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# **MECHANICAL AND ELECTRICAL TECHNICAL SPECIFICATION**

**for the  
Replacement Chiller Works**

**at**



**European Bank**  
for Reconstruction and Development

Prepared by



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FHPP

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## SECTION 1.00 - Introduction

### 1.01 Building Description

This detailed specification has been prepared by FHPP Ltd to enable interested parties to prepare tender submissions for the chilled water plant replacement works at the Headquarters building for the European Bank for Reconstruction and Development (EBRD) that is located at One Exchange Square, London EC2A 2JN.

The intention of this Project is to replace 3No existing water cooled chillers with new equally sized water cooled chillers with variable speed drives. The works under this contract includes the preparation of the site and the enabling works and also the installation of the new equipment and it's testing and commissioning. The temporary chiller and 3 No permanent chillers will be procured by EBRD direct.

### 1.02 Description of existing system

The European Bank for Reconstruction and Development (EBRD) is a 13 storey office building. The existing cooling system within the building consists of 3No YORK water cooled chillers installed around 1989, located in the ground floor plant room. Condenser water for the chillers is provided from 4No roof mounted open circuit evaporative cooling towers. There are existing heat exchangers within the chiller plant room that were installed to provide free cooling to the building during the colder months. This system is no longer in use and it is redundant. The chillers serve the building via two separate chilled water circuits. The primary circuit provides chilled water for the cooling coils in numerous air handling units that serve the VAV system within the building. The primary chilled water flow to the cooling coils is controlled via a pressure operated 2-port motorised control valve. As the motorised valve closes the chilled water is regulated via a bypass system installed at the end of the primary chilled water run.

The secondary chilled water circuit was not part of the original installation and it has been installed at a later stage to suit the specific Bank's requirements and it serves IT suites within the building. The system demands cooling 24/7 and is referred to in this specification as an essential cooling load system.

The existing installation also includes 2No 5000 litre buffer vessels connected to the secondary circuit to back-up the cooling if the primary system fails. The buffer vessels are located in the mezzanine plantroom.

### 1.03 Description of the proposed works

The new works consists of replacing of the existing the chillers, pumps, valves and replacement of all final connections to the chillers and pumps. The work is to be carried out in phases so that shut downs are minimised and the chilled water to the IT rooms is maintained. To maintain the cooling to the IT rooms during the chiller replacement a temporary chiller is to be installed during the enabling stage of the works. The new chillers shall be installed one at a time to minimise the risk. This will enable the new plant to be installed in a manner so it works along side the existing equipment during a period of time.

The new plant has been sized to match the capacity of the existing chillers, although the building heating loads were calculated to be 30% lower. The new equipment will be connected to the existing BMS system, modified in accordance with revised hydraulic design.

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Further works will also include for the refurbishment of the existing Motor Control Centers (MCCA & MCCB) as described in a later section of this specification.

During the proposed works the existing heat exchangers are planned to be removed from site and the existing buffer vessels require modifications.

All the above works are described in detail within the later sections of this specification along with the Mechanical and Electrical tender drawings.

## SECTION 2.00 - General Requirements

### 2.01 Regulations and Standards

#### .01 Design Criteria

Maximum External Temp Summer	30 °C
Minimum External Temp Winter	-5 °C
Main Chillers Capacity	3 No 2500 kW
Temporary Chiller Capacity	250 kW
New Chilled Water Primary	6.7 °C flow /13.3 °C return
New Chilled Water Secondary	8.5 °C flow /13.5 °C return
Condenser Water Temperature Set point	Variable (summer/winter )

#### .02 Regulations and Standards

The complete mechanical and electrical services installation shall be supplied, installed, tested and commissioned in full accordance with the following regulations and standards:-

This shall include but not be restricted to:-

- FHPP Technical Specification.
- British Standards.
- Current Codes of Practice.
- CIBSE Design and Commissioning Codes.
- Client's insurance Requirements (copies shall be provided on request to the Contractor).
- Local Planning Requirements.
- Building Regulations - all relevant Approved Documents and Clauses.
- Health and Safety at Work Act 1974 and associated references.
- Machinery directive (2006/42/EC)
- EMC Directive (2004/108/EC)
- Pressure Equipment Directive (97/23/EC)
- Safety Code for Mechanical Refrigeration (EN378-2 (2008))
- I.E.T. Regulations, 17th Edition.
- Construction (Design and Management) Regulations (CONDAM).
- Environmental Health Requirements.
- Fire Officer Requirements and Precautions Act.
- Local Bye-Laws.
- FOC Rules.
- Control of Pollution Act 1974.
- DDA Requirements

All current standards to be utilised for each service.

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The above list is provided as a guide to applicable regulations and standards only and shall not be deemed as an exhaustive list.

### .03 Engineering Guidance Principles for Design

- The engineering services shall be capable of satisfying the following needs:-
- To provide and maintain the environmental conditions within the building.
- To provide the facilities for departments and services to function.
- To comply with all Statutory Requirements, National and Regional guidance.
- To be planned for economy in design and operation with adequate safe access, ease of maintenance and full use to be made of standardisation.
- Consideration should be given to the availability of service spares when selecting items of plant and equipment.
- To provide standby services where specifically stated.
- The essence of the construction of the installation shall be simplicity, reliability and ease of maintenance, with particular attention being paid to the internal and external access to facilitate inspection, maintenance and cleaning.
- All equipment shall be installed in accordance with the Requirements of this Specification

## 2.02 Contract Conditions

For details of Contract Conditions refer to the Main Contractors Terms and Conditions.

The Contractor shall ensure that the system and design method complies with the Construction (Design and Management) Regulations 1994.

## 2.03 Definitions

Appertaining to this Specification, the following works shall have the meanings assigned to them unless there is something in the subject matter or context consistent with such construction:-

‘Project Team’ shall mean the Bank, Project Manager, Consulting Engineer, CDM Coordinator, Planning Supervisor, Consulting Engineers

‘Consulting Engineer/Engineer’ shall mean the Building Services Consultant.

‘Bank’s representatives’ – shall mean Bank, Project Manager, Consulting Engineer, CDM Coordinator, Planning Supervisor, Consulting Engineers

‘Contractor’ shall mean the Principle Contractor appointed for the works and shall include the legal personal representative and successor.

‘By other’ means a Specialist Contractor appointed by the Contractor or Bank to carry out a specific item of work.

‘Tender’ shall mean the Engineer’s Tender Form on which the Contractor shall have shown the Contract Price.

‘Equipment’ shall mean fixed machinery provided under the contract.

‘Plant’ shall mean portable tools, instruments and machinery, to be used in carrying out the works.

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‘Provision Works’ shall mean and include all equipment to be provided and work to be done under the contract and shall include supplying, fixing, testing, regulation and commissioning of the installations described in the Specification.

‘Specification’ shall mean the Specification on which the Tender is based.

‘Site’ shall mean the actual place or places to which equipment shall be delivered or where work shall be done by the Contractor, together with so much of the area surround the said place or places as the Contractor shall actually use in connection with the Works otherwise than merely for the purpose of access to the said place or places. The site boundaries shall be shown on the contract drawings and agreed with the Main Contractor.

## **2.04 Compliant Tender**

In considering a tender proposal, the Bank and his authorised representatives will assume that the tenderer has made due allowance for all works under his control and that the submission of an offer is deemed to include all requirements for labour, materials, transport, out of hours working and the like for both the design and execution of the work within the time scale detailed in the tender documents.

The successful tenderer will be obliged to provide any and all procurement information, whether prepared by the tenderer directly or by his sub-contractor/supplier, as requested by the client or his authorised representative for consideration by a nominated specialist.

Due allowance of time shall be deemed to have been included for the completion of the procurement, together with approvals, preparation of the builders work drawings, completion of the procurement of goods, and services in order that the master programme can be satisfied.

The Contactor shall ensure that all aspects of the works, whether Mechanical, Electrical or Building, are closely co-ordinated as no extra costs will be accepted for any works required due to non-compliance with this clause.

The Contactor shall ensure that, where necessary, the manufacturer and equipment suppliers receive copies of the Electrical and Mechanical and Building drawings and information to ensure the above is fulfilled.

## **2.05 Tender Information**

The drawings relating to the Contract provided by the Bank’s representative shall be read in conjunction with each other and all relevant Specifications in the preparation of the Tender by the Contractor. No claim will be considered on the grounds of want of knowledge in this respect.

## **2.06 Documentation Prior to Tendering**

Any questions in respect of the requirements for testing and commissioning shall be raised, in writing, with the Consulting Engineer during the tender period.

No claims for extra will be considered if the Contractor neglects to examine the full requirements.

## **2.07 Project Programme**

For a detail project programme please refer to Appendix C. The Contractor is required to review the works described in this specification and with his expertise to develop a proposed programme of works where he shall illustrate a revised time scale for each activity, if he feels that it would be more suitable for the installation works.



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## 2.08 Discrepancies

All equipment shown on the drawings and not detailed in the specification/room data sheets and all items detailed in the specification/room data sheets and not shown on the drawings shall be deemed to be included and detailed in both. Where there is a discrepancy between specification/room data sheets and drawings, tenders shall allow for the most onerous condition and identify any such instances with this tender.

Any queries on the specification and drawings shall be clarified with the Consulting Engineer not later than 10 working days before the date of return of the tender.

## 2.09 Working Area & Contractor Facilities

Contractor Facilities and the Contractor's Site Boundary have been identified on the Ground Floor Plan drawing in Appendix G. The Contractor is to agree with the Bank's representative on the location of the welfare facilities.

For the works in restricted iareas identified in the Appendix G, the Contractor is obliged to obtain a Site Working permit from the Banks representative each time he needs to access and work within these areas.

A separate Event Schedule will be issued by the Banks representative on a weekly/Monthly basis that will restrict the noise in the generator room/chiller room (as detailed in Appendix G) in order to minimise disruption to the building operation.

## 2.10 Schedule of Quantities and Rates

The Contractor shall provide, within ten working days of asking, a priced schedule detailing the manner on which the tender for the Contract Works has been based.

This Schedule shall give:-

- .01 Quantities of all items, the net cost, the total net cost per item and the total net cost of all materials.
- .02 A schedule of labour hours allowed for the work, together with the basic hourly rate and the total basic labour cost for the contract.
- .03 The overheads and profit margin for the contract.

Totals for .01, .02 and .03 when added, shall be equal to the contract price excluding provisional sums and Main Contractor's discount.

The said Schedule shall show in detail the quantities, prices and extensions used in the calculation of the Tender and the Contractor shall accept responsibility for the accuracy of any quantities and extensions contained therein and the said Schedule shall balance with each item of the Tender Summary submitted with the tender.

If the Quantity Surveyor Engineer, when examining the priced Schedule of Quantities and Rates supporting the Contractor's Tender, discovers any obvious errors in arithmetic, the Contractor will be given details of such findings and shall be required to confirm or withdraw his Tender within a reasonable time scale.

The Contractor shall identify the amounts for preliminaries, overheads, design fees, profits and Main Contractor's discount along with any other factors applying at the end of each section.

The said schedule accompanying the Contractors tender shall follow the same headings as those laid down within the Tender Summary.

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The net rates in the said Schedule shall be used for measurement and valuation of any alteration, addition to or omission from, the Contract Works authorised by the Bank's representative.

Where it is not practical to apply the net rates in the manner aforementioned, such alterations, additions and omissions as ordered shall be valued at rates or prices as may be agreed with the Quantity Surveyor and/or the Consulting Engineer in accordance with the provisions of the Main Contract.

## 2.11 Variations

The Bank's representative shall be allowed to issue written instruction to vary the Contract Works, in accordance with the Main Contract.

Upon receipt of an instruction a fully detailed priced estimate for such variation shall be submitted via the Bank's representative to the Quantity Surveyor and Consulting Engineers within seven days, inclusive of non-working days.

The value of all variations to the Contract Works shall be determined by the Quantity Surveyor in accordance with the provisions of the Main Contract.

## 2.12 Provisional Sums

Provisional Sums shall mean a sum to be spent or not spent at the Bank's discretion. No guarantee is given or implied that the expenditure of such sums will be authorised in whole or in part. The sum stated shall be included in the Tender for the Contract Works without any addition of any kind. The full amount of all Provisional Sums shall be deducted from the Final Account to which there shall be added the agreed cost of such works as carried out against the Provisional Sum.

## 2.13 Contractor Supplied Information

The contractor shall supply the following information at the time of tender submission.

- .01 List of equipment used and manufacturers of equipment.
- .02 Fully completed Summary of Tender.
- .03 Any applicable qualifications.
- .04 Proposed Programme of Works
- .05 Method Statements
- .06 Proposed Team CV's

## 2.14 Programme

The Contractor shall be responsible for familiarising themselves with the site and any relevant documentation within the tender or otherwise which provides details relating to the programme, phasing of works, out of hours working, dates and time periods for executing such works. All works shall be carried out and executed in accordance with the main programme. The Contractor shall ensure the Bank's representative is fully aware of the requirements for testing, commissioning and verification of the installation.

The time allocated for the above sequence of works shall not under any circumstances be reduced or compromised to allow other activities to be carried out. The criterion for system verification is paramount.

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## 2.15 Inspection of the Site

The Contractor shall be deemed to have visited the site to establish the details, site conditions and existing services before submitting his tender bid.

No claim for extra costs will be considered in respect of any items the existence of which could have been established by inspection of the site.

The Contractor must make all arrangements to visit the site during the tender period with the named Client's representative.

## 2.16 Inspections and Approvals

The Contractor shall be responsible, and shall make due allowance in the Tender, for giving all notices to and attendance for inspection by the local Authority required for the execution of the Contract Works, obtaining all necessary licenses, approvals etc. and paying all fees, charges, rates and taxes legally demandable.

The Contractor shall install the Contract Works in accordance with the Bye-Laws, Building Regulations and Regulations of all interested parties as previously noted and utilising best practises throughout.

Prior to commencement of the works a joint inspection of all areas where work is to be carried shall be undertaken and a detailed photographic record taken of all areas and existing services to form the basis of an agreed record of the areas to be handed to the Contractor.

## 2.17 Use of Services Installations by the Bank

Prior to Practical Completion of each Section of the Works the Bank reserves the right to have beneficial use of the Services installations/premises or any portion thereof subject to agreement with the Contractor, such Agreement not to be unreasonably withheld.

## 2.18 Co-ordination

It is essential and the responsibility of the Contractor to liaise fully with all other trades and specialist manufacturers/ suppliers to ensure full co-ordination of installations prior to any installation commencement to avoid any misinterpretation which may occur between disciplines and which may impede progress of works on site.

## 2.19 Liaison Between Services Contractor and Manufacturer

The Contractor is to ensure that the closest possible liaison is made between other Sub-Contractors and Manufacturers.

The Contractor is to ensure that all aspects of the works whether mechanical, electrical, control or structural are closely co-ordinated, as no extra costs will be accepted for any works required due to non-compliance with this Clause.

The Contractor shall ensure that where necessary, the manufacturer and equipment suppliers receive copies of the working and installation drawings and complete information to ensure the above is fulfilled.

Notwithstanding the fact that EBRD are purchasing the temporary and permanent chillers direct, the Contractor shall be responsible for and liaise fully with the chiller manufacturer to provide all necessary attendances, coordinate deliveries, installation/removal, testing & commissioning, and setting to work/monitoring of the completed works.

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## 2.20 Early Plant Deliveries and Extended Warranties

The Contractor shall include in his tender for the timely delivery and protection of all equipment, materials and plant as may be necessary to ensure the works proceed in accordance with the overall programme, together with extended warranties to ensure all manufacturers warranties are valid for at least the full defects liability period, commencing after acceptance of the complete installation under this Contract. The Contractor shall take account of the severely restricted space available for the storage of equipment, materials, etc. Under no circumstances will any storage be allowed in the Service Road outside the plantroom. The Contractor shall also advise when he anticipates deliveries and offloading of any consequence 10 days in advance of such deliveries and which will have to be carried undertaken outside of normal working hours.

## 2.21 Lifting, Hoists And Temporary Scaffolding

The Contractor shall include for all temporary hoists, temporary scaffolding, etc, necessary to complete his services installations.

The Contractor shall submit, to the Engineer, a method statement describing the proposed procedures and sequences for the delivery to site and hoisting into final position of the mechanical and electrical services equipment for each and every stage of the project.

## 2.22 Labels, Charts and Notices

All labels, charts and notices shall be in accordance with this Specification. The details below give typical information on the type of labelling to be used on the project.

