Mechanical Systems

Brief

Proposal

For Renslade House

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MECHANICAL SERVICES INSTALLATION

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JJR MECHANICAL

JJR ELECTRICAL

SECTION C

C.1 SERVICES TO BE PROVIDED

JJR shall undertake the co-ordination, supply, delivery, positioning, installation, setting to work, testing and commissioning of the engineering systems as set out below:-

(i) Incoming services

(ii) Central Heat Recovery Ventilation Systems

(iii) Domestic Water Distribution services

(iv) CHP Boilers if Applicable

(v) LTHW Heating system

(vi) Controls installation

(vii) Gas pipework

(viii) Dry Riser installation

C.2 SERVICES DESCRIPTION

C2.1 Incoming Water Services.

The water supply for the development will be provided by a bulk supply; this will enter each building at ground floor into the plant room. The authority's meter shall have a pulsed output and will be located within the footpath adjacent to the building. JJR shall extend the main from the authority's stopcock into the building.

The incoming main shall be fitted with a pulsed output water meter, and a leak detection system shall be installed. This is to be an audible alarm, activated when the flow rate through the water meter is above a certain level (TBA) for a pre-set amount of time; it shall be programmable to suit the building occupier's flow criteria and shall be capable of identifying different flow rates (and thus leakage rates). The leak detection system shall be as Waterguard Series 7 or similar.

The installation is to be provided with a Chlorine Dioxide injection system. This system is to dose the cold water storage tank with Chlorine Dioxide in order to prevent the growth of Legionella and other organisms, and prevent the formation of biofilm, in both the boosted cold water and LPHW systems. This unit shall be as Powermag or similar.

C2.2 Heat Recovery Ventilation Systems

Please see separate sheet for the proposal of the ventilation systems.

C2.3 Domestic Water Distribution Systems

Main Distribution

All studio apartments and landlord supplies will be serviced from the boosted water supply located in the plant room. The system will consist of a sectional storage tank, and packaged inverter-driven booster set.

The tank shall be sized to provide the minimum storage capacity in the event of incoming supply failure, for the minimum time as stipulated by the Local Water Authority and in accordance with CIBSE guidelines. The storage capacity shall be actual usable water.

The booster set will be fully automatic. The system shall be designed to ensure a minimum of 2.5 bar maintained pressure to each studio apartment. The unit will be provided with three main inverter driven pumps; each pump will be capable of 50% of the design duty. The system will be complete with a draw down vessel for low load situations.

The break tank will be an insulated GRP sectional tank and shall be of materials and construction accepted by the National Water Council & manufactured by Nicholson Plastics Ltd or equivalent. The tank panels will be externally bolted. The tank will be divided equally into two sections to facilitate maintenance without interrupting the supply. Covers shall comprise standard GRP externally flanged plates for external applications. For internal applications bolted ribbed aluminium sheets with readily removed sections for ball valve attendance and access may be used.

The tank is to be mounted on a plinth or piers as indicated on the manufacturer's specific detail drawings.

Each tank section will have Keraflo Aylesbury high flow float valve, overflow and warning pipe of the sizes indicated on the drawings.

All internal ladders, straps, ties and similar fittings shall be nylon coated and internal bolts; nuts and washers shall be stainless steel.

Openings for connections up to 50/54mm diameter may be cut on site and the connections made for the backnuts and plastic washers. For pipe connections 65/67mm diameter and above, studded pads shall be provided.

Boosted cold water mains will distribute in copper pipework and fittings..

The boosted cold water main will leave the plant room at high level and will run to the dedicated mechanical riser shafts. Within the riser shaft a rising main will run up the building with a take-off at each level complete with an isolating valve, pressure reducing valve and drain valve. The individual boosted cold water mains shall leave the riser at each level and distribute to the apartments and communal facilities, to terminate in the studio apartments with a stopcock, double-check non-return valve and drain valve. Communal facilities are to be provided with isolation valves and backflow prevention measures as necessary.

Boosted cold water pipework within apartments is to be installed using copper pipework to table X. All connections to outlets will be provided with ballofix valves for isolation and maintenance and flow restrictors.

