator run time for testing information to landlord and/or city.					X	
1.1.10	Review utility agreement including load ramp letter, exemptions, rebates, and contract review						
1.1.11	Initiate coordination with BCM Development team and Operations in order to bring the system online						
1.1.12	Establish permit signoff sequence and schedule					X	Regionally Specific
1.1.13	Identify purchased critical spare parts to operations for acceptance					X	May or may not be part of GC
1.1.14	Provide leasing requirements (if applicable)						
1.1.15	Provide Ops with landlord personnel and set up recurring meeting						
1.1.16	Provide Ops list of existing IBX's with similar BMS and MEP systems for review and training						
1.1.17	Provide a list of all critical warranties, defect liability periods, and maintenance agreements to Site Ops for gap analysis.				X	X	'Warranties' section 5 Handover Checklist
1.1.18	Update Capacity Management Forecasting tool with project specific engineering data etc.						*New Item* - under development with Infra Eng
1.1.19	White Space Available (Early Access for customers)					X	*New Item* - Agree via STC, the sales pipeline, urgent customer installations and planned early access date / expectations with the contractor(s).
1.1.20	FM Global Checklist Submission					X	*New Item*

-30 DAYS PRE RFS				**DATE:**			
1.2.1	Create GC critical (delays CRD) and non-critical punch lists					X	
1.2.2	Receive startup and functional test reports and certifications				X	X	'Certifications' section 4 Handover Checklist
1.2.3	Environmental protection in place (spill kits, spill prevention plan)					X	
1.2.4	Set up BMS email account and provide ISPs to BMS contractor					X	May or may not be part of GC
1.2.5	EQIX cage, network connectivity up & running					X	May or may not be part of GC
1.2.6	Turn up Equinix Wi-Fi network					X	May or may not be part of GC
1.2.7	Set up EQIX workstations and telephones						
1.2.8	Create single point of entry for construction personnel					X	
1.2.9	Provide Operations EQIX storage room (keyed separately)					X	
1.2.10	Obtain approval of security site acceptance/commissioning script (CCTV, Access Control) from Operations					X	
1.2.11	Provide method statements (i.e. Methods of Procedures, Standard Operating Procedures, and/or Sequences of Operation) for all electrical and mechanical equipment.					X	
1.2.12	Provide commissioning agent's MOP, test scripts and list of expected alarms according to MOP and test scripts.					X	
1.2.13	Test air balancing at minimum and maximum capacity and document results with all related set points for recommended optimization.					X	
1.2.14	Security guarding to protect assets						
1.2.15	Coordinate carrier cage buildout with IT (if required)					X	
1.2.16	Establish Day 2 construction activities to be completed				X	X	'Out of Scope' section 7 Handover Checklist
1.2.17	Provide critical contracted spare parts, breakers, fuses					X	
1.2.18	Provide spare PDUs and Cage Mesh Material						EMEA revision (no RPPs)
1.2.19	Successfully complete pre-IST					X	
1.2.20	Provide marketing fact sheet to Operations including building and roof wind speed rating, and 100/500 year flood elevations relative to slab.						
1.2.21	Provide Operations IST Training Day				X	X	'Training' section 3 Handover Checklist
RFS				**DATE:**			
1.3.1	Successfully complete IST				X	X	'Certifications' section 4 Handover Checklist
1.3.2	Successfully complete security commissioning				X	X	'Certifications' section 4 Handover Checklist
1.3.3	Provide all permits and certificates of occupancy to Ops for posting						
1.3.4	Receive comprehensive project directory including vendor/general contractor/sub-contractor contacts.				X		'Contracts' section 5 Handover Checklist
1.3.5	Provide "as-left" or final settings after commissioning for circuit breakers, relays, and VFD's.						
1.3.6	Provide backup copies of PLCs (if applicable)						
1.3.7	Single line electrical and mechanical diagrams posted in respective rooms						
1.3.8	Final fill fuel tanks						
1.3.9	Agree on daily process for contractor personnel access						

1.3.10	Provide Operations with redline as-builts and any specifically requested O&Ms				X		'O&M Manuals' section 2 Handover Checklist
1.3.11	Provide operations with hourly contractor rates and contract terms for any future expansions or customer fit-outs				X		'Contracts' section 5 Handover Checklist
1.3.12	Provide any information regarding discounts or exemptions from tax (sales, material, etc.) to Operations (i.e. Capital Improvement Projects).						
1.3.13	Provide Operations with arc flash label forms for future installs						
1.3.14	Issue final updated BOD including phasing plan.						
1.3.15	Provide local IBX Ops and Document Management with CD of MEP drawings and set of as-built prints on racks as well as all MEP, BMS, Security systems				X		'Drawings' section 1 Handover Checklist
1.3.16	Provide construction standby personnel (mech, elec, BMS) 1 week after CRD						
1.3.17	Transfer BMS to EQIX Operations and delete temp accounts						
1.3.18	Hand over any and all keys.						
1.3.19	Inform relevant business groups such as regional finance and compliance departments (i.e. NAIBXCompliance@win.equinix.com) on Equinix "customer ready" project completion email announcement.						EMEA revision for email account?
+45 DAYS POST RFS (Ops Handover)				**DATE:**			
1.4.1	Provide Operations with Day 2 construction activity progress				X		
1.4.2	Provide final subcontractor payment lien waivers (if applicable) and execute substantial completion letter for bond release (if applicable)						
1.4.3	Issue LEED certification plaque			+ 100 days			
1.4.4	Commission economizer mode for mechanical equipment (if applicable, season dependent)						
1.4.5	Confirm and provide regional jurisdiction flood elevation certifications (i.e. Federal Emergency Management Agency).						
1.4.6	Provide FINAL comprehensive closeout package, reviewed by internal/external engineering teams and Operations.				X		Handover Checklist deliverables + additional 'Files' column on this sheet
1.4.7	Provide landlord as-built drawings and post condition survey.						