The Contractor shall note that the labelling requirements are extensive and detailed schedules and proposals shall be issued for comment prior to any labels being procured.

- Labels to indicate danger or acting as a warning shall be red characters and on a white background. Labels on the outside of switchgear shall be laminated plastic with black characters on a white background. Character for labels fitted to isolators and at the origins of installations shall be 10mm high and 1.5mm thick. All other labels shall be 4mm and 0.5mm thick. All labels shall be fixed with screws and shall not be glued or similar.
- Labels on single phase equipment as part of a three phase installation shall be indicated to which phase they are connected.
- Danger labels should be provided to all items of equipment and plant to identify where there is a separate source not isolated by the local point of isolation that needs to be isolated elsewhere.
- Each item of plant/equipment shall be provided with an engraved label providing advice as to its function, area that it serves, where necessary the key name(s) and reference identity associated with the existing BMS shall also be provided on the label.
- Every valve associated with the project to have a circular valve tag fitted which shall have an engraved number on it that shall relate to the valve schedules and plant schematic drawings provided by the Consulting Engineers and as later developed by the Contractor.

The Contractor must ensure that all labelling and identification follows the scope, style and extent of the existing installations across the site.

## 2.23 Out of hours working

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Because of the existing function of the building and the retaining of the existing system during the replacement works the Contractor shall include for all necessary out of hours working. Where this work will entail any major drain down of systems or work which prevents the use of the primary cooling system, this work shall be carried out over a weekend. The detailed scope of works is described in later section of this specification.

## **2.24 On Site Manager**

The Contractor shall allow for a full time on-site manager dedicated to this project alone, not a working foreman, to ensure that all operations are carried out in accordance with the Bank's requirements and to attend the site meetings with Bank's representatives. This Manager shall also be responsible for the liaison between the users on site, Bank's representative and Consulting Engineers to ensure that when existing services are shut-off, modified cut back etc that all parties are aware and in agreement with the proposed works, well in advance of their implementation.

## **2.25 Origin of Equipment**

Wherever practicable, equipment installed shall have been manufactured in a country within the EEC. The equipment shall carry CE markings for proof of construction to International Standards. Where equipment does not carry CE marking, copies of conformity certificates shall be provided. Any equipment not meeting this criterion may be rejected and any costs associated with this rejection will be borne by the Contractor.

## **2.26 Standard of Manufacture**

Where equipment is identified either by manufacturer and/or model number, it shall be taken that this is the standard of quality expected. However, this does not preclude the offer of alternative equipment provided it is of equal standard and quality to the named manufacturer.

## **2.27 Equipment**

Equipment shall be installed and connected to the manufacturer's recommendations unless detailed otherwise in the Specification or agreed in writing with the Engineer.

## **2.28 Equipment Quotations**

The Contractor shall ensure that where quotation references are given in the Specification, the equipment and numbers of items offered by the manufacturer comply with the details given to the relevant drawings and in this Specification.

Contractors shall note that quotations cannot be accepted on a fluctuating price basis and shall take account of these fluctuations within his tender figure, as future increases in costs shall be borne by the Contractor for the scheme.

## **2.29 Accessibility to Plant and Equipment**

The Contractor shall provide marked up drawings/schedules showing the sizes for all access openings required for maintenance, installation etc, which shall be submitted for comment.

The Contractor shall co-ordinate and agree all such access points with the Bank's representative.

## **2.30 Supports, Hangers and Fixings**

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The Contractor is to prepare and issue for comments to the Bank's representative prior to commencement of works, drawings and details showing proposed methods of support, including fixings to the structure. All support details and locations shall show the anticipated services weights with adequate allowance for future additions.

The Contractor must provide all supports and fixings necessary for the works and must not assume that any brackets or supports will be provided for his use.

### 2.31 Fire Barriers and Openings

The Contractor shall provide all fire barriers and sealing of openings between fire compartments, internal to external openings, all internal partitions, walls and floors and floors above and below.

The fire barriers shall be provided to maintain the integrity of the fire compartment in strict accordance with the building layout. Details of the fire barrier construction for various containment systems are covered in the relevant sections of the Specification.

The location of penetrations shall be clear of an access routes.

Any openings shall be sealed as soon as possible to avoid the ingress of dust and debris, where openings need to be left open for periods of time they shall be temporarily covered and protected.

The Contractor shall provide a detailed drawing of every type of penetration for comment prior to construction commencing.

### 2.32 CDM Regulations

All works shall be carried out after a detailed risk assessment of the works and installation drawings have been carried out for the whole of the mechanical and electrical installation.

All relevant documentation for the Health and Safety file shall be issued to the Bank's representative. The Contractor is required to work strictly in accordance with the Contractor Code of Conduct and all relevant pre contract H&S documents.

All risks wherever possible shall be designed out.

The Contractor is to strictly follow the working restrictions detailed under Section 2.09 Working Area & Contractor Facilities.

### 2.33 Drawing Production

The Contractor shall submit working, installation and detailed drawings for review/comment, at a time consistent with the programme, which shall be reviewed by the project team.

The Contractor shall review the working drawings to satisfy himself that they are in general accordance with the contract and drawing review procedure but neither such review nor the project team comments shall relieve the Contractor from responsibility for:-

- Any deficiency or inaccuracy or non-compliance with the Contract or of the Specification.
- Any error in the proper fixing of the Contract Works.
- The necessity of providing any work required by the Contract or the Specifications not indicated on the Working Drawings when reviewed by the Main Contractor.

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All drawings shall be produced at the following minimum scales:-

Layout drawing and general arrangements	1: 50
Plantroom and switchroom layouts	1: 20
Sections	1: 20
External Services	1: 200
Schematics	No Scale

All drawings wherever possible to be on A1 sheets.

All drawings shall be AutoCAD format Version 2004 as a minimum. Standard symbols shall be used throughout and a legend drawing or legend shall be attached to each drawing.

The Contractor shall take note that the level of information submitted must fully reflect the requirements of the specification and documentation issued for the project by the project team.

Should the level of information not be in line with the documentation or the level of information provided is lacking or indeed the Contractor does not rectify any issues on the second attempt then the project team reserves the right to financially contra charge the Contractor with any abortive time incurred reviewing or rechecking information.

#### .01 Working, Installation and Detail Drawings

- Dimensioned layout and fabrication drawings.
- Fully detailed arrangements of plantrooms, etc.
- Detail drawings of distribution, support systems and connections to plant and equipment.
- Power and control wiring diagrams.
- Drawings showing the work of Specialist Contractors and Manufacturers.
- Manufacturers drawings generally.

The Contractor shall submit drawings as required to suit the construction programme. The drawings shall be progressed to a level sufficient to allow full coordination with other services and the information included is sufficient to permit proper installation of the works.

Drawings prepared for each area shall be produced to allow a minimum period of two weeks for consideration by the Project Team, who may wish designs to be amended or the addition of further details or items of clarification. Work on site shall not commence until each drawing has been submitted for comment and formally issued in accordance with this specification.

#### .02 Builderswork Drawings

- Equipment base details (where required).
- Major holes through structures (above 500mm DIA)
- Primary support steel requirements.
- Access requirements.

The Contractor shall, in accordance with the Main Contract, and in accordance with the Main Contractor's programme, provide detailed builder's work information detailing, without limiting the generality of the foregoing, the positions of all holes, chases, ducts, trenches, manholes, plinths, bases, building in requirements for brackets or inserts, cut-outs etc. and all related making good requirements.

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The Builder's work shall be carried out by the Contractor

## 2.34 Definition of Approval

### .01 Submission Of Working Drawings

The Contractor shall be required to provide all necessary working drawings, details for the correct execution of the works and method statements. These drawings shall include, but not be limited to, information for builderswork, co-ordination with the work of other disciplines and any other drawings reasonably requested by the Client or his authorised representative. All drawings shall be submitted for approval/comment by the design/construction team at least 10 working days prior to the date whereby the information is to be implemented.

The Services Contractor shall provide three (to scale) paper copies of each drawing per issue and 3 A3 copies of each drawing per issue. Additionally, all drawings shall also be in AutoCAD format, Version 2004 (as a minimum).

### .02 Working Drawing Review Procedure

After the submission of drawings for approval, they shall be returned to the Project Administrator indicating "Status A", "Status B" or "Status C" as described in the Drawing Review Procedure set out below. Upon return of these drawings, the Contractor shall take such action as is required by the Drawings Submission Procedure contained in the Specification.

The terms "Status A", "Status B" and "Status C" referred to shall bear the following meanings:

"Status A " The Contractor may proceed to authorised fabrication, manufacture and/or construction providing that the work is in compliance with the Contract and the Specifications. Acceptance of the work will be contingent upon such compliance.

"Status B " The Contractor may proceed to authorise fabrication, manufacture and/or construction. The Consulting Engineers' final acceptance of the work will be contingent upon the compliance with any notations on the Drawings made by the Consulting Engineers' and upon compliance with the Contract and the Specification.

"Status C" The Contractor shall not authorise work to be fabricated, manufactured and/or constructed.

The Contractor shall be responsible for providing prints of all working drawings stamped "Status A" or "Status B" and for their distribution Bank's representative.

The Bank's representative shall review the Working Drawings to satisfy himself that they are in general accordance with the Contract and Drawing Review Procedure but neither such review nor the Consulting Engineers' stamp and signature shall relieve the Contractor from responsibility for:



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- i. any deficiency or inaccuracy or non-compliance with the Contract or of the Specifications.
- ii. any error in the proper fixing of the Contract Works.
- iii. the necessity of providing any work required by the Contract or the Specifications not indicated on the Working Drawing when reviewed by the Bank's representative.

In any case in which a Working Drawing is stamped "Status C" by the Consulting Engineers the Contractor shall as soon submit an amended drawing or sample the Bank's representative.

### **2.35 Method Statements (Access Method Statement)**

The Contractor shall ensure that when any system is to be isolated and modified a method statement is produced setting out the processes involved and the time scales. The Contractor shall also provide method statements relating to the delivery of each major plant of equipment, including proposed access, storage and positioning.

The method statement shall be submitted to the Bank's representative and shall be subject to Approval by the Project team as stated in clause 2.33.

### **2.36 Test and Commissioning Certificates**

The Contactor shall provide test certificates for all items whether tested at site or at a supplier's works. Due allowance shall be made for the time required to assemble the inspecting authority, where applicable, to witness any and all tests carried out at the discretion of the inspecting body.

All tests shall be carried out in accordance with the recommendations of this specification and requirements of the professional bodies recognised as offering authoritative matter on the subject.

All costs incurred in complying with the foregoing shall be deemed to have been included by the Contactor

Any defect which occurs after the date of Practical Completion of the Works for any section of the works due to non-compliance shall be made good by the Contractor at his expense within 28 days or sooner of notification, dependent upon the nature of the defect.

### **2.37 Client Instruction**

The Contractor shall after satisfactory testing, commissioning and putting to work all the installations carry out a detailed Client Instruction procedure.

The instruction shall include for training up to 3No of the Bank's team. The Contractors shall include for every installation and every Specialists to provide representation on an agreed date to instruct the Bank's team in the operation of the system.

The Contractor shall prepare a detailed programme together with a schedule of proposed items to be covered to the Bank's representative and Consulting Engineer for approval prior to the demonstration commencing. They shall be given 5 working days to provide any comments on the programme.

The demonstration may if felt necessary include classroom type discussions and visit to the manufacturers premises.

### **2.38 As Built drawings and O&M Manuals**

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The Contractor shall not later than 6 weeks prior to practical completion provide the completed operating manuals and as fitted drawings.

At the commencement of the testing and commissioning the draft copies of the manuals and drawings shall be available for the bank's representatives and Consulting Engineers comments.

The completed manuals and drawings shall be handed to the Bank via a hand over certificate suitably signed.

The Contractor shall note that a separate copy will be required for the Health and Safety file.

#### .01 As built Documents

The Contractor shall provide 3No paper copies, 3No CAD current version (2004 as a minimum) copy of all 'as built' drawings.

When produced 'as built' drawings shall present to the Bank's staff sufficient diagrammatic information to enable them to maintain and operate the plant as effectively as possible to the original design standard.

#### .02 O&M Manuals

The service manual documents shall be contained in suitable binders. The binders shall be Nyrox Sliplock NLA/A4 welded PVC with pull open two rings fittings at 80mm centres of 50mm width, lever arch type shall be used where large quantities of information are to be held in the binder.

Wherever possible papers (except where shown below) should not be larger than International A4.

The following descriptive elements should be provided:-

- Title Page showing the following:-
  - Client/Company Name
  - Title of Installation
  - Date of Completion
  - Consultants
  - Main Contractor
  - Scheme and Specification Numbers
  - Section
- Description of Design Intent and the Engineering Installations including specific components which may affect its operation. Sufficient information should be provided to enable engineering systems to be initially started-up prior to commissioning taking place in addition to the continuing operation and maintenance.
- Hazardous substances used shall be clearly identified and safe methods of handling and operation clearly documented to ensure compliance with statutory requirements.
- Lubrication Details and Procedures Summary Manufacturer's Service Manuals and Spares, details of ordering.
- Operational instructions describing all features and fully explain setting to work instructions and line diagrams. Safety features including emergency shutdown buttons.
- Schedules of Mechanical Equipment and Fittings.
- Typed operating procedures for the use of Client's technical or non-technical staff.

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- Inventory of equipment supplies, showing details of make, model type, serial number, rating, date of manufacture (where known), installation date, location, etc. This item shall include a schedule of all luminaire types installed.
- Repair and maintenance instructions for equipment installed, including guidance on assembly and dismantling, safety, special tools and maintenance equipment, test
- Instruments and any spares provided under the contract.
- Maintenance Instructions in chart form showing sequencing and timing of essential maintenance.
- Applicable catalogues, sources of supply, colour codings and recommended holdings of spares.
- Warranties and insurance test certificates, where applicable.
- Details of Emergency Call out Service with telephone numbers of personnel available.
- Completion Certificate and test certificate to BS7671.
- All relevant British Standard Certificates and specialist certificates.
- Commissioning and test results.

All Operating and Maintenance Manuals shall include the necessary safety information and details in accordance with the Construction (Design and Management) Regulations related to operating and maintaining the completed systems.

The Contractor shall include for all costs and expenses in this context and should indicate the item separately in the Tender Summary.

It shall be a condition of the submission of the Tender that should the Consulting Engineer deem the amount to be inadequate for the purpose, it shall be in the Consulting Engineer's power to recommend that a common amount be employed for the purposes of comparison of Tenders and that the Contractor shall become liable for such sum as if such sum had been originally included subject to the Tenderer having been given the option to confirm or withdraw his Tender.

In the event of the Contractor failing to comply with this Clause in the stipulated time for production etc. the Consulting Engineer shall have the power to recommend that the Contract Works as being unacceptable to hand over to the Bank due to insufficient information available to enable the Bank to operate and maintain the plant, in accordance with the Health and Safety at Work Act, and furthermore shall have the power to instruct such Work to be carried out by others and deduct the resultant costs from the Contractor's Final Account.

On final acceptance of the manuals, electronic copies of the manuals shall be provided on Compact Diskette's.

## 2.39 Spares and Tools

At the completion of the project the Contractor shall provide the following spares and tools as a minimum:-

- Lockshield valve (doc) key
- Replacement fuses for all control systems.
- 1 no replacement of each type of sensor.
- All keys and lock releases as necessary for each and every installation.

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All spares shall be fully labelled and located in an agreed position. All tools and keys shall be fully labelled and held on tool racks and within a key cabinet in a position to be agreed.

A signature shall be obtained from the Client at handover.

Together with the above spares the Contractor shall provide a detailed schedule of recommended spares together with their part number for 'All' installations.

This shall be presented to the client prior to handover for him to review the necessity (if any) of purchasing further spares.

## **2.40 Making Good Defects**

The Contractor will be provided by the Bank's representative, upon Practical Completion, a list of incomplete and unacceptable works. The Contractor will immediately be provided with written notice by the Bank's representative to remedy the incomplete or unacceptable works within one month.

The Contractor is to produce a written schedule of those items on the Bank representative's list of incomplete and unacceptable works, that he is unable to remedy within the period of notice, together with a fully detailed programme of when such works can be completed.

The incomplete and unacceptable works will be valued by the Bank's representatives.

The Bank's representatives will recommend to the Bank that this sum will be a minimum to be withheld from the Contractor's Final Account pending remedy of the incomplete and unacceptable works.