The water system shall be installed in full accordance with the water byelaws, BS 6700:2006 and HSE HS (G) 70.

The entire system is to be chlorinated on completion; this is also to include all pipework within the studio apartments, communal areas and all distribution pipework within ceiling voids and the plant room. JJR has allowed for chlorination to be carried out in stages, due to the nature and size of the building.

All mains cold water and boosted water distribution pipe work is to be insulated in accordance with Building Regulations and TIMSA guidance.

Any mains pipe work running externally will be insulated to prevent freezing; external taps are to be sited and piped such that the minimum amount of pipe work is exposed. Where pipe work is exposed it will be insulated

The hot water cylinders shall be fitted with an unvented kit in accordance with Part G3 of the Building Regulations. The Pressure Reducing Valve shall provide balanced hot and cold water which shall be extended to all outlets via the ground floor ceiling void.

All hot outlets will be provided with TMV3 mixing valves and all hot and cold outlets shall be fitted with combined isolation valves and flow restrictors.

A hot water secondary circulation system shall be provided to reduce dead legs and minimise hot water draw off times. The secondary circulation pump shall be bronze bodied and controlled via a dedicated timer. Thermal Balancing Valves (TBVs) as Reliance Water Controls (or equal) shall be installed**.**

CHP Boilers (If Applicable)

If required the development is to benefit from the installation of a combined heat and power system, sized to meet the requirements of BREEAM Ene01 and as supplied by SAV Systems. The CHP units are to be fitted in series with the boiler plant to ensure that they run as much as possible, and are to

serve the flow header via packaged thermal stores and controls provided by the manufacturer. Thermal store capacity will be calculated by the manufacturer during development of the scheme.

The CHP unit and LPHW boiler installation shall be configured to make use of the thermal output from the CHP unit for all low-load conditions, the boilers only augmenting LPHW output when the CHP is running at maximum capacity and is not meeting demand.

The CHP plant shall be a packaged unit as supplied by SAV Systems or equivalent; the plant shall have modulating output and self regulating control system. The CHP flue is to be separate from the boiler flue, but will rise through the building in the same riser and terminate on the roof.

The flue shall extend 1000mm above the roof and shall be adequately supported with brackets and guy wires to prevent collapse during adverse weather conditions.

All joints in the flue shall be positioned such that they are readily accessible for inspection.

C2.4 Heating System

Primary low temperature hot water (LPHW) shall be generated by gas fired, fully modulating, condensing boiler plant located within the ground floor plant room.

The boiler plant shall include 4No. Ideal EvoMax 150Kw packaged boiler sets. The boilers will be packaged complete with matched primary circulating pumps and controller.

The boilers shall be stainless steel high efficiency low NOx emission (Class 5) fully modulating, condensing boilers conforming to BS 799 or DIN 4702 with pre-mix gas burners providing a net calorific efficiency of at least 95% at full and part load. The burner shall be mounted on a hinged panel which shall also provide access to the combustion chamber.

All surfaces in contact with the flue gas condensate shall be manufactured using stainless steel with the condensate discharge to foul drain.

The boilers shall be fitted with the following accessories: -

- Safety valve with discharge pipe extended to floor level and clear of the boiler shell or casing.
- 25mm Drain valve.
- Flame sight glass.
- Flue gas thermometer.
- Thermometer.
- Altitude gauge.

The gas fired boiler installation, materials, workmanship and testing shall comply with the requirements of BS 6644 and also with Gas Safety (Installation and Use) Regulations and shall follow the recommendations of Institution of Gas Engineers (IGE) publications IGE/UP/2, 5, 12, 16 & 18.

Condensate from the boiler flue gases shall be run to discharge to the stub stack located within the plant room. The condensate pipework shall be of press-fit stainless steel.

The flue installation shall be carried out in full accordance with the manufacturer's recommendations and instructions.

The heating to the building will be provided by variable flow LPHW circuit to serve each space. LPHW pipework is to be run in copper pipework and fittings. All LPHW pipework shall be insulated in accordance with Building Regulations and TIMSA guidance.