1.1.21 OPERATIONS CHECKLIST

Project:

Facilities Manager:

-60 DAYS PRE RFS				**DATE:**			
Item	**Description**	**Target Date**	**Actual Comp.**	**Comments**			
2.1.1	Incremental resources hired and in place (technicians & engineers)						Section still under review with stakeholders to provide comment;
2.1.2	Familiarization of leasing requirements (if applicable) provided by Construction						Minimum effort will be to delineate between Ops and TFM
2.1.3	Familiarization of landlord personnel including regular meeting forums, as relevant						
2.1.4	Familiarization of BMS system including review and training of similar installation at alternative site. Request CM assistance as necessary						
2.1.5	Familiarization of MEP systems including review and training of similar installation at alternative site. Request CM assistance as necessary						
2.1.6	Participation in project construction OAC meetings						
2.1.7	Participation in project construction Commissioning meetings						
2.1.8	Participation in project construction Security meetings						
2.1.9	Participation in project construction BMS meetings						
2.1.10	Participation in equipment startup in order to generate questions ahead of training						
2.1.11	Participation in IST Script Review (as a means of further understanding operations and failure modes of system)						
2.1.12	Plan and coordinate office relocation (if applicable)						
2.1.13	Review and approve SOO's						
2.1.14	Adhere to sign-in procedure for any construction site tours (investors, sales, customers)						
2.1.15	Prepare Gap Analysis of critical warranties/Defects Liability Periods and maintenance agreements, and engage vendors to quote.						
-30 DAYS PRE RFS				**DATE:**			
2.2.1	Participation in project construction Commissioning process including functional testing, Pre-IST, and IST						
2.2.2	Participation in security commissioning process						
2.2.3	Establish security personnel schedule						
2.2.4	Implementation of operations and maintenance services contracts including cleaning (green if required by LEED), landscaping, baler, etc.						
2.2.5	Order vending machines, games, coffee, office supplies, etc.						
2.2.6	Populate EQIX storage room with Day 1 supplies						
2.2.7	Implementation of Maximo				X		Asset list template from Ops Eng (Gaby)
2.2.9	Establish MOP/engineering script and CMR process for post CRD activities (if applicable)						
2.2.10	Provide staff information and photos for customer welcome signage						

2.2.11	Issue access cards to any remaining construction personnel and commissioning team.						
2.2.12	Identify project specific high priority training requested prior to CRD						
2.2.13	Attend Operations IST Training Day						
2.2.14	Prepare maintenance schedule across all critical equipment and services for 1st Year of operation.						
RFS				**DATE:**			
2.3.1	Acceptance of all building systems (BMS, security, mechanical, electrical, etc.)						
2.3.2	Attend any requested early systems and equipment training and submit attendee logs						
2.3.3	Sign off on completion of critical punchlist items (Commissioning, QA/QC deficiencies)						
2.3.4	Replace temporary construction door key cores with permanent cores and return temporaries to construction.						
2.3.5	Operational security personnel in place						
+45 DAYS POST RFS (Ops Handover)				**DATE:**			
2.4.1	Attend systems and equipment training and submit attendee logs						
2.4.2	Sign-off completed non-critical items punchlist						
2.4.4	Receive and inventory non-critical attic stock						
2.4.5	Contribute and participate in lessons learned process						
2.4.6	Confirm BMS settings are per SOO						
2.4.7	Cancel construction personnel access cards						

Appendix 05 – Sample O&M Format

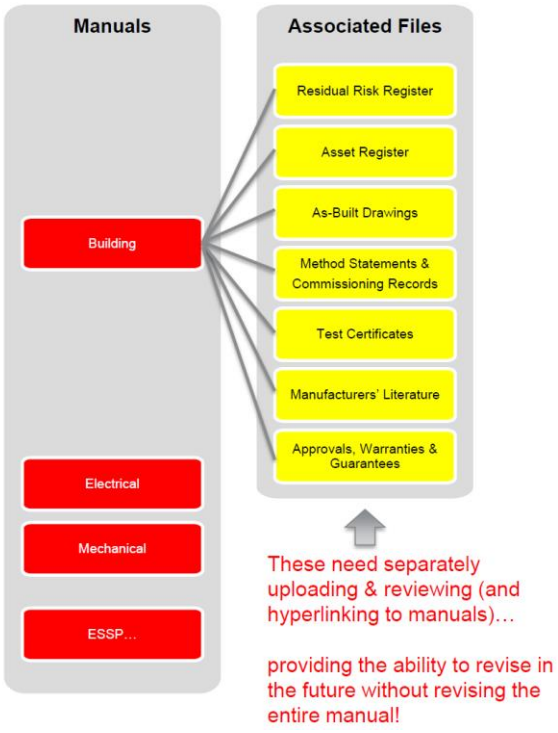
O&M Manual Format

General Contractor:

1. Building
2. Electrical Services
3. Mechanical Services

ESSP Suppliers:

4. Generator
5. Switchgear
6. UPS
7. Chiller
8. CRAHs….



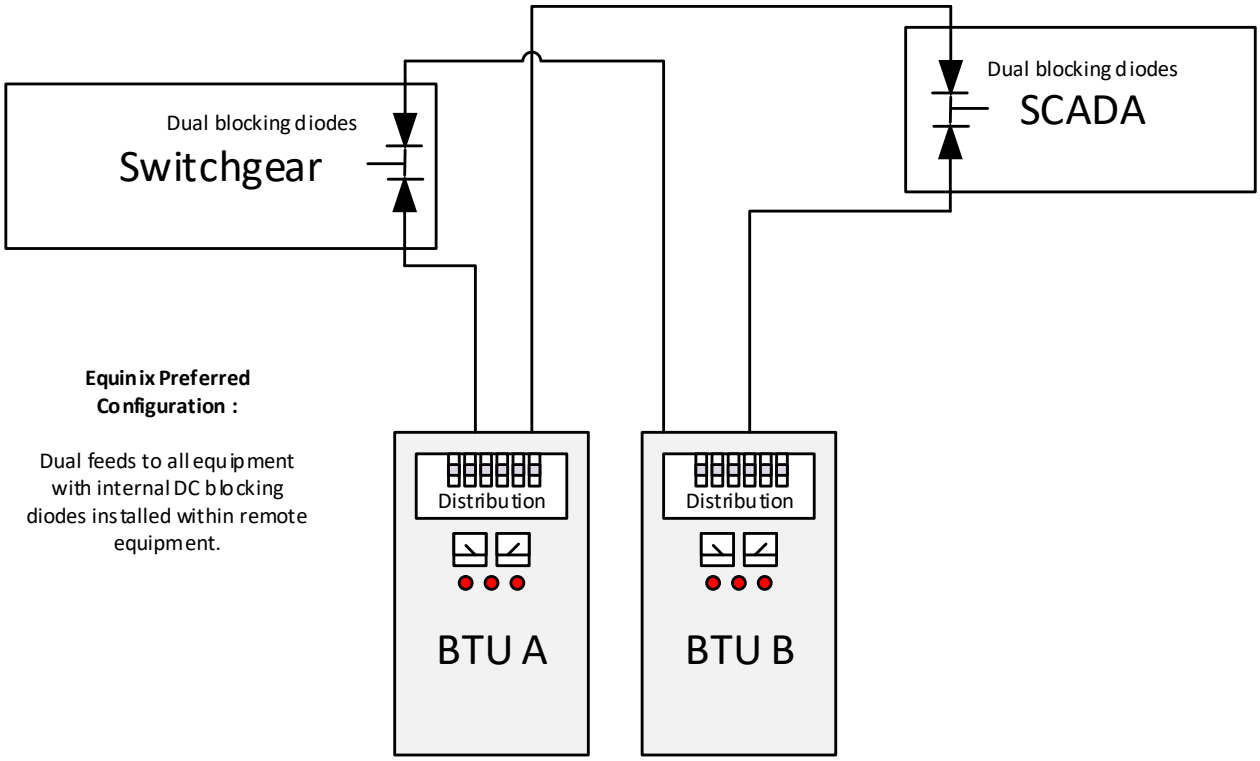
Appendix 06 - Cable Bend Radius Guidance Example

As a rule, Equinix allow a minimum bend radius of 12-15 times the cable diameter, to protect the cable.
Also, to give more flexibility to in the event of a circuit breaker or cable fault, damaging the end of the cable or lugs, to allow a reasonable cable length to re-lug cable.

MV cable with insufficient bend radius – cable is over-bent.

Control cables with insufficient bend radius – cable is over-bent!