Should the Contractor fail to remedy the defects within the specified time period issued under written notice, the Bank's representative shall instruct the works to be executed by other competent bodies and the costs of this instruction will be deducted from or added to the retained sum.

In the event the Contractor calls the Bank's representative for re-inspection of the works and the works are deemed unacceptable and not remedied, the cost of the Bank's representatives abortive visit will be charged against the retained sum.

All lists of incomplete and unacceptable work prepared by the Bank's representatives will be carried out at the discretion of the Bank's representatives.

The Contractor shall carry out his own detailed inspection of the works prior to notifying the Bank's representatives that the works are fully complete and ready for inspection.

All services prior to being covered up shall be offered for inspection with a minimum 5 days notice being provided.

In the event that the inspection carried out by the Bank's representatives produces an excessive list of items that are incomplete or needing corrective action, then the Bank's representatives reserves the right to contra charge the Contractor the cost of carrying out the inspection

## **2.41 Maintenance During Defects Liability Period**

The Contractor shall include for the full planned preventative maintenance of all installed plant and ancillaries during the 12 months Defects liability Period (including the extended warranty period).

The maintenance shall allow for attendance by the relevant manufacturers of specialist equipment which shall include controls, water treatment, chillers etc.

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The Contractor shall include in the Tender for all necessary tools, equipment and materials to properly effect the maintenance of the installation to the satisfaction of the Bank and bank's representatives.

The Contractor shall include, relevant to this clause only, details of all percentage on costs required on items such as Sub Contract replacement parts, plant hire etc.

The Sub Contractor shall provide at the commencement of the Defects Liability Period, a maintenance programme for approval by the Bank's representative. Further, the Sub Contractor shall provide following each service visit during the Defects Liability Period and consequent thereto, a report on plant and services which shall include;

- .01 Details of works undertaken.
- .02 Plant Condition report.
- .03 Repair recommendations.

This report shall be forwarded to the Bank's representative within 5 working days of the visit.

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## SECTION 3.00 –Scope of Works

The named Services Contractor herein after referred to, as the Contractor shall be responsible for the supply, delivery, installation, testing and commissioning of all of the mechanical and electrical installation works as shown on the tender drawings and described in this specification.

The scope of works shall be as follows:-:-

### 3.01 Site preparation

The first phase of the chiller replacement work would involve site preparation that would enable the actual equipment replacement. The works under this part involve, but are not limited to the following:-

- Site preparation
- Freezing of the primary chilled water pipework and installation of the new main isolating valves on the chilled water side
- Modifications to the secondary chilled water circuit and existing low loss header
- Modifications to the existing buffer vessels
- Installation of a new temporary chiller chilled water pipework and circulating pump set and temporary electrical and control wiring
- Condenser water drain out and replacement of the existing isolating valves
- Isolating of the existing heat exchangers
- Chilled Water Bypass
  - Option 1 - Modification of the existing primary chilled water by pass ( to be priced as optional item)
  - Option 2 - Installation of the chilled water by-pass on primary chilled water run (to be priced as an optional item)
- Testing and Commissioning of the temporary chilled water system

### 3.02 Installation of the Temporary chiller

As already mentioned, in order to eliminate the risk of the whole replacement work and to minimise the shut down period, a 250 kW Johnson Controls (YORK) air cooled chiller is being temporarily added to the installation. The temporary chiller is being purchased by EBRD and is to be installed by the Contractor. The temporary chiller was sized essentially to cover the IT room cooling loads during the work on the chillers.

### 3.03 Modification and Strip Out of Existing Services

The Contractor shall allow for the stripping out of the existing chilled water pipework and the stripping out and removal from site of all redundant materials associated with the Mechanical services installation. This shall include, but not be limited to the following:

- Replacement of the existing chilled water run and standby pumps located at the ground floor plantroom.
- All existing connections to the existing chillers in the ground floor plantroom

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- All existing connections to the existing pumps in the ground floor plantroom
- All existing valves that are to be replaced on the chilled and condenser water system.
- Removal of the existing heat exchangers
- Any works associated with the enabling and installation works
- Removal upon completion of the temporary chiller and pipework with electrics. If required by the Bank's representative the Contractor is to also allow for making good louvre penetrations.

The decommissioning and removal of the existing water cooled chillers, including the existing refrigerant disposal that will be undertaken by Johnson Controls (YORK) under the control and supervision of the Contractor.

### **3.04 Chillers and associated equipment**

The new scheme shall provide 3No VFD Water Cooled chillers each rated at 2500kW. The new chillers are procured by EBRD direct under a separate contract.

The whole scope of replacement works of the existing chillers have been phased into 3 periods. At each period only one chiller shall be replaced with its associated pumps. During the last phase the standby pumps shall be replaced.

Due to the restricted access and service space each chiller is to be delivered to the site dismantled and is to be rebuilt in the chiller plant room by the chiller manufacturer Johnson Controls (YORK). The manufacturer is to be responsible for the delivery, positioning, installation and commissioning of the chillers. The pumps, chilled water connections and controls are to be the responsibility of the Contractor. After each installation period the new equipment will be tested and commissioned so that its operation will match the existing equipment. After the replacement of the third chiller and all associated equipment the Contractor is to allow for the re-commissioning of the whole installation under the instructions of the new schedules. The testing and commissioning procedure is described in detail in a separate section of this specification.

### **3.05 Builders work**

The Contractor shall provide builders work for the new bases for the new chillers, pumps, etc. as detailed in a separate Builders work section. In addition, holes for pipework through walls etc. shall be formed and the hole made good afterwards. Where existing pipework is stripped out, any redundant holes through walls etc. shall be made good. The builders work shall also include for the modifications of the existing Motor Control Centre enclosures to match the proposed electrical and automatic control modifications.

The Contractor shall provide Builders work drawings for approval prior to the works being carried out.

### **3.06 Electrical Services**

The Contractor shall provide new electrical services to feed the new temporary chiller and pumps, modify the existing electrical services to the replacement chillers, and replacement of isolation and current devices within the existing Motor Control Centres.

### **3.07 Automatic Controls**

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A new controls system is to be provided for the operation of the temporary chiller, this shall interface with the existing Trend BMS to pick up the failure alarms. The new chillers are to be controlled from the existing Trend BMS controls system which is to be modified to match the operation of the new equipment. All wiring associated with the controls system shall be carried out by Trend Control Systems Ltd.

### **3.08 Installation Programme**

The installation of the new system shall be achieved, as far as possible, whilst maintaining the operation of the existing chilled water system. Therefore the replacement works have been phased out to minimise the risk and number of shutdowns. The proposed phasing in relation to the project programme shall be as described in this Specification, however, the Contractor is deemed to review the works described in the specification and with his expertise provide detailed method statement for each and every stage of the installation.



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## SECTION 4.00 – Enabling Works

All works described under this section are to be read in conjunction with the phasing sketches attached to Appendix E of this specification.

### PART 1 PREPARATORY WORKS

All preparatory works are to be undertaken in the period shown on the project programme and are to be completed prior to the first weekend shutdown.

The following works are to be included within the preparatory works:-

#### 100.010 SITE CLEARING

##### Chiller Plantroom

The Contractor is to allow for the clearing of the existing chiller plant room of all non-essentials /fixed equipment to allow the replacement works to commence. The existing water treatment storage and bulk containers shall be rationalised and if they are identified as non-essential by the Bank's maintenance team they shall be relocated or removed from site. The Contractor is required to closely collaborate with the site maintenance and building management team to establish in detail all the equipment that is to be moved and to also establish new fixing positions for any relocated plant.

The Contractor is to also allow during this period preparation of the existing pipework for the future works and shall strip off and dispose of all existing insulation as necessary where the pipework is to be amended. Due consideration is to be given to minimising the potential for condensation to form on this pipe.

##### Generator Room

The Contractor is to allow for clearing of the site in the vicinity of the existing attenuation louvres where the installation of new pipework is to take place, as identified on the tender drawings.

##### Temporary Chiller Compound

The Contractor is to allow for preparation of the temporary chiller compound. The works should include for building a temporary chiller enclosure to provide a secure area and to limit the noise breakout of the temporary chiller.

A site adjacent to the EBRD building and the temporary chiller compound is currently being refurbished and is a building site. To prevent any accidental damage from the site goods lift the Contractor is to allow for a suitable crash deck to be installed above the temporary chiller once the temporary chiller is delivered and positioned in the compound. The Contractor is to also allow for the supply of temporary base for the temporary chiller. The base is to be used purely for ensuring that the floor is in one level and to protect the existing tiling. The temporary chiller is to be provided with its own spring mounts. Any crash deck installed is to not impair the operation of the temporary chiller.

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During these preparation works the Contractor is to also allow to measure and manufacture of a dummy louvre which is to be used as a replacement for the existing attenuation louvres in the area where temporary chiller chilled water pipework and cabling is to be installed.

#### 100.020 INSTALLATION OF THE TEMPORARY CHILLED WATER PIPEWORK

Temporary chiller chilled water pipework shall be installed from the chilled water plantroom through the generator room ready for connection through the generator room louvres during these works. The chilled water pipework is to be installed with all associated valves incl. thermal insulation in the position as shown on the detailed tender drawings and in accordance with this specification. The pipework is to be finished with flanges at the end of the generator room, before the attenuation louvre wall. The Contractor is to include for all builders work associated with this work, generally as detailed in Section 8.00 of this specification.

#### 100.030 POSITIONING AND INSTALLATION OF THE TEMPORARY CHILLER CIRCULATING PUMPS

New circulating pumps are to be installed on the buffer vessel circuit. The pumps are designed to work in a run and stand by arrangement and will be used as shunt pumps for the buffer vessel circuit during normal operation when the temporary chiller is not in operation. When the temporary chiller is required to run the pumps will be used as main circulating pumps. The pumps are to be installed at mezzanine level in the chiller plantroom, just above the low loss header connection in the location identified on the tender drawings.

During the preparatory works the Contractor will install the pumps on a new base ready for the chilled water pipework connections. The type and duty of the pumps is detailed in Section 5.00.

#### 100.040 PREFABRICATION OF INSTALLATION PARTS

The Contractor shall measure all stool pieces required for the existing pipework that is to be amended and procure all necessary components, ie. valves, flanges, etc. as required by the installation during this period.

If scaffolding access equipment or task lighting is required for any of the above works the Contractor is to allow for these as necessary.

### **PART 2 FIRST WEEKEND SHUTDOWN**

To eliminate the number of shutdowns of the secondary circuit that provides the essential cooling to the IT rooms a temporary chiller is to be introduced to the system. The temporary chiller (provided by EBRD) is to be installed during the enabling stage, so when the further works are undertaken on the primary chilled water system, the secondary chilled water system will remain in operation. The temporary chiller is to be connected to the system via a modified existing buffer vessel connection on the secondary circuit low loss header in the chilled water plantroom.

The whole of the system is required to be shut down during these installation works. The planned shutdown can be undertaken in a maximum length of one weekend and shall not start sooner than 12.00pm on Saturday and end at 12.00pm on Sunday. The Contractor is required to produce a method statement on the proposed staging of the works as set out in the General Conditions of this specification.

#### 200.010 SITE PREPARATION

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The Contractor is to isolate the secondary system by using the existing isolating valves on the primary chilled water flow and return connections before the low loss header and the isolating valves on the chilled water flow from the secondary pumps. Once the section of the secondary circuit is isolated the system is to be drained down. The existing buffer vessels in the mezzanine plant room are also to be drained down.

## 200.020 MODIFICATIONS TO THE EXISTING SYSTEM

Once the preparatory works are completed the Contractor is to undertake the following:-

### Buffer vessel

The two existing buffer vessels are installed on the primary side of the 3 port secondary mixing valve, and are each sized at 5000 litres. These provide additional backup to the supply of chilled water in the event of the smallest chiller or pump failing. The current arrangement on the flow and return to the buffer vessels is incorrect as the flow from the buffer vessels is on the top and therefore the flow is at a higher temperature than the flow to the buffer vessels. To take advantage of the lower water temperatures at low level in the buffer vessels, it is proposed to reverse the fluid flow through the buffer vessels, resulting in the infill being at the top. These works would involve the existing buffer vessel connections on the secondary flow pipework to be cut off so the connections can be reversed.

### Existing Low loss Header

- Cut the existing chilled water flow and return connections for the buffer vessels from the secondary chilled water flow pipework after the low loss header and install new isolating valves alongside new blank flanges to enable new connections to the low loss header.
- The existing low loss header blind flanges on either end are to be removed and replaced with flanged eccentric reducers and fully lugged butterfly isolating valves on either side, the pipework is to be completed with blind flanges. Before the reducer an air purger is to be installed on the low loss header. A flanged drain valve is to be also installed after the isolating valves to enable the buffer vessel section of the system to be drained down in the plant room during further works.

## 200.030 FILLING AND TESTING OF THE SYSTEM

Upon completion of these works the system shall be refilled, vented, tested and dosed while eliminating all air using the new purging point in the system. The buffer vessel circuit is to remain completely isolated and empty.

## **PART 3 POST WEEKEND WORKS – normal working hours**

During these works it is intended that the installation of the temporary chiller be completed including electrical connections, building the temporary chiller enclosure and the controls modifications, so no future shutdowns of the IT rooms would be required.

## 300.010 INSTALLATION OF TEMPORARY CHILLER

The works under this part shall include for installation for the following:-

- Installation of the new temporary chiller chilled water pipework from the chilled water plantroom

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- Installation of the new circulating pumps on the temporary chiller chilled water pipework.
- Installation of the new electrical connections for the temporary chiller
- Installation of the 250 kW Johnson Controls (YORK) air cooled chiller externally in the location shown on the tender drawing, further described in Section 5.00
- Installation of the new controls including electrical works in connection.

#### Temporary chilled water pipework and circulating pumps

At this stage of the works the Contractor is to complete the installation of the modified buffer vessels chilled water pipework that reconnects the new circulating pump with the existing buffer vessel flow connection and the new modified connections on the low loss header. The Contractor is to allow for the installation of all associated valves as detailed on the tender drawings and in line with the valve schedule. The existing cable tray that runs alongside the mezzanine level is to be removed and the cables located on this tray are to be repositioned to the adjacent tray. This would enable the buffer vessels chiller chilled water pipework to be routed to and from the mezzanine level.

New connections for the temporary chiller chilled water shall be installed on the buffer vessels flow chilled water pipework alongside a new fully lugged butterfly type isolating valve.

The return chilled water pipework from the buffer vessels shall be reconnected to the prepared connection on the low loss header.

The new buffer vessel connections from the low loss header shall be interconnected with the existing flow and return connections on the buffer vessels will remain operational once the temporary chiller is not working.

Once the connections are completed the Contractor shall allow for interconnection of the temporary chiller chilled water pipework with the new connections on the buffer vessels connection side.

Within the generator room the Contractor is to create the builders work openings through the generator wall louvres for the temporary chiller flow and return pipework and the electrical connections. The builders works are described in further detail under the Builders work Section 8.00. The chilled water flow and return pipework shall have flanges provided on internal side of the louvre wall to enable easy maintenance and disconnection. The connections are to be provided with blanked flanges within the generator plantroom until the temporary chiller is delivered on site.

#### Temporary chiller

The Contractor is to closely liaise with the temporary chiller manufacturer (Johnson Controls - YORK) on the delivery date of the temporary chiller so its installation is scheduled within the enabling package scope of works. Once the temporary chiller is delivered on site and positioned, the Contractor is to extend the temporary chiller chilled water flow and return connections and connect the temporary chiller to the system with all associated valves. A detailed description of the chiller and its controls can be found in Section 5.00 and 7.00. The pipework is to run externally on a suitably sized galvanised tray supported from the fixed external surface on "duck-foot" supports.

#### Electrical works

The electrical contractor shall be responsible for installing a 315 Amp TP&N isolator within the generator room for connection of the temporary chiller. This shall be located adjacent to the northerly facing acoustic louvres, mounted directly to the wall.

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The isolator shall be fed via LV switch panel 2B.