LTHW flow and return pipework shall distribute via the ground floor ceiling void to serve the radiators on all floors.

Ensuite bathrooms shall be heated electrically.

Pumps shall have a maximum sound pressure level of 60dBA re 10^{-5} N/m² at a distance of 1m and a minimum pumping efficiency of 55% at the stated duty. All pumps shall have the motor, motor frame, impeller casing and drives of sufficient size to allow the capability of a 10% minimum increase in head generated at the stated flow rate by increasing the impeller size only. All pumps shall be selected and suitable for the liquid pumped and the temperatures required.

Pumps will be installed on anti-vibration mountings and will be fitted with flexible couplings.

Close coupled pumps shall be centrifugal, end suction type with gun metal casings and mounting feet, cast bronze impeller, ball type bearings, stainless steel shaft, mechanical seal, flanged connections, vertical/side discharge and complete with TEFV squirrel cage motor directly coupled to the pump but suitable for back pull-out design.

Pumps will be complete with watertight terminal box, drain plugs, pressure gauge tappings on both suction and discharge flanges, and sealed-for-life bearings.

Inline pumps will be vertical spindle, pipeline-mounted type, gun metal or stainless steel, cast iron casings, mechanical seals, screwed connections or flanged with mating flanges, complete with a close coupled fan cooled squirrel caged motor.

The heating system will be a pressurised system with a packaged pressurisation unit to provide adequate pressure and water volume control during all operational and non-operational conditions. The pressurisation unit will be sized to ensure any anti-flash margins are maintained.

The water pressurisation fill sets shall comprise pressure vessel, break tank, pump, pressure gauges and controls all mounted on a common rigid base plate.

The pressure vessel will be in accordance with BS 4814 and BS 7074 and shall be all welded steel construction epoxy lined with a replaceable EPDM bag diaphragm. The vessel shall have a fixed

charge of nitrogen.

Expansion vessels will be sized in accordance with BS 7074.

The heating system will contain 1No. 10 Litre dosing pot manufactured with welded end caps, air cock, filling funnel with non-return valve at its base, inlet, outlet and drain connections and 22mm bronze globe valves. The dosing pot will be installed in accordance with the supplier's instructions.

A dirt separator and de-aerator will be installed in the heating system, as Spirotech Spirocombi or similar

The unit will have an operating temperature range of 0°C-85°C, standard operating pressure of 6 bar, with minimum inlet pressure being 1 bar.

As supplied by Engineering Appliances Limited, Spirovent Superior Type DA44 for LPHW (or approved equivalent).

The pressure differential de-aerator will be connected to the system in accordance with the manufacturer's recommendations.

The De-aerator will be commissioned by the manufacturer's representative.

C2.5 Controls Installation

The controls strategy for the building is to keep the system simple whilst still complying with the requirements of the building regulations. As indicated in the various sections each item of equipment is self contained including associated controls.

Boiler control including modulation, sequencing, rotation and load sharing shall be provided by the boiler sequencing controller within the lead boiler. This unit is also to receive demand signal via the mechanical control panel, from the temperature sensor located in the flow from the flow header to the LPHW circulating pump.

The water booster plant is to be fully packaged and automatic and shall include the ability to restart automatically after any interruption to the electricity supply.

All mechanical plant within the plant room shall be provided with a common volt-free contact, to provide a signal to the management office via the mechanical control panel in the event of an alarm condition. Equipment to be fitted with this shall include, but shall not be limited to the following:

Boiler Plant
LPHW Circulator Pump
Booster Break Tank Low Level Alarm
Booster Break Tank High Level Alarm
Booster Pump Set
Pressurisation Unit

Water Conditioning Plant

JJR has included for all control wiring, all associated containment, power supplies and final connections.

C2.7 Gas Installation

A new gas supply will be provided as part of the Utility enabling works and will terminate with a governor, meter and isolating valve within the plant room.

An emergency knock off button shall be provided at the entrance to the plant room, to isolate the gas supply. In addition a rate of rise heat detector shall also be provided above each boiler to automatically isolate the gas supply in the event of malfunction.