Appendix 07 – BTU connection requirements



Appendix 07 – Transformer Testing Diagrams

1.1.22 Test Voltage Table

Transformer Insulation Resistance Acceptance Testing

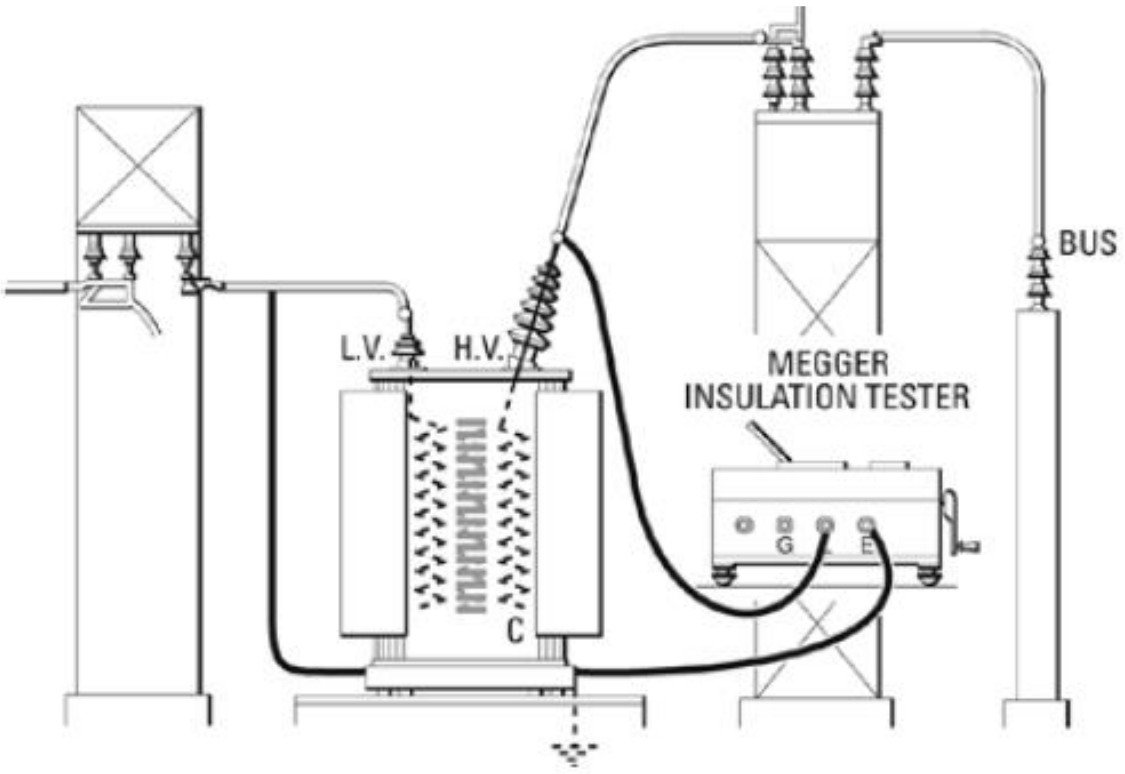
Transformer Coil Rating Type in Volts	Minimum DC Test Voltage	Recommended Minimum Insulation Resistance in Megohms	
		Liquid Filled	Dry
0 - 600	1000	100	500
601 - 5000	2500	1000	5000
Greater than 5000	5000	5000	25000

In the absence of consensus standards, the NETA Standards Review Council suggests the above representative values.

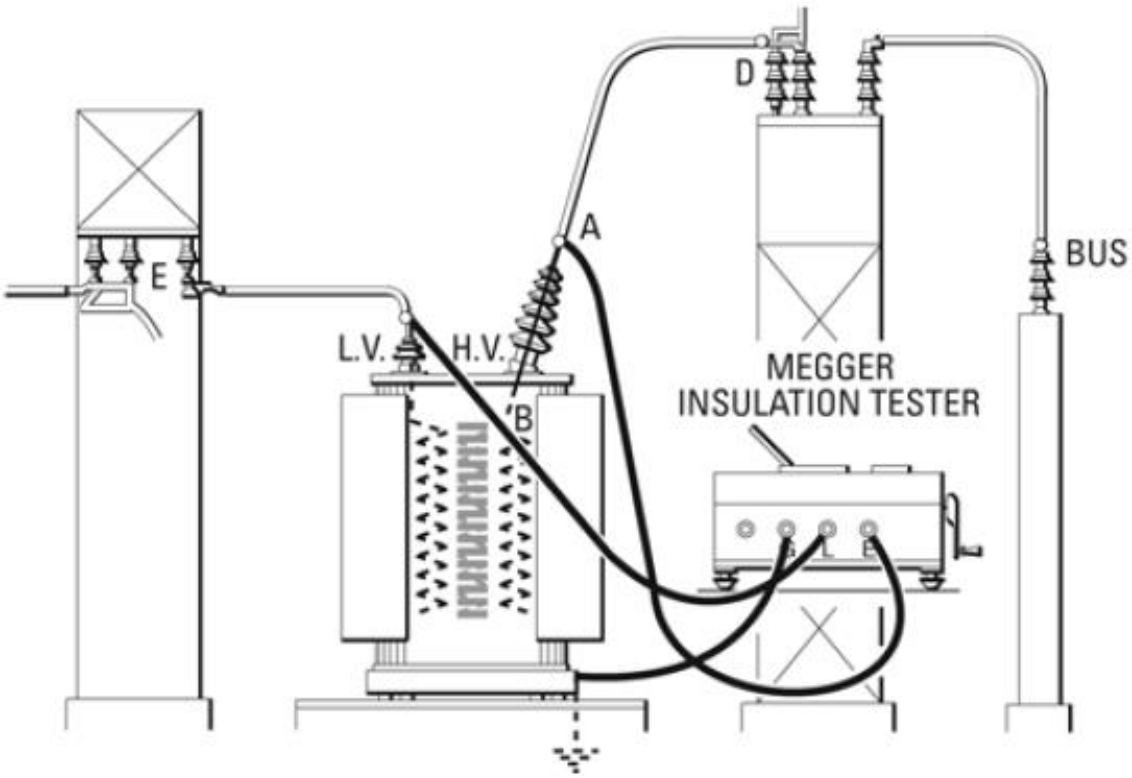
See Table 100.14 for temperature correction factors.