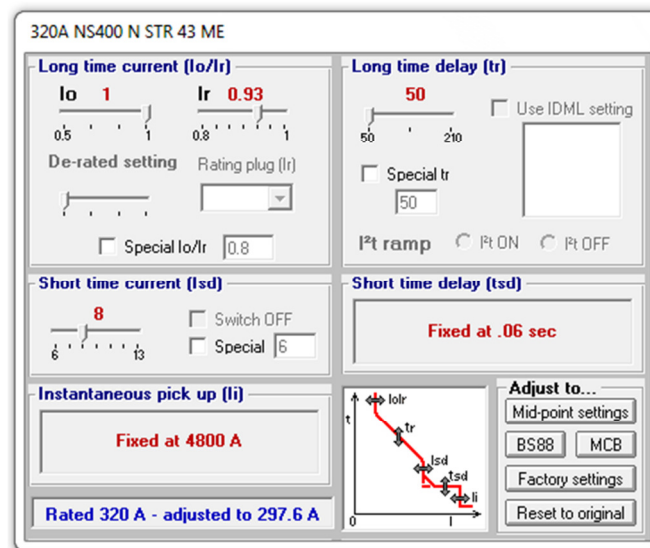
The supply from switch panel 2B shall be taken from way 18 utilising the MCCB installed previously by others.

The electrical contractor shall install a 95mm<sup>2</sup> XLPE/SWA/LSF cable and auxiliary 50mm<sup>2</sup> CPC from way 18 of switch panel 2B to the temporary chiller 315 Amp TP&N isolator.

All cabling shall be installed on the existing containment where possible. Any additional containment required shall be installed to match the existing and as illustrated on the scheme drawings.

As part of a pre-enabling works package, the moulded case circuit breakers installed within the main switch panels are to be replaced by others, this shall enable connection of the new temporary chiller LV supply from the HV/LV room through to the generator room.

The MCCB associated with the temporary chiller shall be set as illustrated below;



**Switch panel 2B Way 18 MCCB Settings for Temporary Chiller**

The contractor shall allow for the final connection to the temporary chiller using 4 core 50mm<sup>2</sup> XLPE/SWA/LSF cable and auxiliary 25mm<sup>2</sup> CPC. This cable shall be installed on to an external uni-struct frame with cable ladder and "Big foot" floor pads to protect the existing concrete slabs located between the exit point of the cable to the temporary chiller position.

The contractor shall ensure the Final termination in to the temporary chiller is in line with the manufacturers recommendations.

A temporary connection shall be made from the temporary chillers steel framework to the nearest earth spike pit in accordance with BS EN:62305. This cable shall be protected throughout its length mechanically and for the avoidance of theft.

The temporary chiller shall require a new BMS outstation located adjacent to the LV isolator in the generator room, the electrical contractor shall provide all necessary power supplies to this equipment wired using XLPE/SWA/LSF cable from local distribution boards.

The power supply to the chiller shall be metered and monitored as the existing metering in the building.

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### Testing and Commissioning

Upon completion of the works the system shall be refilled, vented, tested and dosed after eliminating all air. The buffer vessels shall be refilled. Subsequently the pump and the chiller shall be energised and commissioned to the design flow rates.

Once the system is commissioned the isolating valves on the temporary chiller chilled water flow are to be returned to the closed position and the isolating valve on the chilled water flow pipework to the buffer vessel is to be left open, this will enable circulation around the buffer vessel circuit using the circulating pump and complete isolation of temporary chiller.

## **PART 4 SECOND WEEKEND SHUTDOWN OF PRIMARY SYSTEM**

The second weekend shutdown is scheduled to enable the Contractor to undertake works on the primary circuit and to replace the existing isolating valves on both the primary chilled water flow and the return pipework.

During these works, the essential IT cooling loads will be covered by the temporary chiller. The Contractor is to test the functionality of the temporary chiller and ensure that the secondary system runs without any complications, prior to these works. As the temporary chiller only covers essential cooling loads the Contractor is to ensure that the Bank's "representatives" have prepared and tested all additional methods of cooling for the nonessential cooling loads for the remaining secondary cooling loads.

The primary circuit shall be isolated from the secondary using the existing isolating valves on the primary chilled water flow and return before the low loss header. The isolating valves on the temporary chiller connection would be opened and the main circuit valve on the buffer vessel chilled water flow will be closed. This action will divert water through the temporary chiller.

To enable the isolating valve replacement without draining down of the whole system the Contractor is to appoint a specialist company to undertake a pipework freezing of the primary chilled water flow and return pipes at plantroom level.

### **400.010 PIPEWORK FREEZING**

The pipework shall be frozen in the chilled water plant room in the location identified on the tender drawings using liquid nitrogen. To freeze the 400mm diameter mains chilled water pipework flow and return would take 4-6 hours. Upon this, the system shall be drained down to a sufficient level to relieve excessive pressure and undertake subsequent installation of the new lugged butterfly isolating valves and an air purger on the chilled water flow.

When the installation is completed the pipework shall be slowly thawed with the help of a local heat source which would melt a channel in the frozen plug. Once the water has then passed through the plug induced by the system pumps, the remaining ice will be flushed away rapidly. The estimated time for the de-frosting is 1-2 hour.

Once the works are completed the chilled water system shall be topped up, purged of all air from the system and the working section of the pipework is to be pressure tested. On completion of these works the Contractor shall restart the system and test its operation. It is necessary for the Contractor

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to produce a method statement for the proposed works during this shutdown period as set out in the General Conditions of this specification.

The pipework freezing shall be undertaken by:-

**IPS - Industrial Pipefreezing Services Ltd.**

8 The Coles Shop  
Merton Abbey Mills  
Watermill Way  
London SW19 2RD  
Web: [www.ipsgroup.net](http://www.ipsgroup.net)  
Steve Turner  
Phone: 07768 616 020  
Fax: 020 8543 8748  
Mail: [steve@ipsgroup.net](mailto:steve@ipsgroup.net)

## **PART 5 SUBSEQUENT WEEKEND SHUTDOWN OF PRIMARY SYSTEM**

Each scope of the works described below is to be undertaken during an individual weekend shut down. As all works require complete isolation of the primary system and it is crucial to cover the essential cooling loads at all times, the following operations shall repeat before commencing of any works.

- Produce a method statement on the proposed works during the shutdown as set out in the General Conditions of this specification.
- Test the functionality of the temporary chiller and ensure that the secondary system runs without any complications, prior to commencement of any works.
- Ensure that the Bank's "representatives" have prepared and tested all additional methods of cooling for the nonessential cooling loads for the remaining secondary cooling loads.

Once the works are completed, the system is to be topped up, purged of all air and the relevant section is to be pressure tested. If no problems are observed, the Contractor shall restart the system and test its operation.

### **500.010 WORKS ON CONDENSER WATER SIDE**

A subsequent weekend shut down would be required to accommodate the modification works on the condenser water circuit. The modifications would enable complete isolation of the condenser water circuit and disconnection of the heat exchangers.

Once the temporary chiller is running, the Contractor is to drain the condenser water side of the system. The drainage of the system needs to be closely controlled and it is necessary to take into consideration that it can take up to 5 Hrs. The weekend shutdown works cannot extend outside the previously stated period for weekend shutdown. The existing isolation valve on the condenser water flow shall be replaced with a new butterfly valve including a new air purger. On the condenser water return pipework the Contractor is to remove the existing motorised valve and install a new butterfly isolation valve.

Upon completion of these works the Contractor is to test the system as described above, before bringing the system back into operation.

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#### 500.020 DISCONNECTION OF HEAT EXCHANGERS

Similar to the previous operation, to enable disconnection of the existing heat exchangers on the chilled water side it is necessary to isolate and drain down the relevant section of the system during weekend shutdown.

By using the existing isolating valves on the heat exchanger side of all existing chilled water pumps and chillers, the chilled water system shall be isolated and drained down locally. The existing motorised valve is to be removed and replaced with new butterfly isolation valve. The existing connections to the heat exchanger shall then be cut off and new blank flanges installed.

Upon completion of these works the Contractor is to test the system as described above, before bringing the system back to operation.

#### 500.030 INSTALLATION OF THE BYPASS

The installation of the chilled water bypass is to be priced as an additional option as it yet is to be determined if a new bypass is to be installed or the existing bypass is to be reused.

##### Option 1 - Existing Bypass

If an existing bypass is to be reused, the Contractor is to allow for replacement of the existing double regulating valve on the chilled water bypass and allow for an installation of new metering station.

##### Option 2 - New Bypass

The new chillers variable flow system arrangement requires a by-pass installed on the primary chilled water pipework after the pumps to ensure that a minimum flow on the chillers is maintained at all times. The primary chilled water pipework bypass is to be installed during a weekend shutdown. The bypass is to be completed with an isolating valve and a 2port motorised valve. The by-pass shall be closed until the chiller replacement scheme is complete and the new system commissioned. The above works are to be quoted as on additional option, as there is a possibility to reuse an existing bypass on the existing chilled water system.

#### 500.040 ALTERNATE CONNECTION TO THE PRESSURIZATION UNIT

To avoid the need for a new pressurization unit during periods when only the temporary chiller is in use, it is proposed to use the existing pressurization unit which is located on the roof but with a new connection to the secondary CHWS circuit.

A new connection will be run from the existing system fill line and connected to the existing secondary circuit having removed the existing automatic air eliminator. The new connection will incorporate isolation valves and pressure switch for automatic control of the pressurization unit.



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## SECTION 5.00 – Chilled Water System

### PART 1 SYSTEM OBJECTIVES

#### 100.010 PERFORMANCE OBJECTIVES

The Contractor shall supply, install, test and set to work a fully functional chilled water system. The installation will involve replacement of the existing chilled and condenser water pumps, replacement of existing isolating, double regulating and motorised valves and modifications to the existing pipework.

#### 100.020 EXISTING SYSTEM

The building is currently served by 3 No chillers, with chillers 3-1 and 3-2 rated at 3165 kW and chiller 3-3 rated at 1400 kW and these were installed around 1989. They each have a capacity control system using inlet guide vanes which partially block the inlet to the compressor and thereby reduce the refrigerant flow and ultimately the output. The chillers are therefore capable of some capacity control, although overall COP (Coefficient of Performance) suffers as they throttle down.

The above chillers therefore provide a theoretical output of around 7730 kW, but this has been reduced by the use of the refrigerant R123 which replaced R11, the original refrigerant, when this was no longer available. Information from the manufacturer would indicate that after the refrigerant replacement, the overall output of the chillers dropped to around 7350kW.

The existing chilled water pumps are not all the same size, with 3 No(P3-1, P3-2, P3-3) each the same and sized for the flow rate from the larger chillers 3-1 & 3-2, with the last pump P3-16 sized for the smaller chiller 3-3. Although the system serving the air handling units is a 2 port valve system which would intimate variable flow, in reality the system is a stepped flow with chillers and pumps switching off if the cooling requirement drops. Therefore as the 2 port valves around the building throttle down, because the pumps are fixed speed, the excess flow passes around a bypass at the top of the building until the point is reached where a chiller and matched pump can switch off and at that point the chiller is isolated from the system with 2 port valves.

On the condenser water side, the pumps replicate the logic of the chilled water system with pumps switching off and chiller isolated when the system turns down. Again the 3 No pumps (P3-4, P3-5, P3-6) are sized for the larger chillers 3-1 & 3-2 and a smaller pump P3-17 was installed to serve chiller 3-3.

The existing system incorporates heat recovery in the form of plate heat exchangers that allow, through a system of bypasses and 2 port valves, the condenser water to cool the chilled water and in theory provide free cooling. This only works when the external temperature is quite low and the low condenser water temperature can provide cooling to the chilled water without the need to operate the chillers.

The above system describes the Landlords base scheme originally provided to the building. However, as part of the tenant fit out, a secondary chilled water system was installed that provides higher temperature chilled water to the building IT server and patch rooms and this system operates 24 hours per day and 7 days per week. The main chilled water system normally works on 6.7°C flow and 13.3°C return, but the secondary system works on 8.5°C flow and 13.3°C return, and this is achieved using a conventional mixing circuit with a 3 port valve. Separate constant speed chilled water pumps serve this circuit which is a constant flow circuit with 3 port valves on the room cooling units.

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Given that the above system operates nights and weekends when there is no cooling load elsewhere, the requirement for the chillers is very low at those times and hence the 1400 kW chiller (chiller no 3) operates during those hours together with the smallest chilled water pump and condenser water pump. The minimum turndown of the existing chiller is unknown, but probably around 20-25%, and this equates to around 280 – 350 kW.

Linked to this system, but installed on the primary side, are 2 No buffer vessels each sized at 5000 litres and essentially piped onto the flow. These provide additional backup to the supply of chilled water in the event of the smallest chiller or pump failing.

#### 100.030 PROPOSED SYSTEM

The proposed replacement works involve installation of 3 No 2500kW water cooled centrifugal chillers. The chillers are proposed to be variable speed drive to enhance the efficiency of the cooling system in the building. The chillers are proposed to connect to the existing primary and secondary chilled water system. The system capacity has been sized to match the capacity of the existing chillers to ensure that the landlord system capacity would remain the same once the building changes its tenant. The current cooling demand of the building has been calculated to be 4750 kW, which is approximately 35 % lower than would be the actual chiller capacity. As the proposed chillers are variable speed drive, this would enable the system to stimulate its output so it runs on its best efficiency. The actual proposed control system is described in more detail in Section 7.00.

One of the leading criterion for the chiller selection was the ability of the chiller to turn down to 10% of its total load and to remain without tripping at this load for a longer period of time. This criterion has been derived from the essential cooling requirements that are required to run 24 hours a day. During the out of working hours and weekend when the building is unoccupied the chiller will always be required to run on its minimum loads.

The chillers are proposed to be replaced alongside the existing chilled water and condenser water pumps. It is proposed to install a sensor-less variable speed pump on the chilled water side. On the condenser water side the pumps are to be fixed speed, however they are to be provided with an inverter control to simplify the commissioning process and also to ensure that the pump would be set on its best system resistance.

As described previously the chillers are to be replaced one at a time and there selected a testing period for each chiller and a set of pumps before a subsequent replacement of another chiller takes place. Before all three chillers are replaced, it is important for the new system to match the operation of the existing system, therefore the inverter drives on chillers and pump shall be disabled until the installation is completed. Once all of the works are completed the system controls are to be rewritten under the dictates of the new system. This part of the testing and commissioning is more closely described under Section 8.00.

The existing condenser water circuit is to remain the same, although to gain the most efficient operation it is proposed to amend the cooling water temperature set point at 13.5 deg C. At this point the refrigerant R134a that is used in the water cooled chiller would work most efficiently.

The existing secondary pumps are to remain operational and are to be refurbished as a part of the EBRD's own refurbishment programme.

To minimise the risk on the project an additional air cooled 250kW temporary chiller is to be introduced to the system, this chiller will support the essential cooling loads during the primary

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system shutdowns. The temporary chiller is to be installed alongside a new circulating pump which is to be retained on site once the temporary chiller is decommissioned.

## **PART 2 SPECIFICATION CLAUSES SPECIFIC TO T69**

### **200.010 DESCRIPTION OF WORKS**

The whole scope of replacement works of the existing chillers have been phased into 3 periods. In the first period existing chiller No 3-1 is to be replaced with its associated pumps No P3-1 & P3-4. It is proposed to replace the Refrigeration machine No 3-1 first so the Refrigeration Machine 3-3 that directly works under the dictates of the secondary circuit is replaced last. This would enable the chiller to run in the existing arrangement whilst eliminating the risk of unnecessary problems on the secondary circuit.

In the second period chiller No 3-2 shall be replaced with its chilled water and condenser water pumps No P 3-2 & P3-5 in the same manner as the first chiller. During this phase the standby pumps no P 3-3 and P3-6 shall be replaced too.

In the last period, chiller No 3-3 shall be replaced with its associated pump no P3-16 & P3-17.

The following description of works is to be read in line with the phasing drawings in Appendix E.

### **200.020 RESPONSIBILITIES**

As the proposed temporary and main chillers will have been procured by EBRD, the following scope of works have been agreed and is expected to be undertaken by Johnson Controls(YORK) during the replacement programme:-

#### Temporary Chiller

- Supply packaged liquid chiller complete with motor, compressor, condenser, evaporator, starting and control equipment and all auxiliary and ancillary items to complete the refrigeration cycle.
- The unit is to be factory assembled with all interconnecting refrigerant piping and wiring ready for field installation.
- The unit is to be pressure tested, evacuated and fully factory charged with refrigerant and oil in each of the independent refrigerant circuits.
- The unit shall be delivered to site and installed in the compound indicated on the external services drawing on a cork or similar "TICO" pad to protect the existing tiled support base areas.

#### Existing Chillers

- Decommissioning of the existing units, one unit at a time before the installation of new chiller (in line with the programme above)
- Removal and safe storage of the refrigerant R123 on site until the final removal of the third chiller.
- Dismantling of the existing machines and the safe removal from site.
- Disposal of the existing machines in line with the requirements of current regulations.