To ensure the pipework is adequately isolated a gas solenoid valve shall be provided upon entry to the boiler room and shall be activated by the emergency knock off or heat detector signal.

The installation, materials, workmanship and testing of gas pipework and equipment will be in accordance with The Gas Safety (Installation and Use) Regulations and shall follow the recommendations in the Institution of Gas Engineers (IGE) publications IM/2, IM/5, IM/12, IM/16, IM/18 and BS 6644 and BS 6173.

C2.8 Dry riser Installation

A dry riser is to be installed within each core of the scheme and will be approved by the fire officer.

The dry riser installation shall comply with BS9990:2006

A dry riser inlet breeching fitted within an inlet cabinet with two-way inlet breeching is to be installed at Ground Floor level adjacent to each entrance.

The inlet cabinets will be constructed from 16swg Zintec with a powder coated polyester paint finish for corrosion protection. It will be complete with Georgian wired cast glass 6-7mm thick and a spring cylinder lock and key. JJR will ensure that the lock provided meets with the local fire authority's requirements.

Each inlet breeching shall comply with BS5041: Part 3.

From the inlet a 100mm galvanised steel riser will rise up the building complete with landing valves complying to BS5041: Part 2 at each level.
All inlet boxes shall comply with BS5041: Part 5.

All outlet boxes shall be purpose made to comply with BS 5041.

An air release valve will be fitted to the top of the dry riser, which should terminate above the level of the uppermost floor landing valve.

C3 DESIGN AND PERFORMANCE PARAMETERS

This section sets out the principal design parameters relevant to our Mechanical Services Installation.

C3.1 External Temperatures

The maximum summer external ambient conditions for general design purposes shall be 28°C db, 20°C wb.

The minimum winter external design conditions for general design purposes shall be -4°C saturated.

C3.2 Internal Temperatures

The required internal heating temperatures for design purposes shall be as follows:-

Bedrooms	22°C
Communal Rooms	22°C
Corridors (with external walls)	18°C
Bathrooms & En Suites	22°C
Internal Common Circulation Spaces	Unheated

C3.3 Infiltration

An allowance as detailed within the CIBSE guidelines shall be made for the purposes of design

C3.4 Mechanical Ventilation

Continuous ventilation to studio apartments with boost facility in compliance with Building Regulations Approved Document F.

C3.5 Hot Water Systems

Domestic hot water systems are to be designed to operate between 65°C and 43°C.

C4 COMMISSIONING AND TESTING

C4.1 General

JJR will employ a specialist to carry out all commissioning and management including co-ordination and setting to works of the plant.

The specialist will be employed at the start of the project and shall be responsible for the total commissioning of the mechanical services including locations of control and regulating devices, sensor locations, etc.

In advance of completing this project JJR will prepare O & M manuals and record drawings and submit with ample time for approval.

JJR will provide a detailed commissioning procedure and programme prior to the commencement of any testing and commissioning.

This procedure shall include full details on all commissioning works, including flushing, pre-testing, etc.

During the testing period all systems or system components shall be witnessed by the Main Contractor. JJR will provide a minimum of seven working days notice in writing prior to an intended test date. At the successful completion of tests, JJR shall prepare appropriate test witnessing sheets describing the system/component tested, the type of test applied, its duration (if relevant), the date of the test and the final test result. A copy of the final test sheets, signed by JJR and the person witnessing the test, shall be included in the O&M Instructions.

JJR will commission the complete installation and leave it in a correct working condition prior to handover. JJR will carry out pre-commissioning checks to ensure that all system components are installed and in working order, all cable terminations are secure, all pipes and pipe connection are secure and all signs and notices are in place. The final commissioning shall be witnessed by the Main Contractor or the Client's appointed representative.

C4.2 Gas Testing & Purging

Gas pipelines shall be tested in accordance with the procedures laid down in IGE publication UP/5. A test point, comprising a 15mm size plugged or capped valve, shall be located on the downstream side of each isolating valve controlling a pipework section.