NOTE: Since insulation resistance depends on insulation rating (kV) and winding capacity (kVA), values obtained should be compared to manufacturer's published data.

1.1.23 5kV DC insulation Test High Voltage Winding to Low Voltage Winding and Earth diagram

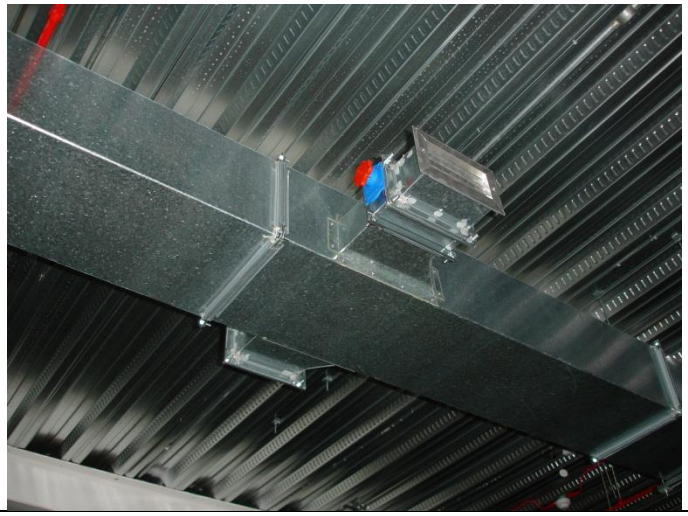


1.1.24 1kV DC Insulation Test High Voltage to Low Voltage Winding and Earth



2.0 Benchmarking Photos

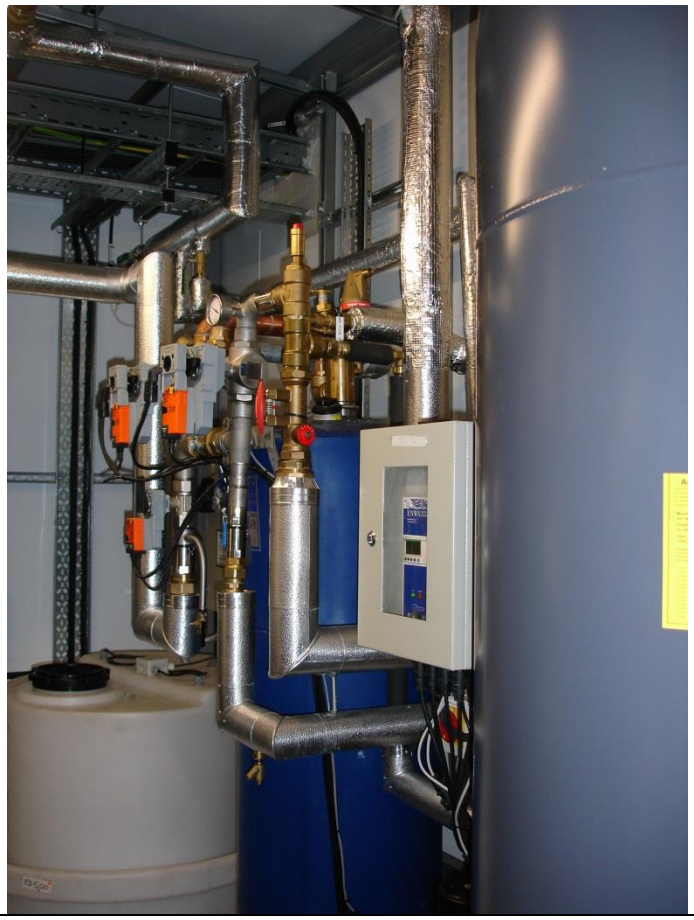
HVAC		
Grilles		Vent grilles require correct housings and filters
Fire Dampers		Acceptable installation
Filters		
Insulation		Acceptable installation

Supports		Acceptable installation – ensure hanger brackets are square with the ductwork.
VAV Actuators		Acceptable installation
		Insufficient access to the damper actuator

		Insufficient access to the damper actuator
		Insufficient access to the damper actuator
Fresh air AHU plant		Acceptable installation Pipework and containment turn up close to the AHUs to run at high level. Neat insulation and finishes to connecting ductwork.

Plant room vent. AHUs		Acceptable installation As above.
AHU gauges		Acceptable installation Well distributed gauges in a visible location, firmly mounted to the relevant equipment. Access is not impaired. BMS conduit and cables neatly terminated with coiled up spare cables.