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- Safe disposal of the refrigerant in line with the BS EN 378-4:2008 (on replacement of the third chiller)

#### New Machines

- The Manufacturer will factory assemble the units with all interconnecting refrigerant piping and wiring ready for the field installation. The units are to be pressure tested, evacuated and fully factory charged with refrigerant and oil in each of the independent refrigerant circuits.
- When assembled, each chiller is to be factory tested on its full thermal load and each part load + minimum load
- The manufacturer is to allow for the weighing of the final charge of refrigerant for the end users maintenance records.
- Upon completion of the “off site” testing (to be witnessed by the Bank's representatives) the manufacturer shall allow for the chillers to be discharged of refrigerant and stored in the manufacturer's facility in accordance with their recommendations.
- Prior to delivery of each chiller unit, it shall be dismantled and delivered to site in pieces to allow installation in space restricted areas. The chiller manufacturer shall allow for long term storage and protection within his tender.
- Once the chiller is delivered to site the manufacturer is to allow for rebuilding the chiller within the plant room, positioning on suitably adapted bases, refilling with oil and refrigerant and commissioning. This scope shall be repeated for all three chillers.
- The manufacturer is to allow for the commissioning of each individual chiller upon completion of its installation. When all three chillers are installed the manufacturer shall allow for final seasonal commissioning of the chillers in conjunction with the BMS system and circulating pump design strategy. Setting to work and commissioning shall be in accordance with CIBSE code “R”.
- Upon completion of the chiller installation and the final “combined” commissioning, the manufacturer is to supply the final O&M documentation.
- Johnson Controls (YORK) shall submit a proposed method statement for all works with this tender.

The Contractor will be responsible for all liaison with Johnson Controls(YORK) on the proposed works, to ensure that all works have been scheduled and the equipment is delivered in line with the planned project programme.

The Contractor will be responsible for the works associated with the installation of the chillers, including existing pipework modifications, replacement of the valves and procurement and installation of the plant associated with the chillers.

#### 200.030 REPLACEMENT OF CHILLER NO 3-1

Prior to the replacement of any equipment during the main works it is necessary for the contractor to prepare the plantroom for the installation works. The Contractor is to also liaise with the chiller

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manufacturer to schedule the delivery dates. The following preparation works prior to the installation processes are to be repeated for each chiller replacement as follows:-

#### Preparatory works

- Scaffolding and task lighting shall be installed where necessary.
- Where the works on the existing pipework are going to be undertaken the insulation shall be stripped off and cleared from site.
- The contractor shall measure for all stool pieces and procure all necessary components, i.e. valves, flanges, etc.,
- During the preparatory works the Contractor shall test the functionality of the temporary chiller and ensure that the secondary system runs without any complications.
- Any additional methods of cooling for the non-essential cooling loads shall be prepared and tested

#### Weekend Shutdown

During the first weekend shutdown of the main chiller replacement works, the essential IT cooling loads shall be covered by the temporary chiller. The primary circuit would be isolated from the secondary using the existing primary isolating valves before the low loss header. The isolating valves on the temporary chiller connection would be opened and the main circuit valve closed. The Contractor then would energise the temporary chiller.

Once the temporary system is running both the primary chilled and condenser water circuits would be isolated using the new isolation valves and drained down in the whole plant room.

The pumps that serve chiller No 3-1 are chilled water P3-1 and condenser water P3-4 pumps. These shall be disconnected back to the main headers and new isolating valves and double regulating valve shall be installed, completed with blank flanges. The chilled and condenser water connections to the chiller No 3-1, would be disconnected back to the chilled water and condenser water headers and new isolation valve and double regulating valves incl. commissioning station would be installed on the connections. Once all of the above works are completed the Contractor is to ensure that the newly installed valves are in a closed position.

Once the above scope of works are completed, the system consisting of the remaining two chillers is to be topped up, purged of all air and the relevant section of the system is to be pressure tested. Upon completion of testing the system is to be energised and the Contractor is to test its operation to ensure that the system is operational. If no problems are observed the works can be completed by opening the primary and secondary circuit whilst turning off the temporary chiller.

#### Post weekend shutdown normal working hours

During the post-weekend works the Contractor is to closely coordinate with the chiller manufacturer to ensure completion of the following works:-

- During the post-weekend works the existing pumps and chiller will be dismantled, removed and disposed of from the site.

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- Existing support bases shall be cleaned, extended as required and prepared for delivery of all new equipment.
- New pumps will be installed together with the associated accessories while the new valves would provide isolation from the operational system.
- New chiller will be delivered to site in parts due to access restriction and will be reassembled in plant room by Johnson Controls (YORK) and prepared for connecting by the contractor.
- The Contractor is to install new 2 port control motorised valves on the chilled and condenser water side along with temperature, pressure gauges, sensors, flow switches and other accessories, generally as detailed on the relevant tender drawings.
- Having the primary system isolated via the new isolating valves the chiller connections shall be reassembled and connected to the existing system.
- All essential electrical connections will be installed to the pumps and chiller during the duration of the above works.

Upon the completion of the above works, the new controls for the pumps and chiller shall be incorporated into the existing BMS control system. The variable speed function on the new pumps shall be disabled and the pumps shall work on fixed speed only until all three chillers are replaced. New chiller and pumps shall be programmed to match the operation of the existing system.

After the chiller has been charged with oil and refrigerant, the valves would open and be made available for refilling of the system. The system is to be vented, pressure tested and dosed, while eliminating as far as practicable, all air. The last phase of these works is the commissioning of the new chiller based on the full load operation, described in more detail under Section 8.00.

#### 200.040 REPLACEMENT OF CHILLER NO 3-2

All of the scope of works during the replacement of the Chiller No 3-2 and chilled water pump P3-2 and condenser water pump P3-5, with the only difference that the stand by pumps are to be replaced during this phase. The chilled and condenser water stand pumps are numbered pumps No P3-3 and P3-6. The replacement process is to follow the scope of works as in the replacement of chiller No 3-1 for all preparatory, weekend shutdown and post-weekend shutdown works.

It has to be noted that the replacement of Chiller 3-2 in line with the current programme becomes feasible only if the operation of new Chiller No 3-1 and associated pumps is unproblematical during the testing period.

#### 200.050 REPLACEMENT OF CHILLER NO 3-3

Prior to weekend shutdown, the Contractor is to prepare the site as described previously.

#### Weekend Shutdown

During the first weekend shutdown of the main chiller replacement works, the essential IT cooling loads shall be covered by the temporary chiller. The primary circuit would be isolated from the

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secondary using the existing primary isolating valves before the low loss header. The isolating valves on the temporary chiller connection would be opened and the main circuit valve closed. The Contractor then would energise the temporary chiller.

Once the temporary system is running both the primary chilled and condenser water circuits would be isolated using the new isolation valves and drained down in the whole plant room.

The pumps that serve chiller No 3-3 are chilled water P3-16 and condenser water P3-17 pumps. The pumps are to be disconnected back to the main headers and new isolating valves and double regulating valve incl. commissioning set would be installed. The chilled and condenser water connections to the chiller No 3-3, would be disconnected back to the chilled water and condenser water headers and new isolation valve and double regulating valves incl. commissioning station would be installed on the connections. Once all of the above works are completed the Contractor is to ensure that the newly installed valves are in a closed position.

The system consisting of remaining two chillers is to be topped up, purged of all air and the relevant section of the system is to be pressure tested. Upon completion of the testing the system is to be energised and the Contractor is to test its operation to ensure that the system is operational. If no problems are observed the works can be completed by opening the primary and secondary circuit whilst turning off the temporary chiller.

#### Post-weekend shutdown normal working hours

During the post-weekend works the Contractor is to closely coordinate with the chiller manufacturer to ensure completion of the following works:-

- The existing pumps and chiller are to be dismantled, removed and disposed of from the site.
- Existing support bases shall be cleaned, extended as required and prepared for delivery of all new equipment.
- New pumps will be installed together with all associated accessories while the new valves are providing isolation from the operational system.
- New chiller is to be delivered to site in parts due to access restriction and will be reassembled in plant room by Johnson Controls (YORK) and prepared for connections by the contractor.
- The Contractor is to install new 2 port control motorised valves on the chilled and condenser water side along with temperature, pressure gauges, sensors, flow switches and other accessories, generally as detailed on the relevant tender drawings.
- Having the primary system isolated via the new isolating valves the chiller connections shall be reassembled and connected to the existing system.
- All essential electrical connections will be installed to the pumps and chiller during the duration of the above works.

After the chiller is charged with oil and refrigerant, the valves would open and made available for refilling of the system. The system is to be vented, pressure tested and dosed, while eliminating as far as practicable, all air.

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Upon completion of these works the Contractor is to allow for testing and commissioning of the whole of the system under the dictates of new control schedules. The detailed description of the proposed commissioning is to be found under Section 8.00.

#### 200.050 COMPLETION WORKS

Upon the complete chiller replacement the Contractor is to allow for complete drain down and disconnection of the temporary chiller. The temporary chilled water pipework and temporary chiller controls are to be retained in the generator room and the temporary chiller and the external pipework incl. associated accessories are to be stored in the Bank's preferred location. The Contractor is to allow for the temporary chiller compound and the existing louvre is to be cleared and returned to its original status.

### PART 3 GENERAL REQUIREMENTS

#### 300.010 CHILLERS

The chillers have been procured by EBRD, however the contractor shall be responsible for close liaison with the chillers manufacturer to ensure that all works are undertaken in a manner and as scheduled by the Bank's requirement.

##### Temporary Chiller

The temporary chiller is to be 250 kW air cooled liquid chiller YLAA HE 0260, as manufactured by Johnson Controls (YORK). A detailed technical specification for the chiller is part of an Appendix F.

##### Main Chillers

The main chillers are to be 3 No variable speed drive 2500 kW water cooled chillers YK HDFVP85ENG as manufactured and supplied by Johnson Controls (YORK). A detailed technical specification for the chiller is part of an Appendix F.

#### 300.020 SYSTEM PUMPS

##### General

All moving parts are to be guarded. 100 mm dial altitude gauges are to be supplied and installed in all suction and discharge connections of all pumps. They are to be installed at the same height throughout, at least 2 pipe diameters away from the nearest pipe fittings and pump flanges, if possible. Gauges each to be complete with brass ring syphon and gauge cock. The face of each gauge is to be marked with a red line indicating the normal static head as measured on site.

Isolation butterfly valves and tied flexible connections are to be installed on both suction and discharge of each pump or twin pump. Where shown on the drawings, a strainer is to be installed on the suction side of each pump and non-return valve on the discharge. The discharge part of the pump is to be complete with double regulating valve and commissioning station.

Self-sealing test plugs, (as specified elsewhere) are to be installed on the side of the pipe at the suction and discharge of each pump set, again at least 2 pipe diameters from the nearest pipe fittings and pump flanges, if possible.

All pumps must be installed strictly in accordance with the manufacturer's recommendations. The existing bases are to be reused for the chilled water and condenser water pumps on the primary circuit. A specially fabricated inertia base is to be provided under temporary chiller chilled water pump, as specified in the Section 8.00.



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Impellers to be gunmetal, casing to be cast iron, shaft to be stainless steel and to be complete with self adjusting mechanical seals. All parts in contact with the water to be suitable for the fluid concerned.

Motors are to be totally enclosed fan-cooled squirrel cage induction type, sized so as to be non-overloading at any point on the pump curve.

#### .01 Chilled Water Circulating Pumps P3-1, P3-2, P3-3 and P3-16

The chilled water pumps are to be 4No single variable speed units. Each pump is to be a horizontal in line direct driven unit with a motor running at 1800 rpm maximum. The motor on each pump is to be Inverter ready.

The duty of each pump is to be 90.5 litres/sec at a pressure of 550. kPa.

The pumps are to be type 4300 Starline IVS Integrated 200-375 and 75 kW motor, impeller ready suitable for 400v/3ph/50Hz electrical supply. The pumps shall be as manufactured by:

**Armstrong Holden Brooke Pullen**

tel 0161 223 2223

or equal and approved.

#### Condenser Water Circulating Pumps P3-4, P3-5, P3-6 and P3-17

The chilled water pumps are to be 4No single constant speed units. Each pump is to be a horizontal in line direct driven unit with a motor running at 1800 rpm maximum. The motor on each pump is to be Inverter ready, however this is to be used only for the commissioning purposes.

The duty of each pump is to be 90.5 litres/sec at a pressure of 550 kPa.

The pumps are to be type 4300 Starline IVS Integrated 200-375 and 75 kW motor, impeller ready suitable for 400v/3ph/50Hz electrical supply. The pumps shall be as manufactured by:

**Armstrong Holden Brooke Pullen**

tel 0161 223 2223

or equal and approved.

#### Temporary Chiller Circulating Pump

The temporary chilled water pump is to be fixed speed run and stand by pump.

The duty of the pump is to be 10.101 litres/sec at a pressure of 150 kPa. The pump is to be type 4380 Starline-80-250-3 kW with 3 kW motor.

The pumps shall be as manufactured by:

**Armstrong Holden Brooke Pullen**

tel 0161 223 2223

or equal and approved.

#### Secondary Circulating Pumps No 1&2

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The existing secondary chilled water pumps are fixed speed Holden Brook Starflex centrifugal pumps, size 100-315. The duty of the existing pumps is 25 litres/s at a pressure of 350 kPa. The existing pumps are to be retained, however it has been agreed with the client that the pumps would be refurbished as a part of EBRD own maintenance team works, before the enabling package has taken place. .

### 300.030 PRESSURISATION UNITS

The existing pressurization unit for the chilled water system is located in the 13<sup>th</sup> floor roof plantroom. The existing unit is Worthington Simpson packaged twin pump pressurisation unit with expansion vessel. The unit is to be retained and the connections to the unit are to be modified so that the secondary circuit and the temporary chiller system would be pressurised the same system.

### 300.040 COOLING TOWERS

The existing cooling towers are located in the 13<sup>th</sup> floor plantroom and are 4 cell air cooled open circuit, evaporative, induced draught flow type incorporating fan motor and pan water level controls. The cooling towers are manufactured by Heenan Marley cooling Towers Ltd. The system serves the water cooled chillers with current condenser water flow temperature of 23.8 °C. It is intended to retain the system operation as existing, however in order to make the most of the new chillers and new refrigerant the temperature set point on the outlet water temperature is to be changed from 23.9 °C to a variable figure which at minimum would be 13.5 °C. The temperature set point is to be set so it varies with the external wet bulb temperature.

### 300.050 BUFFER VESSELS

The two existing buffer vessels are installed on the primary side of the 3 port secondary mixing valve, and are each sized at 5000 litres. The buffer vessels are vertical buffer vessels provided by Rother Engineering. These provide additional backup to the supply of chilled water in the event of the smallest chiller or pump failing.

As discussed previously, the buffer vessels are quite important for both the temporary chiller works and for the new chillers. The current capacity of the vessels provides enough storage to cover the anticipated 250 kW essential IT load for 17 minutes which should limit the chiller to a maximum of 3 starts per hour to cover the essential IT loads.

As it has been described previously the current arrangement on the flow and return to the buffer vessels is to be modified and reverse the flow and return from the buffer vessels, having the infill at the top.

The temporary chiller circulating pump is to be also used as a buffer vessel circulating pump once the whole system is commissioned.

### 300.060 HEAT EXCHANGERS

The existing 2 No Alfa Laval plate & Frame heat exchangers are located in the chiller plantroom. As they are not used in the current system arrangement and are not planned to be utilised for the new system, they are redundant and are to be dismantled and remove from site. The heat exchanger are proposed to be disconnected during the enabling stage of the work and it will be beneficial to remove the redundant system before the installation of new chiller, so there is more working space in the chiller plantroom.

### 300.070 REFRIGERANT LEAK DETECTION

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The existing site has an existing refrigerant leak detection system suitable for refrigerant R123. Due to the chiller replacement and change of the refrigerant the Contractor is to be responsible to supply, install, test and commission a replacement refrigeration leak detection system compatible with refrigerant R134a. The system shall be provided with 4 point detection system and connect to the existing 2 point detection devices and 2 new detection devices. .