Gas pipelines shall be purged from downstream of the primary meter (purging of the supply service pipe and the primary meter shall be carried out by Transco). Purging procedures shall follow the recommendations laid down in IGE publication UP/2 using the complete displacement inert purging method. In particular such work shall only be carried out by experienced personnel familiar with such work. Purge points shall comprise a 15 mm size plugged or capped valve located at each section isolating valve and at the end of pipe runs and at other positions to facilitate purging of the gas pipework system.

C4.3 LPHW Pipework pressure testing

The system pipework shall subjected to a pressure test of at least 6 bar for a minimum duration of 2 hours. For the test to be deemed successful, the test pressure shall be maintained, without the

application of additional pressure and with no measurable pressure loss, over the full test period. Any failure shall be rectified and the test repeated.

All apparatus, equipment and consumables necessary for the test, including the dry nitrogen, shall be provided by JJR. The tests shall be carried out in a proper and safe manner in compliance with health and safety legislation with care being taken to avoid causing injury to personnel or damage to equipment, cabling, other services or the building fabric.

By the nature of this gas pressure the test will need to be conducted out of hours.

Upon satisfactory completion of the air test the system shall be filled with Pseudomonas free water and pressure tested to 1.5 times the working pressure (9 Bar). The system shall hold this pressure without addition of further water for 30 minutes.

C5 CHEMICAL CLEANING AND FLUSHING

C5.1 LPHW Water Treatment

This section covers the water treatment of heating system. During the fabrication and installation of pipework systems, JJR shall comply with recommended Codes of Practice and take sufficient care to prevent the ingress of extraneous matter.

The water specialist shall provide a detailed method statement for the chemical cleaning and on-going water quality treatment for the water systems provided under the contract. The method statement shall include maximum agreed Pseudomonas (cfu/l) and TVC (cfu/l) levels. These levels shall be agreed with the main contractor prior to addition of any water filling of the systems. Water samples shall be taken throughout the cleaning process to prove the quality, chemical and microbiological stability of the systems. Following the final flush, system inhibitor and biocide dosing shall be undertaken with water samples taken to record the quality of the water within the systems. Further water samples, from agreed sampling points (5 per system in each building) shall be taken at weekly periods over a minimum of six weeks to clearly demonstrate the stability and quality of the water within the pipework systems.

All water samples taken for chemical and microbiological analysis shall be submitted to an independent laboratory. Results shall be submitted to yourselves for review.

The laboratory used shall have NAMAS accreditation or equivalent for the tests to be undertaken.

Valves required for the flushing and chemical injection shall be included and positioned in accordance with the specialist's instructions.

C5.2 LPHW Static flushing of pipework

JJR shall ensure that appropriate inlet and drain points are installed, and in accordance with BSRIA recommendations.

JJR shall ensure the system is thoroughly flushed with pseudonymous free cold water, via a break tank, all pipework to remove traces of loose dirt, scale and extraneous matter, prior to pre-commissioning cleaning, if specified, or placing into operation the various pipework systems.

The pipework circuits shall be provided with facilities to enable sections of pipework to be isolated and for circuits to be individually flushed in a methodical manner. Pipework circuits serving a number of terminal units, e.g.: under floor heating manifolds shall be provided with valved loop returns at the ends of the circuits to thoroughly clean pipework before flushing terminal units.

When all sections of a system have been flushed, we shall notify yourselves for the cleanliness of the systems to be witnessed.

C5.3 Chemical cleaning and dynamic flushing processes

After completing the static flushing of the heating systems to the satisfaction of the Main Contractor, the JJR shall arrange for a Water Treatment Specialist to carry out pre commissioning flush and clean using chemicals to assist mobility of loose fine deposits and small debris such as cement splashes adhering to the internal lining of the pipework.

Prior to this process being undertaken, JJR shall ensure that the following tests have been carried out and facilities provided:

Systems filled, pressure tested and circulation to all circuits proven.
Systems filled and air vented from all pipework high points.
Break tank and fill pump set available local to fill position to enable systems to be filled with Pseudonymous free water and to provide adequate make-up during flushing of systems to an open drain. It is estimated the amount of water for the process will be approximately 4 times the system capacity.
To meet Building Regulation requirements on effluent removal, a point for the disposal of effluent must be approved prior to all systems being drained down. The disposal point shall be suitable for draining systems simultaneously when all system drain valves are fully open. All acidic solutions used in the pre-commissioning cleaning process to be neutralised to a pH value of 7-8 before discharging them into the nearest main drains.