1.1 Pipework Distribution

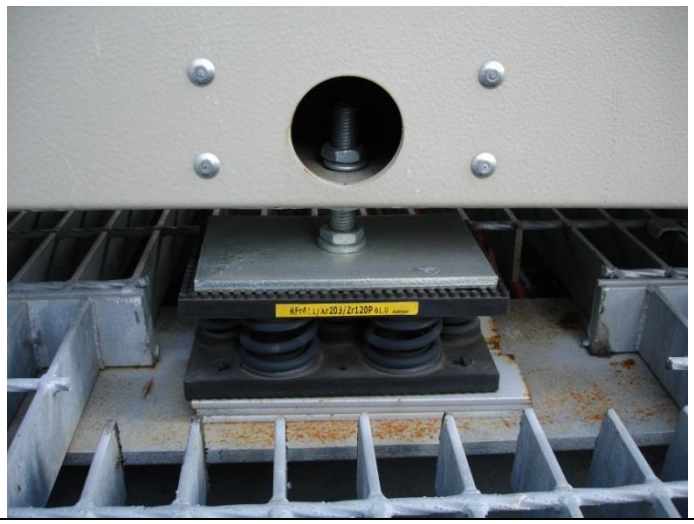
Gaskets		
Valves (incl. control)		Acceptable installation Valves actuators and gauges are accessible and visible from the same side. Electric containment is provided to an adequate height. BMS cable is bunched and distributed neatly, without impairing access.

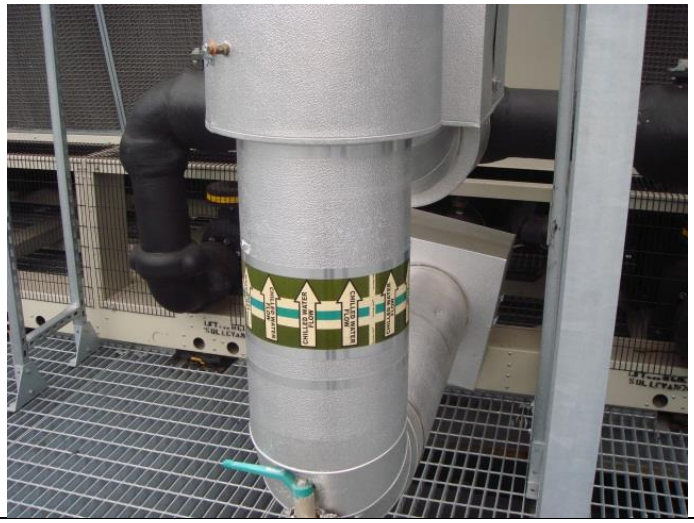
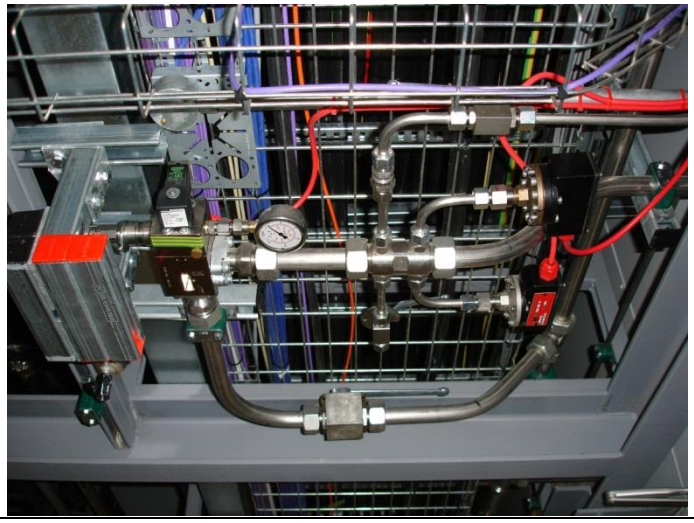
Valve insulation		Acceptable installation Insulation covers valves well, allowing a neat opening for the actuator.
Low level valve actuators		Valve extension installation can be abused as a foot step. Low level valve actuators to face up where possible. Signage required if actuator needs to be side-on

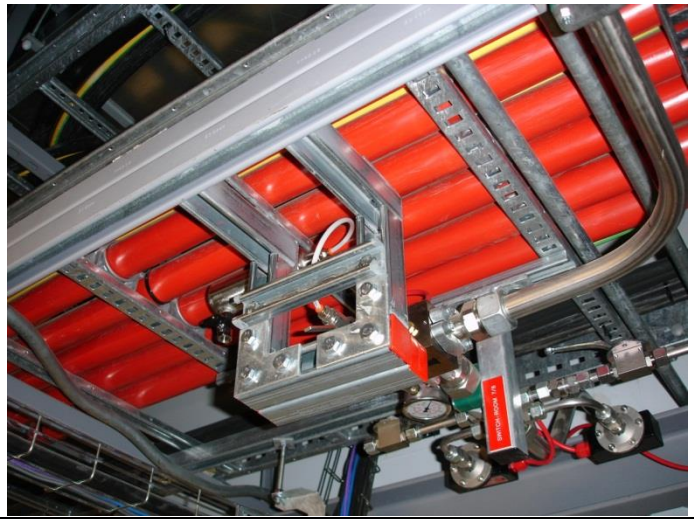
Chemical Dosing Pipework		Non-return valve required for chemical dosing pipework
AHU Condensate NRVs		Plastic non-return valve is inaccessible for a part that requires frequent maintenance. Fragile component gets easily damaged.
Strainers		
CHW pipework and insulation		Acceptable installation Neat insulation and pipe support structure.

CHW secondary mains loop		Acceptable installation Undamaged pipework lagging.
CHW branches in white space.		Acceptable installation – accessible valve arrangement with correct, undamaged lagging.