The existing refrigerant leak detection system is 2 points CHILLGARD RT R123 (Sn 591-B01) supplied by:-

**MSA (Britain) Ltd**

Lochard House  
Linnet Way  
Strathclyde Business Park  
Belshill  
ML4 3RA

Tel - 01698 573357

Fax - 01698 740141

**300.080 ELECTRICAL**

The existing power supplies to the chiller room emanates from the main building HV/LV switch room which is located at Mezzanine level, it is proposed that the MCCB's feeding the chillers will have been replaced prior to the contract. A new MCCB has been installed to feed the temporary chiller, and the existing MCCB's feeding the Motor Control Centres replaced prior to the contract. The contractor shall utilise these devices and associated cabling for the connection of the new chillers, with the exception of the supply to chiller 3 which shall require an additional cable installed in parallel to increase the overall in cabling size.

The existing cables feeding the chillers are 3 core PVC/SWA/PVC which are to be retained and reconnected to the new chillers when installed.

The contractor shall use new cables, delivered to site with seals intact, manufactured not more than one year prior to delivery, labelled with manufacturer's name, size, description, BS number, classification, length, grade and date of manufacture and mark all types of cables with CENELEC cable certification marking or if included in British Approvals Service for Cables (BASEC) in accordance with BASEC regulations.

Supply cables with Low Smoke Zero Halogen (LSOH) sheathing, shall be tested in accordance with BS EN 50267 and BS EN 60332.

Wiring to power; control and auxiliary circuits shall be in accordance with:

Standard - BS EN 50262 metallic, cable retention Class A, protective connection to earth, IP54. Type B as BS 6121-5 Annex A.

All cables which are to run in parallel with new cables shall be harmonised and relabelled as per IET 17<sup>th</sup> Edition of the wiring regulations.

**New Chillers**

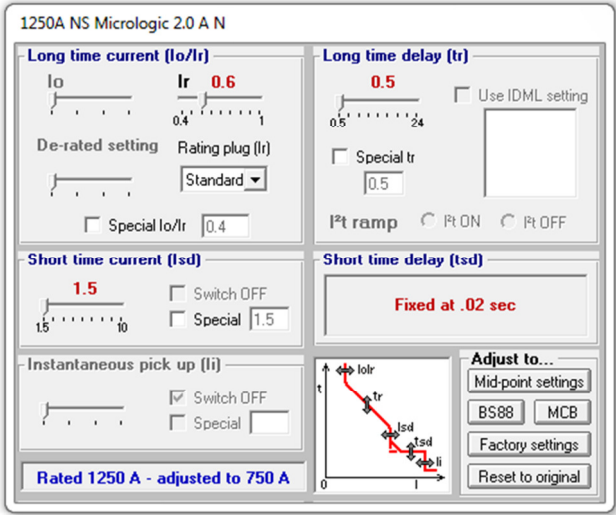
The replacement of the chillers is to be carried out in a phased manner as described above, with chiller No.3 being the first to be carried out.

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Each chiller shall require disconnection in a phased sequence and once chiller No.3 has been disconnected the electrical contractor shall install a new 3 core 240mm<sup>2</sup> XLPE/SWA/LSF cable to run in parallel with the existing 3 core 240mm<sup>2</sup> cable from switch panel 2A way 7.

The MCCB protecting chiller No.3 shall be adjusted to 750A using the settings as detailed below;



**Settings for Main chillers when replacement has occurred**

As the remaining new chillers are connected, the electrical contractor shall adjust the MCCB devices within the main switch panels utilising the settings illustrated above.

### 300.090 MOTOR CONTROL CENTRES

The electrical contractor shall allow for the replacement of each of the protective devices within each of the motor control centres as each item of plant is replaced.

As part of the new chiller installation, the mechanical contractor shall be replacing the pumps associated with the chillers. As each pump is disconnected the electrical contractor shall replace the existing BS88 switch fuse within the MCC with a new BS88 switch fuse rated as the existing as a direct replacement

The electrical contractor shall also install new local isolation devices adjacent each pump as detailed on the electrical services drawings.

The cables feeding from the MCCB's shall be retained and tested at the time of modification to the MCC panel refurbishment as the overall load on the panels will not increase as the installation/replacement of pumps is carried out. Due to the physical constraints within the chiller room the frame of the existing MCC's would have to be retained and new switchgear installed in to this frame as a direct replacement of existing switchgear as the chiller and pump replacement takes place. It is thought at this time that modification to existing busbar and frames internally may be required to enable new switchgear to be installed. Replacement of the main incoming device in each MCC would require a full shutdown of the pumps fed from each panel and thus disable the chillers served by the pumps, this could be considered to take place when pumps are being replaced, with

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careful attention to the location of the panels in relation to which pumps are being replaced and the logistics and planning needed to carry out the replacement. Cables emanating from the MCC's shall be tested as the pumps are replaced to establish their condition, but it is not envisaged these will require replacement as the termination position at the pumps is not being altered.

Switchgear and final local isolation at the pump positions is to be renewed and existing power factor correction removed as the new pumps are installed with variable speed drives located on the new pumps. The section of the MCC's which contains the Trend controller is to be refurbished, with replacement of the controller and associated relays and control equipment, this will need to be carried out item by item as there is no available space in the existing cabinet nor adjacent to the existing panel, alternatively a chassis could be manufactured which would sit inside the existing doors to the cabinet with the necessary control equipment attached, built in such a way to enable removal of existing equipment as it becomes redundant.

### 300.100 SHUNT PUMP ELECTRICAL SUPPLIES.

The electrical contractor shall install the power supplies for 2No. shunt pumps. Shunt pump No. 1 shall be supplied from Motor Control Centre A (MCC A) and shunt pump 2 from Motor Control Centre B (MCC B).

In order to supply the shunt pumps from the motor control centres the electrical contractor shall install a new BS88 switch fuse rated to the load of the pumps which have an FLC of 6.10Amps (3KW). This new switch fuse shall match the existing control centre switch gear manufacturer within each existing MCC. The switch fuse shall utilise one of the existing spare ways within each of the MCC's.

From each MCC the electrical contractor shall install a 4 core 6mm<sup>2</sup> XLPE/SWA/LSF cable installed on new Heavy duty Galvanised tray at high level in the chiller room to a lockable isolator to be installed adjacent to each pump, this shall be controlled via a contactor, which in turn shall be controlled via the Building Management system (BMS). This contactor shall give a signal to the BMS when energised to indicate run status and isolated status. All cabling shall be installed using XLPE/SWA/LSF cable. Enclosures should give IP 55 protection for units installed in boiler rooms, pump rooms and the chiller room and shall be of a standard equivalent to BS EN 60947-4-1 or BS EN 60947-4-2

The contactors shall be rated for continuous use and give in excess of 15,000 operations

The pumps are to be supplied and installed by the mechanical contractor

### 300.110 SMALL POWER INSTALLATION

The existing small power installation shall be modified were necessary.

The electrical contractor shall also be responsible for the provision of LV power to each new outstation on the Building Management System, which shall be located at the new shunt pump position and the temporary chiller position. The power supply shall consist of a unswitched fused connection unit wired in XLPE/SWA/LSF cable from the nearest distribution board with spare capacity available. The contractor shall ensure that the distribution board utilised shall be part of the essential services distribution system and is backed up by the generator in the event of a power failure.

### 300.120 LIGHTING INSTALLATION

The existing lighting to the chiller room in the vicinity of the chillers shall be modified were necessary.

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The electrical contractor shall temporarily relocate the existing light fittings in the area of the chillers where removal/replacement of chillers is taking place to allow unrestricted access/egress of the each chiller.

Once each chiller has been replaced the contractor shall install new Cooper Industries Tufflite IP65 fittings as per the electrical drawing for this area. The fittings are to be High frequency T5 type luminaires and suspended to a height equivalent to the existing fittings. The positions indicated on the drawing are indicative and the exact position shall be agreed on site.

### 300.130 CONTAINMENT

The contractor shall make use of the existing containment system. The contractor shall make the necessary site survey of the existing services route for tendering purposes and to establish the works required.

Any additional containment should be supported and installed to match the existing containment system. The new containment should be routed as not to conflict with the existing and proposed services.

Tray and rack shall be Flanged or return flanged. Perforations shall be admiralty pattern for light or medium duty; GDGD pattern standard 23; or manufacturer's standard pattern.

The contractor shall use factory made fittings throughout of same material, type, pattern, finish and thickness as cable tray. Join lengths of tray and fittings using manufacturer's standard shouldered ends, fish plates, or couplers, with galvanized or zinc plated slotted domed head 'roofing' bolts, nuts, washers and shakeproof washers.

The Material shall be hot rolled steel galvanized after manufacture to BS EN 10327 or BS EN 10143.

Trays and rack are to be supported from building fabric with minimum clearance behind of 20mm. Install fixings at regular intervals to prevent visible sagging when loaded, with maximum spacing 1.2m and 230mm from fittings.

Keep cutting of cable tray to a minimum. Cut along a line of unperforated metal. Make good finish with zinc rich paint, primer and top coat, or two pack epoxy paste, as appropriate to tray material and finish.

Fit holes cut in tray for passage of cables with grommets, bushes or other lining.

Install all bolts, fixings and hangers with threaded portion away from cables. Cable routes to cross at right angles or spacing to BS EN 50374.

Cable cleats shall be one piece or single way pattern or claw pattern or two bolt pattern. Manufactured from Die cast aluminium alloy; moulded black polyethylene; or nylon.

### 300.140 MODIFICATIONS TO BMS

The proposed works to the BMS system is described in the mechanical portion of this specification.

The contractor shall allow for the installation of all containment required for the installation of the BMS.

### 300.150 FIRE DETECTION AND ALARM INSTALLATION

The contractor shall modify the existing fire alarm circuit in the chiller room where necessary to suit the alterations indicated to plant and equipment on the FHPP Drawings.

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All works, including device disconnection and reconnection, programming and commissioning shall be undertaken by the Honeywell the Bank's incumbent fire alarm maintenance provider.

Any alteration in the area of works which forms part of the Banks system shall only be worked on, out of office hours, and with the permission of the Client. Areas requiring alteration shall be taken off line whilst works are carried out, and the client informed with regard to the system being on or off line.

### 300.160 EARTHING SYSTEM

An earthing system shall be provided to conform with BS7671:2001, BS7430:1991 and local electricity supply authority guidelines:

The Equipotential bonding conductors shall include, but not be limited to:

- Drainage pipework
- Ventilation ducts
- Mechanical services pipework
- Mechanical Plant
- Domestic hot & cold water pipe
- Cable ladders/trays/trunking/conduit
- All conductors shall be sized in accordance with BS7671:2001.
- Cable Trunking and Trays

The ends of protective conductors which are to be connected to the earth bar shall be terminated in a crimped cable socket, and bolted separately to the earth bar using brass bolts, nuts and washers with locking arrangements.

Each connection to the earth bar shall have an engraved label fixed to the cable.

Existing bonding in the area of works shall be checked for compliance and modified were necessary.

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## SECTION 6.00 – Chilled Water Pipework and Fittings

### PART 1 SYSTEM OBJECTIVES

#### 100.010 PERFORMANCE OBJECTIVES

Install set and commission a fully functional chilled water system with all pipelines and ancillaries as set out in this specification.

### PART 2 SPECIFICATION CLAUSES SPECIFIC TO THIS PROJECT

#### 200.010 CHILLED AND CONDENSER WATER PIPELINES

The Contractor shall supply and install all pipework and fittings as indicated on the drawings and described in the specification. All new chilled and condenser water pipework shall be installed in heavy grade steel tube to BS 1387 up to 150 mm and AP15L Sch20 Welded tube for the pipework above 150 mm with welded joints and fittings as detailed in PART 3 GENERAL REQUIREMENTS.

Where required, unions shall be used on pipework, up to and including 50mm, whilst 65mm and above shall be flanged.

All pipework and fittings shall be thermally insulated in full accordance with section 100.030 Thermal insulation shall be CFC free foil faced phenolic foam installed fully in accordance with manufacturer requirements and recommendations. Aluminium cladding will be required within all plantroom areas and where exposed externally.

The systems shall be duly pressure tested, flushed, cleaned and treated with inhibitors as per section 3.3 prior to commissioning.

All chilled water services pipework shall be installed as a traditional two pipe flow and return system complete with all necessary draining, venting, commissioning and isolation valves required to commission and maintain the system.

#### 200.020 CHILLED WATER VALVES AND FITTINGS

##### Motorised Valves

A motorised control valves are to be provided generally on chilled and condenser water connectors to the chillers, generally as shown on the tender drawings and described elsewhere in this specification. The motorised valves are to be fully lugged butterfly valves provided with a 0-10 V actuators.

The motorised valves are to be manufactured by Keystone (or equal and approved) and to be:-

HiLok tyco lugged valve bodies w/ EPI<sub>2</sub> modulating matching actuators.

##### Isolating Valves

The following valves are to be provided and fixed as required by the Specification and/or shown on the Drawings. Generally isolating valves are to be provided with handwheels whilst regulating valves are to be of the same pattern but of the lockshield type. The isolating valves are to be:-

##### *Cast Iron Fully Lugged Butterfly Valves*

Cast iron butterfly valves for closed circuits shall be constructed to BS.5155 with a pressure rating of PN16. Castings for bodies, bonnets, yokes, stuffing boxes and wedge shall be grey cast iron conforming to BS.1452 grade 110. All valves to be lever-operated, with a latch to hold the valve's



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disc in the fully open and fully closed (and intermediate) positions. To give tight shut-off when closed against 10 bar pressure, with the low-pressure side drained. Approved isolating valves or equal and approved are Hattersley and of the exact type as set in the valve schedule.

Flanges are to be to B.S.4504, Table 6/11, wherever the manufacturer's standard range allows, whilst screw threads are to be to B.S.P.T. Where valves are bolted to other items, the Contractor is to ensure that flanges are compatible.

#### Double Regulating Valves

The double regulating valves are to be provided as required by the Valve Schedule and in positions shown on the Drawings for regulating the water flow rate. The degree of opening of the valve during commissioning is to be set on the 'stop' on the valve to enable it to be repeated. Plug to be characterised to give good regulation over the full travel of the spindle. Pressure drop/flow curves are to be provided for all valves installed. Approved double regulating valves are Hattersley and of the exact type as set in the valve schedule (or equal and approved).

Cast iron double regulating valves shall be constructed to BS.5152 with a pressure rating of PN16, be of the oblique pattern with characterised disk, bronze trim, bolted bonnet and bolted gland. Castings for bodies, bonnets, yokes and disks shall be grey cast iron conforming to BS.1452 grade 220. Valves shall incorporate a lockable double regulating device and position indicator. Pipe connections shall be to BS.4504

#### Metering Stations

Metering stations are to be provided adjacent to every double-regulating valve (except those with integral flow measurement tappings and those in the by-pass connections of 3-port valves), and in any other locations required by the Specification and/or shown on the Tender Drawings, for measuring water flowrates. Each metering station is to be supplied with two test plugs, complete with captive blank safety caps, to obtain a pressure drop signal. The pressure drop/flow curves are to be provided for all metering stations installed.

Metering Stations                      Gunmetal screwed body.

(50 mm and under)

Metering Stations                      Stainless steel for connecting between flanges.

65 mm and over:

Approved metering stations are Hattersley and of the exact type as set in the valve schedule (or equal and approved).

The Contractor is to ensure that straight lengths of steel tube, of the same size as the valve, are provided upstream and down stream of each metering station, to the distances recommended by the manufacturer.

#### Plantroom Drain off Valves

At all low points and on the downstream side of all isolating valves and wherever else shown on the drawings, and elsewhere as necessary to ensure that all sections which may be isolated may also be drained.

Copper alloy drain cocks for closed circuits shall be suitable for service conditions of 10 bar and 120 deg C and be of the glanded type. The pipe connection shall be threaded male parallel to BS.2779 with hose union outlet, cap and strap.

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Approved drain cocks are Hattersley and of the exact type as set in the valve schedule (or equal and approved).

Drain valves are to be fully in accordance with B.S.2879.

#### Air Vent

Wherever high points or other air traps occur, the Contractor is to supply and fix an air release unit or 'bottle' comprising a 75 mm length of 32 mm nominal bore pipe with 6 mm nominal bore tube to an air cock fitted in an accessible manner, so that all sections are efficiently vented. In all Plant Rooms and wherever else specifically noted, air vents are to be of the automatic float type made by Charles Winn Ltd., Type A or other equal and approved, with lockshield isolating valve, discharging to the nearest drain or to atmosphere through a 15 mm copper drip pipe terminated with mitred end.

Automatic air vents are not to be fitted to pipework which may be at negative pressure under certain conditions of service, or at a negative static pressure with all pumps and any pressurising devices turned off. Air 'bottles' as described above are to be provided instead in these locations.

