Addendum to M&E 8 Philosophy document

Ground Source Energy Systems (GSES)

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Date of issue: December 2012

1. Design & Specification Phase

1.1. GSES within the University must be designed, installed, controlled and interfaced with other systems with the primary purpose of reducing Carbon emissions. The control strategy for carbon emissions reduction may be different from those for cost savings. The programming of the GSES controls must make reference to the actual efficiencies of the installed conventional plant (if installed) so that the plant only runs when it is more (carbon) efficient than the alternative.

1.2. Systems should be designed so that the amount of heat extracted from the ground annually is reasonably well balanced with the amount of heat rejected to the ground as far as is practical. The depth of the loops is limited by the Great Oolite Aquifer which is especially limiting where buildings have deep basements.

1.3. The designer will need utility cost and tariff information from Estate Services (ES) sustainability section and will be forced to make assumptions of future costs (it is important that the assumptions of future costs are agreed by all parties otherwise the design / payback rationale could be misunderstood). Savings should be calculated using the seasonal energy efficiency rates of the chillers and boilers selected for the project and not a typical figure for relevant plant.

1.4. The designer must set out clearly in the Stage reports of how much heating and cooling the system is designed to supply, both in absolute and percentage terms, the likely availability of the system (and what happens if this is not achieved), and the annual average COP of the system in heating and cooling. The heating and cooling data will be based on a model which makes many assumptions. The assumptions must be well documented and approved by the PSG.

1.5. The interface of the GSES with other control systems needs to be considered carefully. The extent and speed of data transfer should be minimised. Data traffic increases as systems mature so what works at handover may not continue working for long. Detailed consideration must be made of how GSES interfaces with building TREND BMS.

1.6. The designers must ensure that there is separate metering so that the GSES actual performance can be verified independently. The heat meters should be in the best

possible positions (appropriate lengths of straight pipes up and down stream) to give accurate readings. Note there will be discrepancies between the meters but the designer should agree with the Contractor what the acceptable error should be before measurements start. All meters must be connected to the BMS or other approved metering system. The designer must clarify which meters will be used to assess the system performance. Buffer vessels must be carefully sized to minimise starting cycles. The designers must ensure that heating and cooling outputs from the GSES are metered separately and that the GSES's electrical consumption in heating and cooling respectively can be separately identified. They should ensure that all parasitic loads e.g. ground loop pumps are also metered.

1.7. The designers must ensure that conventional systems do not take away load from GSES. Dead bands and control set points must be carefully considered.

1.8. The project manager must get a quotation for comprehensive 5 year maintenance as part of the project costing. Current experience is that critical components - compressors expansion valves and header valves are inherently unreliable so comprehensive contracts are essential.

1.9. The project manager must engage with the University's IT services to ensure that a comprehensive remote monitoring system is available TO THE CONTRACTOR BEFORE THE START OF COMMISSIONING. The frequency of monitoring and reporting must be agreed.

1.10. The project costing must include for regular and seasonal reviews of system performance post handover. Seasonal commissioning must be built into the contract price. The number of years of commissioning should be based on the complexity and criticality of the system. Consider the use of a specialised validation engineer to review the performance at a detailed level and the interface with the BMS controls.

2. Installation

2.1. The Designer must witness the factory testing of the heat pumps **under load at representative source and load side temperatures.** ES's Mechanical Engineer should also be given the option to attend.

2.2. Ensure that (client) IT infrastructure for the remote monitoring of the system by the supplier is available **before** commissioning. It is important to start discussions early as there are potential security considerations.

2.3. Ensure that meters are only reset to zero after ALL meter readings have been taken.

2.4. Both the BMS and the GSES will have to be tuned and some of this will be interdependent. Both systems will also require seasonal commissioning post handover and this should be coordinated. The avoidance of short cycling is important but neither do you want to keep bringing on auxiliary heating and cooling.

2.5. The description of operations (DESOPs) needs to be written in sufficient detail and structured so as to be useful for witnessing. The BMS DESOPs must be coordinated with the GSES DESOPs, and any other relevant third party controls e.g. chiller / boiler sequence controllers. The system needs to be witnessed jointly with the BMS after both systems have been commissioned fully.

2.6. All systems must be installed so as not to let the conventional systems take away load from the GSES.

2.7. A refrigerant leakage detection system must be installed in appropriate locations around the GSES and connected to the BMS system.

3. Handover

3.1. The GSES needs to be handed over to the following groups all of whom have a role to play in the successful operation of the system:
- 3.1.1. The department building manager;
- 3.1.2. Estates Services Mechanical engineer;
- 3.1.3. Estates Services Energy manager;
- 3.1.4. The DLO mechanical supervisors.

3.2. The handover of the system should be coordinated with the handover of the BMS. Suitable and sufficient training, instruction and documentation (including the DESOP for both the GSES and the relevant sections of the BMS) must be provided.

4. Operation

4.1. Ensure that meters are only reset to zero after ALL meter readings have been taken. If you are trying to interpret the information that is obtained from the system to assess either carbon saving or energy savings it is critically important that very good records are kept of anyone working on the system and what they have done or are doing be it remedial, repairs replacement etc---without this and knowing for example when meters have been off it is impossible to have faith in the readings and hence faith in the energy / carbon saving results. Meters should be read locally and cross checked against the metering system periodically.

4.2. The maintenance of the system must be overseen very closely. Ensure any problems picked up by the contractors maintenance engineers are reported to the projects team and rectified under defects liability.

4.3. The contractor and designer should produce regular (monthly) reports of performance post handover which should be reviewed by ES repairs and maintenance and the Project team. Major reviews should be carried out to assess seasonal performance and used to inform the fine turning during the soft landing period. The project manager should coordinate these meetings with participation from designers, GSES contractor and Estates Services mechanical and Sustainability teams.

4.4. The system must be operated so as not to let the conventional systems take away load from GSES.