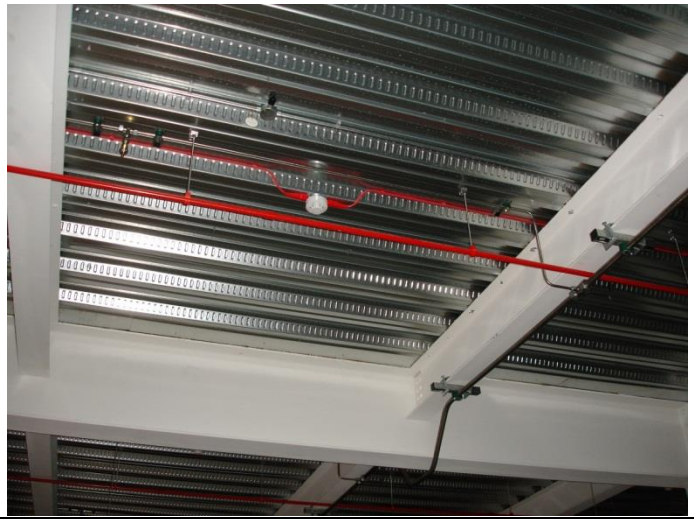
Pump Rooms		Acceptable installation Pipework and instrumentation fully lagged around pumps. Clear labelling. Slack BMS cabling coiled with rigid containment to adequate level. Evenly distributed pump modules.
Supports		Acceptable installation Although ladder rack does not need to be located at high-level

		Acceptable installation – clear pipework labelling, full undamaged insulation, correctly adjusted pipe hanger.
		Inadequate support. Pipework assembly T-section should be supported either side.
Chiller mounting feet.		Acceptable installation Anti-vibration mounting is adjusted correctly. There is sufficient travel in the springs.

Chiller feet		Anti-vibration spring has been fully compressed (preventing it carrying out its isolation function). Shims to be applied to other feet (as in photo above) to prevent this occurring.
Labelling		Pipework labelling held in position
## 1.2 Fire Suppression		
All Section Valves		Acceptable installation Note that the lever on the left end needs adequate physical protection against accidental impact.

		Acceptable installation Note that the lever on the left end needs adequate physical protection against accidental impact.
Actuator Heads		Acceptable installation

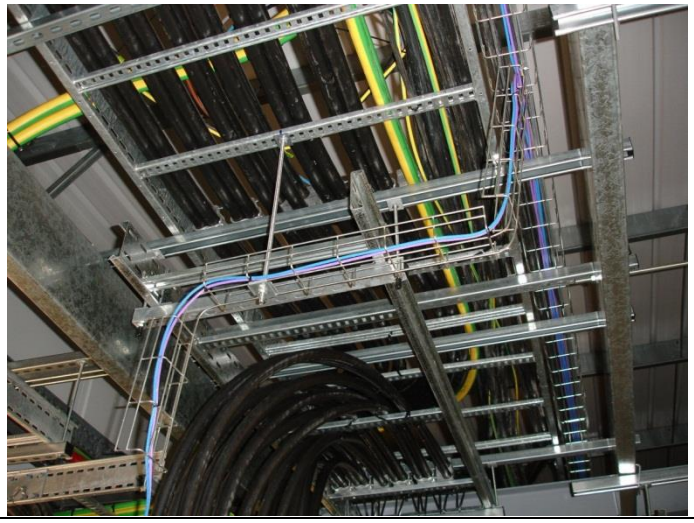
Pipework		Acceptable Marioff pipework support
		Acceptable Marioff pipework support

		Acceptable installation
		Acceptable installation

		Marioff pipework unacceptable. Pipework should be cut to suit grid
		Marioff pipework support not acceptable

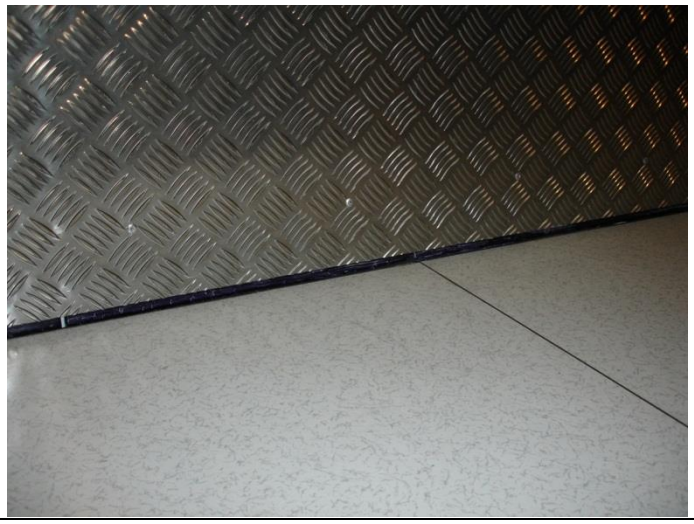
		Marioff pipework support not acceptable
1.3 Leak Detection		
All Sensor Cables		Acceptable installation – cabling runs flush with the floor.
Control Units		
1.4 Controls and Instrumentation		
Gauges		