#### Strainers

Where indicated on the Drawings, the Contractor is to supply and install 'Y' type strainers with B.S.P.T. connections and gunmetal body on sizes up to 50 mm, and flanged cast iron body on sizes 65 mm and above. All units to include stainless steel strainer element and have integral tapped test points either side of the element plus gland cock (for draining purposes) in the cap/cover. Flanged strainers are to also incorporate a magnetic core element in the cover plate. Screwed strainers are to incorporate a hose-connection gland cock in the plug.

Approved strainers or equal are Hattersley and of the exact type as set in the valve schedule.

#### Non Return Valves

Non return valves are to be provided on the discharge pipelines of individual pumps and in other locations required by the Specification and/or indicated on the drawings. All non-return valves are to be suitable for both horizontal and vertical pipelines.

Non Return Valve            Swing check pattern to B.S.5154 PN25. Gunmetal or Bronze  
(50 mm and under)        body screwed to B.S.21 taper.

Non return valves            Wafer pattern to BSEN 1092-2 flanged connectors  
(65 mm and above)        to B.S.1452 GR220 cast iron body, Gunmetal disc and EPDM seal.  
Approved non return valves or equal are Hattersley and of the exact type as set in the valve schedule.

#### Test Points

To assist with commissioning, self-sealing pressure/temperature test plugs are to be fitted in the locations listed below, and wherever else shown on the Drawings or called for in other Sections of this Specification. Each is to be fitted to the side of the pipe to prevent collection of air or scale. Each is to be complete with a screw-on brass cap, and is to be suitable for the fluid in the pipe throughout its range of operating temperatures and pressures.

Test points to be constructed from a single piece of copper alloy body with two Elastomeric cores to provide a dual seal to prevent leakage when withdrawing P/T probes. The cap is to have an "O" ring seal allowing positive finger tightening.

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Test points to be Figure 631 "standard" length when fitted directly to uninsulated pipework/components, and Figure 633 "extended" type for insulated pipework/ components.

To be manufactured by Hattersley.

or equal and approved.

#### Pressure Gauges

The Contractor shall supply and install in the positions indicated on the drawings, (including the schematic layout) and where described in the specification pressure gauges. Pressure gauges shall have 100mm diameter dial faces. Gauges shall be selected such that the working pressure is mid-point on the scale. Prior to placing orders for the gauges the Contractor shall check with the engineer to confirm the ranges of the gauges being proposed. Unless otherwise detailed, all gauges shall be pipework mounted on brass ring siphon tubes and be preceded by a gauge cock.

#### Temperature Gauges

The Contractor shall supply and install in the position indicated on the drawings (including the Schematic layout) and where described in the specification, temperature gauges. Temperatures gauges shall have 100mm dial faces. Gauges shall be selected such that the operating temperature is mid-point on the scale. Prior to placing orders for the gauges the Contractor shall check with the engineer to confirm the ranges of the gauges being proposed. Unless otherwise detailed, all gauges shall be pipework mounted and be of the vapour pressure type with brass pipe insertion pocket of suitable depth for the location.

#### Flexible Connections

On the suction and discharge connections of all chilled and condenser water pumps, and the chillers, "tied" flanged rubber flexible connections are to be installed, of the same size as the pipe concerned, to provide a degree of isolation between equipment and pipework.

Rubber type to be selected to suit the fluid concerned, over its whole range of operating temperatures and pressures. To be as manufactured by Powerflex Ltd. their 'Elaflex' range or equal and approved.

### 200.030 THERMAL INSULATION

The Contractor is to include the provision and fitting of thermal insulation of the type, grade and thickness all as specified later but generally to:-

- All new chilled and condenser water pipework (except gdrains, and overflows) within plantroom on the ground floor and externally in the temporary chiller location.
- The areas where modifications and replacement of the pipework and valves was undertaken.

Insulation is to be installed in a neat manner, and particular attention to neatness is required in the plantroom and other areas where it is exposed to view. The method of installation of each type of insulation is to be strictly in accordance with the manufacturer's recommendations. All insulation is to be in accordance with B.S.5422:2001 and the appropriate thickness tables therein. The thermal conductivities of the insulating materials and tables to be used are as listed below.

All insulation shall be zero ODP and a maximum GWP of 5 such as phenolic foam as manufactured by Kingspan Kooltherm, installed fully in accordance with their requirements and recommendations. A complete vapour seal shall be made to all insulated ductwork, even at support points by the use of spacer Kooltherm or wooden blocks at pipe clips and brackets.

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A Class O foil finish shall be applied throughout, with matching 100mm wide self-adhesive Class O tape.

(a) Internal Pipework:

Use Table 8, for contents at 5°C and a thermal conductivity of 0.040 W/(m·K) for Mineral Wool and 0.020 W/(m·K) for Phenolic Foam.

(b) External Pipework:

Use Table 23, and a thermal conductivity of 0.035 W/(m·K) for Mineral Wool and 0.020 W/(m·K) for Phenolic Foam.

(c) Trace Heating

Where pipework has trace heating tape along its length, due allowance is to be made for "pipe insulation" size to accommodate same. The thickness of insulation should also be as recommended by the trace heating tape manufacturer if thicker than B.S.5422:2001 This applies to HWS pipework for maintaining the "hot" temperature or any other pipework for freeze protection.

All flanges and valves on insulated pipework of 65 mm nominal bore and larger are to be fully insulated. Valves flanges and all other fittings on chilled and cold water pipework are to be fully insulated and vapour sealed.

All flanges, valves, and other fittings which are to be insulated on any pipework are to be enclosed additionally in removable buckle-fixed 0.6 mm Stucco Aluzink (Dobelshield) enclosures.

All services in the plantroom external/or which are less than 2.5 metres above floor level to their underside, are to be fully insulated and finished with 0.6 mm Stucco Aluzink (Dobelshield) sheet metal.

All insulation is to have a factory applied finish of "Bright Class 0" reinforced aluminium foil. The Contractor is to be responsible for ensuring that no paint or other covering is applied to the surface of any portion of the insulation that will impair its Class 0 rating.

Any insulation work which is at variance with the specified requirements, or which exhibits inferior workmanship, is to be removed and subsequently replaced free of charge.

All pipes are to be insulated individually, and not in groups of two or more, and there is to be a minimum of 25 mm clearance between finished surfaces, and 25 mm finished clearance from any building surfaces unless otherwise specified. The Contractor is to ensure that all pipes and ducts are installed so as to meet this requirement. Any variation from this requirement must have the approval of the Consulting Engineers prior to the installation of the pipework.

Care is to be taken that no insulation or cladding by-passes or interferes with any vibration isolation provisions.

The Contractor will be responsible for the protection of all equipment during the application of insulation and is to promptly remove all waste, surplus material, and packaging from the site. All un-insulated plant and equipment is to be thoroughly cleaned and left clear of fouling by insulating materials.

No thermal insulation work is to be put in hand until after the satisfactory completion of leakage testing, as specified elsewhere.

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The Contractor is to state on the Summary of Tender the name of the firm or firms to whom the insulation work will be sub-contracted. The firm selected must be of good repute, and a member of the Thermal Insulation Contractors Association.

All services are to be insulated in the following manner.

(a) Chilled Water Pipework generally

To be insulated with rigid preformed sections of "Kingspan Kooltherm Phenolic Foam" or "Knauf Crown Glassfibre" or "Rockwool Rockfibre", each having a factory applied reinforced aluminium foil facing material, or equal and approved. Finish to be Class 'O' as specified by the Building Regulations, Approved Document B. Sections are to be close-buttet, and all longitudinal and circumferential joints are to have an overlap of facing material of not less than 50 mm. Overlaps and butt joints to be well sealed with an adhesive or self-adhesive foil tape approved by the insulation manufacturer and conforming to the Class 'O' requirements. Sections are to be taped into mitred lengths to run in uniform thickness around all bends, sets, and tees. Vapour barriers are to be maintained thorough.

(b) External Chilled Water Pipework

External pipework and fittings are to be insulated as for chilled water pipework generally, but with the following further requirements.

The insulation is to be finished with a covering of Aluzinc 0.6mm Thick "Stucco" finish metal cladding fitted so as to have joints beneath to shed water and with all valves and flanges fitted with lined removable purpose made metal boxes, with quick release metal toggle fasteners.

Cladding to be secured by self-seal pop rivets.

It should be noted that the chilled water flow and return pipework external to the Plantroom is to be electrically trace heated as specified elsewhere, and the insulation sections, support brackets, etc. are to allow sufficient space for this. Sections are to be close-buttet, and all longitudinal and circumferential joints are to be sealed by having overlap of facing materials of not less than 50 mm sealed with an adhesive. Alternatively all butt joints sealed with Idenden T303 aluminium foil adhesive tape as approved by the Insulation manufacturer to form a complete vapour barrier and weathering seal.

Sections are to be formed into mitred lengths to run in uniform thickness around all bends, sets, and tees.

At all pipe support brackets (Kooltherm or similar), high density pipe insulation support units, of a thickness equal to the pipe insulation thickness, are to be installed, with the pipe clips installed over the weatherproof finish. Insulation sections are to be close-buttet to these units, sealed with foil faced Class "O" tape and the weatherproof finish taken over the joints, with the completed work giving a reliable vapour-proof and weather resistant finish.

Flanged joints are to be insulated with oversized insulation sections and site-cut rigid slab sections with the weatherproof finish neatly dressed over the complete assembly, all sealed in accordance with the manufacturer's recommendations. All external valves, including metering stations, are to be insulated with 50 mm flexible mineral mat (Ductwrap) covered in Bright Class 'O' faced foil with all joints taped to maintain the vapour seal around the valve and the adjacent pipework. The valves and flanges are to have a removable 0.6 mm Stucco Aluzink (Dobelshield) box which is to have an internal insulated lining with vapour seal, to avoid damage to the valve insulation when the box is removed and re-fitted.

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The Contractor is to ensure that even minor items (e.g. pipes to sensors, etc.), are fully insulated to prevent freezing and, where main pipes are trace heated, the minor items are also to be trace heated.

It should be noted that during the course of commissioning, access will be required to double regulating valves, metering stations and test points, and due allowance should be made for removal, replacement, temporary weathering and making good of insulation as necessary .

(c) Chilled Water Pipes in Plantrooms and External Areas

To be insulated as described in (a) above, with an additional cover of 0.6 mm Stucco Aluzink (Dobelshield) finish sheet metal, where required by Clause M8.2(c), with sacrificial layer.

Valves are additionally to have a removable 0.6 mm Stucco Aluzink (Dobelshield) - cover, as in (a) above.

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Based on B.S. 5422 : 2001 Table 8 - Thickness of insulation for chilled and cold water supplies to prevent condensation on a low emissivity outer surface with ambient air conditions of 25°C and 80% rh.

Steel pipe size (mm)		Temperature of water (°C)					
		+10		+5		0	
NB	OD	Phenolic Foam	Mineral Wool	Phenolic Foam	Mineral Wool	Phenolic Foam	Mineral Wool
15	15	15	20	15	25	20	30
20	27	15	25	15	30	20	40
25	34	15	25	20	30	25	40
32	42	15	25	20	30	25	50
40	48	15	30	20	30	25	50
50	60	15	30	20	40	25	50
65	76	20	30	25	40	30	50
80	89	20	30	25	40	30	50
100	114	20	30	25	40	30	50
150	168	20	40	30	50	35	60
200	219	20	40	30	50	40	60
250	274	25	40	30	50	40	65
300	324	25	40	35	60	40	65
Vessels and flat surfaces		30	50	40	65	50	80

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Based on B.S.5422 : 2001 Table 23 - Minimum thickness of insulation required to give protection against freezing under specified commercial and institutional conditions.

Initial water temperature		+ 2°C		+ 2°C	
Minimum ambient temperature		-6°C (indoor unheated areas)		-10°C (outdoor)	
Evaluation period		12 hours		12 hours	
Permitted ice formation		50%		50%	
Pipe size (mm)		Thickness of insulation (mm)			
O. Diameter	Bore	Phenolic Foam	Mineral Wool	Phenolic Foam	Mineral Wool
Copper Pipes					
15,0	13,6	23 (25)	78 (80)	68 (70)	413 (420)
22,0	20,2	10 (15)	23 (25)	21 (25)	58 (60)
28,0	26,2	7 (15)	13 (20)	13 (15)	28 (30)
35,0	32,6	5 (15)	10 (20)	9 (15)	18 (20)
42,0	39,6	4 (15)	7 (20)	7 (15)	13 (20)
54,0	51,6	3 (15)	5 (20)	5 (15)	9 (20)
76,1	73,1	2 (15)	4 (20)	4 (15)	6 (20)
108,0	105,0	2 (15)	3 (20)	3 (15)	4 (20)

Table 23 - continued



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Pipe size (mm)		Thickness of insulation (mm)			
O. Diameter	Bore	Phenolic Foam	Mineral Wool	Phenolic Foam	Mineral Wool
Steel Pipes					
21,3	16,0	18 (20)	48 (50)	44 (45)	173 (175)
26,9	21,6	10 (15)	21 (25)	20 (20)	52 (60)
33,7	27,2	7 (15)	14 (20)	13 (15)	29 (30)
42,4	35,9	5 (15)	9 (20)	9 (15)	17 (20)
48,3	41,8	4 (15)	7 (20)	7 (15)	13 (20)
60,3	53,0	3 (15)	6 (20)	5 (15)	10 (20)
76,1	68,8	3 (15)	4 (20)	4 (15)	7 (20)
>88,9	> 80,8	2 (15)	4 (20)	3 (25)	6 (25)

#### NOTES:

Thicknesses given are calculated specifically against the criteria noted in the table. These thicknesses may not satisfy other design requirements. The thicknesses shown in brackets are nearest the standard thicknesses available from manufacturers.

Some of the insulation thicknesses calculated are too large to be applied in practice but are included to highlight the difficulty in protecting small diameter pipes against freezing. To provide the appropriate level of frost protection to certain sizes of pipes, it may be necessary to provide additional heat to the system, for example by thermostat controlled water circulation of the water and/or trace heating.

All pipework to be insulated with minimum thickness 25mm phenolic foam internally and 40mm phenolic foam externally, where the pipework is trace heated.

## 200.040 SUPPORT AND HANGERS

All pipes are to be supported where shown on the drawings and elsewhere as necessary particularly within 150 mm on each side of all changes in direction and everywhere at intervals not exceeding the following:

(a) Mild Steel Pipes

Nominal Bore	Vertically Fixed	Horizontally Fixed
	(Metres)	(Metres)
15 mm	2.5	1.8
20 mm	3.0	1.8
25 mm	3.0	2.1
32 mm	3.0	2.4
40 mm	3.5	2.7
50 mm	3.5	3.0
65 mm	4.5	3.4
80 mm	4.5	4.0
100 mm and above	4.5	4.0

(b) Copper Pipes

Diameter	Vertically Fixed	Horizontally Fixed
(o.d.)	(Metres)	(Metres)
15 mm	1.2	1.0
22 mm	1.2	1.0
28 mm	1.8	1.2
35 mm	1.8	1.2
42 mm	2.5	1.8
54 mm	2.5	1.8
76 mm and above	3.0	2.5

(c) Plastic Pipes

Diameter	Vertically Fixed	Horizontally Fixed
(o.d.)	(Metres)	(Metres)
Up to 50 mm nominal	1.2	1.1

(d) Generally

Steel pipes of 80 mm nominal bore and under, and copper pipes of 76 mm o.d. and under, having an operating temperature less than 95°C, running singly or in pairs, vertically or horizontally, where exposed to view are to be supported by screw-on-type brackets, all

made by Bryson Brackets Ltd., or other equal and approved. Where concealed, and in plantrooms, Unistrut or approved equal may be used.

All supports rods to clips are to have appropriate anti-vibration spring or rubber noise suppression units fitted.

Build-in brackets are to be of the long shank type while screw-on type brackets are to have a minimum of two fixing screws. In either case the half hoop to pass round the pipe is to be secured by a single screw.

Brackets are to be of malleable iron for mild steel pipes, galvanized for galvanized pipes and chromium plated for chromium plated pipes. Brackets for copper pipes are to be of cast and not stamped brass.

Steel pipes larger than 80 mm nominal bore, and copper pipes larger than 76 mm o.d., and all multiple runs of pipe are to be supported on angle iron or equal bearers.

All vertical pipes in vertical ducts are to be supported on specially fabricated mild steel brackets supported from the back wall of the ducts. The detail of the brackets proposed to be forwarded to the Consulting Engineers for comment/approval. All copper pipes supported by this type of bracket to be protected from contact with ferrous metal by 'asbestos-free' ring tape 25 mm wide x 6 mm thick.