All system circulating pumps are to be operational during the complete process.

The size of main drain valves shall not be less than 40mm at the lowest points on the flow and return pipework of each system. All other low points which cannot be emptied via the main drains, are to be fitted with 20mm BSP drains or largest possible on pipework smaller than 20mm bore.

All "dead legs" to be cross connected between the flow and return terminations to ensure adequate circulation of water is maintained during and after the cleaning process. These connections should be of similar bore to the pipework.

Any special fittings on the systems that will restrict the cleaning procedures must be either by-passed or removed, and the flow and return connections to terminal units cross connected where specifically mentioned elsewhere.

Items that may cause problems are:

Fine mesh gauze elements in strainers
Orifice plates and measuring devices
Thermometer probes, sensors, etc.
Strainers fitted to control valves
Small orifice type control valves

The extent of these measures and any others that could restrict effective circulation shall be discussed and agreed with the Engineer prior to carrying out the cleaning process.

Adequate mechanically operated vents on each system to enable air to be purged effectively when filling the systems. Main vents shall be a minimum of 40mm bore to ensure that filling is not restricted. JJR's personnel who are familiar with the pipework systems will be in attendance to advise the Water Treatment Specialist on the operation of valves, pumps, etc., to ensure each system is adequately circulated during the process. These personnel are also to manually operate any control devices to enable individual items of plant to be cleaned at a minimum velocity of 1.0m/s. They shall also provide adequate means of access to the pipework systems during the process and continuity of the works and information detailing:

- The capacity of each system separately.
- The number of stages by which the system must be cleaned.
- Drawings showing plant, pipework size and route and drain / vent points

The Water Treatment Specialist shall be given a minimum of 14 days notice to commence the cleaning process, during which time the Specialist shall visit site to establish that the provisions and facilities for the pipework systems to be cleaned are satisfactory to proceed in accordance with the scheduled programme of works.

C5.4 Proving the Completed Installation

Upon completion of all commissioning and prior to practical completion JJR will leave the system in fully automatic operation for a period of not less than seven days.

The seven day fault free running of the services shall apply to any item that affects the full and proper occupation of the building.

C5.5 Chlorination

Wherever reference is made to a British Standard (BS), a British Standard Institution recognised equivalent European Standard would also apply (see latest BSI Standards Catalogue etc). Each type of equipment/material selected shall comply fully with either the BS or the European Standard.

Cleaning and chemical treatment of the water systems shall be carried out in accordance with the following:-

CIBSE: Commissioning Code W.

BSRIA: Application Guide 8/91 – Pre-commissioning Cleaning of Water Systems.

BS EN :806 (Parts 1-5):
Design, Installation, Testing and Maintenance of Services Supplying Water for Domestic Use within Buildings and their Curtilages.

HSE Guidance: The Control of Legionellosis including Legionnaire's Disease.

Note HS(G)70 (covers chlorination of water supplies).

Each assembled pipe work system shall comprise pipe work and ancillaries which shall have been stored in a clean condition, joined to leave a clean bore, and checked for internal contaminants. The open ends of pipe work shall be capped as work proceeds.

Each completed pipe work system shall be flushed through with water as appropriate; see CIBSE Commissioning Code W and BSRIA Application Guide 8/91 – Pre-commissioning Cleaning of Water Systems. JJR shall include all adjustments or additions to the pipe work systems, over and above that which is shown on the drawings, to comply with the chosen method of pre-commissioning cleaning based on the requirements and details identified in the Guides and Codes.

All incoming cold water, rising and drinking water mains together with all domestic hot and cold water services and associated storage tanks and cisterns are to be disinfected by chlorination or other approved process.

JJR shall be responsible for posting notices during the disinfection process to prevent the unauthorised use of draw-off points and hence dilution of the disinfecting agent.