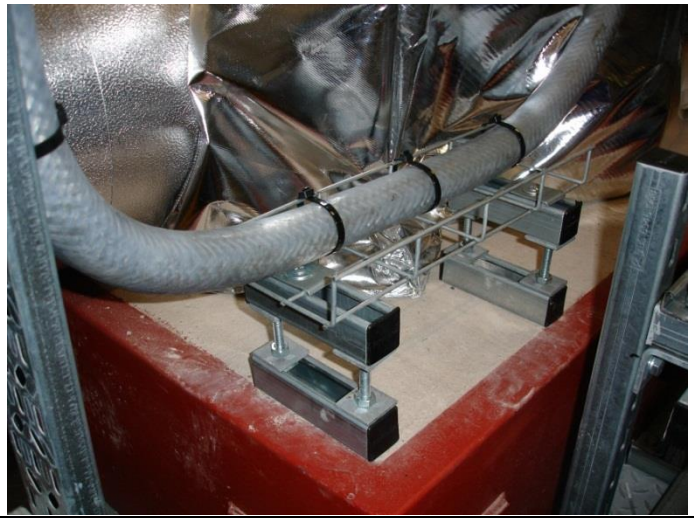
Sensors		Good example of sensor support
Indicators		AHU Room – good example of BMS/control panel
		Pump Room – good example of BMS/control panel
Transmitters		
Graphics Pages from GUI		

Cabling / Containment		Acceptable installation
		Unacceptable installation of containment – passes beneath light fitting in corridor, and is vulnerable to impact. No cross overs allowed at low level of walkways
1.5 Architectural Fittings		
Floor Tiles		Acceptable installation – floor tile layout coordinated to suit CRAC units (i.e. minimizing cut tiles)

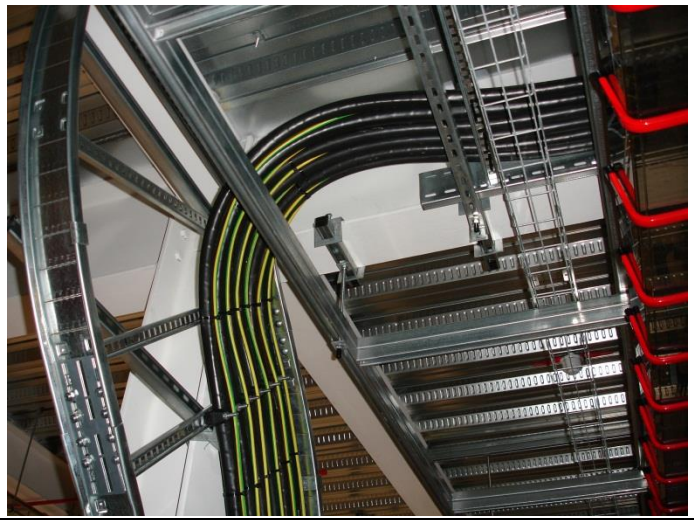
		Good example of raised floor tile cut (and sealed) around building column
		Acceptable installation

Doors		Acceptable installation
		Acceptable installation of ramp over room bund

Walls		Acceptable installation
		Unacceptable installation – checkerplate wall protection should extend slightly below the raised floor level to remove the (uneven) gap between the floor tiles and wall protection

		Acceptable installation
1.6 Power Distribution		
All Containment (incl. cross-overs) and Accessories		Acceptable installation

		Acceptable installation – cables are well spaced throughout the drop from the high-level containment
		Acceptable installation – neat, properly spaced and well supported/ clamped

		Acceptable installation – vertical cables clamped to provide support over long drops
		Acceptable installation

		Unacceptable installation – bunching of cables turning off containment. Cable spacing to be to be maintained.
		Unacceptable installation – cables should have been laid in single layer and not double stacked.
		Unacceptable installation – cable length inadequately supported from containment to termination point

		Unacceptable installation – cables to be in containment under floor (at the edges/next to walls)
		Unacceptable installation – double stacking has caused damage to pipe insulation

Cable Positioning (on containment)		Acceptable installation
		Acceptable installation

		Acceptable installation
Cable terminations (e.g. chillers)		Acceptable installation

		Acceptable installation
		Acceptable installation – penetration is well-sealed to prevent water ingress

		Unacceptable installation
		Unacceptable chiller feed installation

		Unacceptable installation – cables are sweeping downwards into chiller – allowing water to run inside
		Unacceptable installation – cables are sweeping downwards into building – allowing water to run inside

		Acceptable installation – AHU termination
		Unacceptable installation - AHU termination

1.7 Small Power

All Accessories (incl. floor boxes, outlets, and connection units)		Good example of power reel installation
Cabling / Containment		Unacceptable installation – unnecessary amount of conduits

		Poor quality conduit installation. Should stop short of ceiling and cable be fixed to roof structure

1.8 Lighting

All Luminaires and Accessories (incl. PIRs, switches and photocells)		Acceptable installation

		Acceptable installation
		Acceptable installation

		Acceptable installation
Cabling / Containment		Good example of light fitting cable `` with 1metre coiled length

		Acceptable installation – cables / conduits / pipes to either run in straight line within a floor slab 'trough', or immediately adjacent to structural steelwork beams when running in the perpendicular direction