Following the disinfecting process, JJR shall drain and thoroughly flush the systems using clean untreated mains water. 6No. samples shall be taken from draw-off points agreed on site. JJR will arrange to have bacterial tests to be carried out on the samples by an independent testing authority and provide certificates certifying that the water is suitable for drinking purposes.

The Water System, generally, shall be left dry or charged with protection solutions and air systems left charged with reduced air pressure until final commissioning and handover.

Following disinfection and prior to handover, JJR shall carry out a weekly flush of all the hot and cold water systems as a precaution against Legionella. This will involve opening all taps and allowing sufficient water to flow until temperatures stabilise.

C6 OPERATING AND MAINTENANCE MANUALS

C6.1 Record Drawings

During the course of the works, JJR shall maintain on the site a set of drawings clearly marked to show changes, modifications or deviations to the design. These drawings shall be available for viewing by the yourselves and shall form the basis of the record drawing information.

Three folded paper sets at A1 size and one set at A3 size of the as-installed record drawings shall be provided for the mechanical system. Each drawing shall be stored in a clear plastic sleeve in three ring binders each with hard durable outer covers. In addition one copy in a CD format shall be provided also inside a durable case with the AutoCad release used for the preparation of drawings clearly indicated. The details contained on the drawings shall be an accurate record of the installation and shall contain at least the following information:

- Project name and location
- Names of the Contractor, the Client and the Project Manager/Engineer
- Drawing title, project reference, drawing number, scale and indication that the drawings are ‘as-installed’ record drawings
- Details of the installed systems in the form of plans, sections and diagrams showing the routes, arrangement, sizes, ratings, duties, flow rates, capacities and locations of the components forming the systems

A draft copy of the record drawings shall be forwarded to the Main Contractor for review and approval within 10 working days of the contract completion date. JJR shall issue the final approved record drawings to the Client within 10 working days of receipt of the Project Manager/Engineer’s comments or approvals.

C6.2 Operating and Maintenance Instructions

Operating and maintenance (O&M) instructions shall be provided for mechanical systems. Three sets of the O&M instructions shall be provided in a ring binder format with hard durable outer covers and additionally (stored in a durable outer case) one copy in a CD format with the type and version of word processing package used for the preparation of the text clearly indicated. Information contained in the O&M instructions shall be specific to this project and shall comprise at least the following:

- Project title and address with the JJR’s details and the Client’s name on the outer covers and as an inner fly sheet
- JJR’s name, address, project reference, normal contact details and emergency call-out contact details (telephone/mobile phone/fax/e-mail/website)
- O&M instruction contents list

- Descriptions of the installed systems with details of the applicable standards, codes and regulations
- Description of the operation of the installed systems with information on the various modes of operation, the indications and warnings produced and the appropriate actions required by users
- Guidance on trouble-shooting component/system faults that arise
- Guidance on maintenance routines and repairs to components/systems and details of the means of obtaining and installing replacement parts
- Schedules of spares and consumables where applicable
- Manufacturer's and suppliers equipment and component technical literature (in English language) with the actual items/types/models used in the installation clearly identified
- Wiring diagrams, system diagrams and testing/commissioning certificates

A draft copy of the O&M instructions shall be forwarded to the Main Contractor for review and approval 20 working days prior to the contract completion date. JJR shall issue the final approved O&M instructions to the Client within 10 working days of contract completion.

C6.3 Training and Instruction

JJR has allowed to provide a minimum of two working days on-site training and instruction for the client's representatives. The training/instruction shall cover at least the following:

- An overview and description of the system installed
- Instruction on the system operation and the system controls
- Actions to be taken under various scenarios/conditions
- Instructions for simple trouble-shooting
- Instructions on obtaining specialist assistance in case of a system/component failure.

During the training period formal classroom instructions on the systems and their operation, including controls operation, under normal and fault conditions shall be given. This shall occupy approximately 50% of each session with the remaining period consisting of field demonstration.

Following Practical Completion and occupation of the building, JJR, shall retain an on site presence with a suitably qualified person to assist the Employer's Personnel in the operation of the various systems.