All pipes likely to operate at 40°C or over and supported by bearer brackets are to be supported from their undersides with cast iron or non-ferrous chairs and rollers. The Contractor may propose alternative sliding support arrangements for consideration.

Wherever hangers or bolts are to be suspended from the soffit where no insert is provided, the hanger or bolt is to be taken through the concrete slab to a 100 mm square backplate with nuts and washers, except in the case of single steel pipes.

of 65 mm nominal bore and under, and in the case of single copper pipes of

54 mm o.d. and under.

## 200.050 IDENTIFICATION

All pipes and items of equipment, are to be identified in strict accordance with the established Colour Code or with B.S.1710 and are to be further marked for direction of flow. Such identification is to be applied at intervals not exceeding 16 metres, and more frequently as necessary for clarity where any confusion might otherwise exist, including plantrooms (where identification is to be applied to each straight length). All pipework that is trace heated is to be identified as such at a maximum of 3m centres.

## 200.060 TRACE HEATING

The temporary chiller chilled water pipework in the generator room and externally in the temporary chiller compound is to be trace heated with self regulating tapes below the insulation. The trace heating is to be fed from and controlled by the Temporary Chiller Control Panel.

The rating of the tapes must be sufficient to maintain the frost protection of the water in the pipe at 10°K above outside ambient.

The heating tapes are to be moisture-proof and rated at approximately 10 Watts per metre. Each length of tape is to terminate in a waterproof junction box. Tapes are to be spiralled around the pipes, at the pitch necessary to achieve the 10°K differential temperature for the size of pipe concerned. The installation is to be strictly in accordance with the manufacturer's recommendations. Any fittings, valves, air vents, etc., are to be traced.

To be manufactured by:  
Tyco Thermal Controls  
3 Rutherford Road  
Stephenson Industrial Estate  
Washington  
Tyne and Wear  
NE37 3HZ  
Tel. No. 0800 169 6812  
**their Type FS-A-2X**  
or equal and approved.

#### 200.070 FIRE STOPPINGS AND SLEEVES

In all cases where pipes of any service pass through walls, floors or ceilings, the pipes are to be enclosed by sleeves of similar metal to the pipe concerned, and such sleeves are to be of a size to permit free movement of the pipe and carefully cut to length. The Contractor is to acquaint himself with the nature of the wall finishes, and is to co-ordinate his work with the Main Contractor. A neat finished appearance is required.

Where the wall is fire-resisting, oversize sleeves are to be used, and the annular gap is to be packed with suitable fire-resisting material and sealed with intumescent paste.

#### 200.080 ANTI-VIBRATION PADS

Except where higher performance anti-vibration measures are specified, or are necessary to meet the noise limitations specified, the Contractor is to supply only a 25 mm thick 'Ticopad' or equal and approved anti-vibration pad for each pump and temporary chiller or other machine which he is supplying under this Contract and which is to be erected on a concrete base. The pads are to be incorporated onto the base by the Main Contractor.

#### 200.090 PIPELINE WORKMANSHIP

This Section describes the procedure and/or the methods of installation of pipelines and materials etc., to the Standard Requirements of the Consulting Engineers, and is to apply to this Contract, where appropriate, in extension and amplification of the general intent and meaning of the basic descriptions given elsewhere in this Specification and the associated Drawings.

The contractor is to allow for taken welding testing samples to minimise the risk of developing crevice corrosion and to identify the proper materials and practices that are to be used.

#### **Mild steel pipework**

All mild steel pipework is to be run in the quality of tubing later specified with joints, whether screwed, welded or flanged, as stipulated, all to the relevant British Standard. Unless otherwise later specified, pipework of size 50 mm or less to which there is easy access is to be screwed. Other pipework is to be welded.

Screwed joints are to be of British Standard pipe thread, clean threaded and pulled up tight. Joints are to be made with an approved graphite compound and fine threaded hemp or P.T.F.E. tape only. Red lead will not be allowed.

Welded joints are to be in accordance with the requirements of Clause G3.5.

Flanged joints are to be made by screwing on screwed pipework or welded on welding pipework to the ends of the pipes drilled flanges, the flanges to be turned on edge faced full across. The ends of the pipes are to be flush with the face of the flanges.

The two flanges forming a joint are to be flush with one another all round when in position, with all bolt holes in alignment. The joints are to be made with Klingerite or other equal jointing materials, full faced, specially stamped and not cut from sheets on Site, arranged to fit concentrically with the bore of the pipe, and in no way to obstruct the bore of the pipe.

### **Mild steel pipework fittings**

#### **(a) Screwed Pipework**

Malleable iron long and easy sweep, beaded or banded fittings are to be used for screwed and socketed work. Square tees will not be used except where open vents are taken off, or for non-circulatory branches. Eccentric reducing sockets are to be used where changes in pipe sizes occur. Unions are to consist of two screwed halves, with ground spherical faced joints between the two faces, and one of the two faces is to be of bronze. (ie.

#### **(b) Welded Pipework**

##### **Testing Samples**

The Contractor is to allow for 10% of all welds to be X-rayed. If defects are found a further 10% of all welds at contractor cost are to be tested. This process is to be continued and repeated until all defects are eliminated.

##### **Welding General**

Tee branches of smaller bore than the bore of the main are to be welded on site, generally, but not without exception, with a "lead" in the direction of the flow, while branches of equal bore to that of the main are to be prefabricated with ends for butt welding to the appropriate British Standard. Welds shall be suitably assembled to ensure that no crevices are introduced where corrosion may occur.

Bends are to be purpose made, seamless, mild steel, of the same grade as the line, with ends for butt welding, while springs and sets are to be purpose made on the site, cold drawn to a radius of not less than six times the nominal bore of pipes of 50 mm nominal bore and under, and hot bent to a radius of not less than three times the nominal bore of pipes of 65 mm nominal bore and over. In pipes of 80 mm nominal bore and under, the seams are to be arranged along the sides of the springs and sets where possible, or where not possible along the inside radii of springs and sets.

Reducing pieces may either be prefabricated or cut, swaged and welded on Site, with the pieces in either case butt welded into the lines.

Mild steel flanges are to be used for flanged pipework, with welded bosses. Particular care is to be taken to ensure that branch pipes do not protrude into the bore of the main, and that no welding material projects into either of the tubes.

The Consulting Engineers may require to inspect any or all of such pipework before it is installed to ensure that these conditions have been complied with.

Sample tests of welds are to be carried out. To be not less than 1% of the welds on the project, nor less than 3 per welder. Results are to be recorded, and submitted to the Consulting Engineers.

### **Copper pipework and fittings**

All copper pipework is to be run in the quality of tubing specified, with the joints, whether soldered, screwed, brazed, bronze welded or flanged, as stipulated, all to the relevant British Standard.

Flanged joints are to be made by brazing insert-type flanges, with copper alloy inserts and loose steel locking rings, to the ends of the pipe, otherwise as for steel flanged joints except that brass bolts are to be used.

Joints in the run of pipes of 54 mm O.D. and over, in closed-circuit systems only, may be made by bronze welded butt joints in accordance with the requirements of Clause G3.5.

Bends, sets and springs are to be either prefabricated or cold drawn on Site by machine to a radius of not less than six times the nominal bore of the pipe, while branches are to be connected to gunmetal tees. All bends whether prefabricated or made on Site are to be annealed before fixing in place.

Where light gauge copper tube to B.S.2871 Part I is specified the tube is to be manufactured from de-oxidised arsenical copper to B.S.1174.

Light gauge copper tubes and fittings is to be installed in accordance with the manufacturer's directions and using any special tools or fluxes etc., recommended.

The use of old or re-drawn copper tube will not be permitted.

Where it is necessary to connect light gauge tube to iron or gunmetal valves or apparatus, straight through adaptors are to be used where the valve or apparatus is screwed and flanged adaptors are to be used where the valve or apparatus is flanged. Flanges are to be to the relevant B.S. Table, installed as described elsewhere.

### **Pipework generally**

All pipework is to be delivered to site in manufacturers' random lengths and straight runs are to incorporate full lengths. No piecings of short cuttings or the use of long screw connections and backnuts will be permitted. All pipework will be left free from excessive tool marks, distortion of section, or other defects.

Pipe jointing is to be non-toxic used with the minimum of P.T.F.E. tape or hemp. All surplus hemp jointing is to be cleaned off threads and fittings before it hardens.

Reducing pieces are to be eccentric unless otherwise specified, and welded or screwed in the lines as applicable.

All ends of pipe are to be reamed before fixing to remove the burr. Particular care is to be taken to ensure that all vertical pipework is parallel with the adjacent walls and at right angles to the walls and ceilings. Any pipes which, in the opinion of the Consulting Engineers, are not fixed in accordance with the above, are to be removed and refixed at the Contractor's expense. Generally,

pipes are not to be fixed at less than 75 mm clear from ceilings and floors without written sanction to do so from the Consulting Engineers.

The Contractor is to take special care to prevent dirt or rubbish entering the open ends of pipework during erection. Appropriate metal or plastic screwed caps or wood plugs only are to be used to prevent this occurring; plugs of waste or wool are under no circumstances to be used. Should any stoppage in the circulation occur, after the various systems have been put into operation, the Contractor is to attend and rectify the matter at his own expense.

Pipework which is to be insulated is to be fixed in such a manner as to allow each pipe to be insulated around its full circumference, leaving 25 mm minimum between the insulation of any pipe and the finished surfaces of the building or any other pipework, insulation, or other services. Any such pipework incorrectly fixed is to be removed and refixed correctly at the Contractor's expense.

Wherever it is possible to do so, pipework is to be fixed in such a manner that subsequent access to any pipe can be made without disturbing the other pipes. No joints of any kind are to be made within the thickness of walls, floors, or ceilings, or in a vertical duct without permanent access.

In screwed pipework of 50 mm nominal bore and under, unions are to be provided in all cases where they may be required to enable sections of pipework to be subsequently dismantled and refixed without disturbing the building fabric and in any event at intervals not exceeding 12 metres on straight runs. All pipework larger than 50 mm nominal bore/ 54 mm o.d. and all flanged pipework of 50 mm nominal bore and below is to be provided with flanges for the connection of valves, expansion joints, fittings etc., and pairs of flanges in all cases where they may be required, to enable sections of pipework to be subsequently dismantled and refixed without disturbing the building fabric and in any event at intervals not exceeding 12 metres on straight runs.

All pipework and fittings are to be installed at least 150 mm clear from electric conduits and wiring, after allowing for the thickness of any insulation.

### **Anti-electrolytic couplings**

The Contractor is to provide and fix, between copper pipe and all galvanized steel and mild steel pipework and vessels, non-ferrous couplings of an approved type to inhibit electrolytic action.

### **Protection of pipes**

All tubes delivered to the site by the Contractor are to be unpainted and are to be given one coat of an approved preservative before despatch. While stored on site care is to be taken to prevent the tubes from rusting and they are to be properly racked and covered, the necessary racks and covers being supplied by the Contractor.

No installed tubing showing evidence of corrosion will be permitted to be put into service.

### **Pipe grading, air release and draining**

All pipes are to be carefully graded to a rise or fall to facilitate the removal of air and for the complete draining of lines for maintenance purposes, and otherwise as specified.

Wherever high points or other air traps occur, or as noted on the tender drawings the Contractor is to supply and fix an air vent terminals. At all low points and on the downstream side of all isolating valves and wherever else shown on the drawings, and elsewhere as necessary to ensure that all sections which may be isolated may also be drained, the Contractor is to provide a drain valve as specified in this Specification.

## Pipe expansion and anchoring

In the pipework of any service likely to operate at 40°C or over, arrangements are to be made for thermal expansion to be taken up by change of direction or by the installation of expansion joints.

In all cases, free guided movement of pipes is to be maintained and static points are to be arranged between joints by the installation of suitable anchors.

Expansion at changes of direction, expansion joints and anchors are to meet with the following requirements:

The Contractor must ensure that expansion movements do not give rise to noise. Pipes, heat emitters, etc., must be supported on Teflon skids, or hung on swivelling suspension rods, or by other effective means, to eliminate expansion/ contraction noises.

### (a) Expansion at changes of direction

Wherever this is possible bends are to be opened during erection to the full extent of their cold draw.

Where expansion is planned to take place through a change in the direction of the line of the pipe, 'U' bolt guides are to be omitted on the pipe supporting brackets immediately around the bend, in order to permit lateral movement of the pipe.

### (b) Expansion Joints

Expansion joints are to be of the corrugated stainless steel bellows type having outer sliding sleeves and end flanges to the appropriate B.S. Table, as made by Vokes Ltd., Engineering Appliances Ltd., or other equal and approved. All expansion joints are to be compatible with the material of the pipes into which they are fitted.

All expansion joints are to be opened during erection to the full extent of their cold draw, while two suitable purpose-made guides are to be provided on each side of each expansion joint, at spacings as recommended by the manufacturer of the expansion joints, to ensure that expansion takes place in correct alignment.

The greatest care is to be exercised in following the maker's instructions for installation and especially for the hydraulic testing of lines containing expansion joints.

### (c) Anchors

Rigid anchors are to be generally similar to the supporting bearers previously specified with the exception that the rollers are to be replaced by a small piece of RS channel shorter in length than the diameter of the pipe and cut to the radius of the outside surface of the pipe.

This RS channel is to be fixed to the supporting brackets and the pipe rigidly anchored by means of 'U' bolts bent to the radius of the outside surface of the pipe and clamped in position with a locknut on the underside of the flange of the supporting bracket. The supporting bracket is to be suitably braced and fixed to the structure so as to withstand rigidly the maximum load imposed upon it. The Contractor is to supply the Structural Engineer with details of the loads on each anchor bracket, and obtain his approval to the design and location of each bracket. The anchor is to be located approximately mid-way between the points at which provision for expansion is made.

## Testing and scouring



Upon completion, and before insulation, burying or encasing of each section of pipework on all pipework systems, the Contractor is to subject the section to pressure testing and demonstrate to the satisfaction of the Consulting Engineers or other approved witness that the Section is sound.

The testing procedures are to be in accordance with the H.V.C.A. "Guide to Good Practice for Site Pressure Testing of Pipework", published in 1980.

Each witnessed test is to be for a duration of one hour, or such longer time as is necessary to inspect all valves and joints on the section being tested. The decision as to whether or not the section is sound being governed by the rate at which the pressure fails, together with visual inspection of all joints.

All faults discovered during such tests are at once to be remedied by the Contractor at his own cost and expense, and the test re-applied until the Consulting Engineers are satisfied that the section under test is sound.

On completion of the test, the water is to be released and drained completely away as rapidly as possible, the section being then thoroughly sluiced through to ensure the removal of as much dirt and dross as possible before being refilled and put into service.

On lines in which filling points, air release points and drains have not been specified as a permanent feature, they are to be provided by the Contractor to enable the lines to be tested. In these cases, the Contractor is to weld into the crowns and the inverts of the lines at appropriate points 15 mm wrought steel sockets which, on completion of the test, are to be plugged and sealed by welding around the plug.

The Contractor is to include for all drain valves and temporary works necessary to flush out all sections of systems, thus ensuring that the flushing process is effective through

all parts of a section of a system. This work will be deemed to include "looping" of flow and return pipework where heat emitters, equipment, etc., are not installed. The recommendations of C.I.B.S.E. and B.S.R.I.A. relating to flushing procedures and chemical/biocide dosing are to be noted and strictly followed, to avoid subsequent problems arising from the water being insufficiently clean and sterile.

The test pressure to be applied to above-ground water pipework is to be 1.5 times the working pressure or 7 bars, whichever is the greater, or as may be later specified for particular special services. Underground pipework is to be tested at twice the working pressure. Other pipework is to be tested to the pressures recommended in the H.V.C.A. Guide referred to above.

Each isolating valve on the system is to be tested for tightness immediately prior to installation. Any valve not found tight is to be dismantled, cleaned and faced as necessary until complete tightness is obtained.

The Contractor is to issue to the Consulting Engineers a Certificate of Test for each section tested, signed by all test witnesses.

The Contractor is to supply and fix as necessary all testing equipment, including the air compressor where relevant and is also to supply all necessary water for testing. The Contractor is responsible for checking whether any components of the system are unsuitable for the full test pressure, and for temporarily blanking off the pipes at the points of connection to those components for the duration of the test.

## **SECTION 7.00 – Controls**

### **PART 1 SYSTEM OBJECTIVES**

#### **100.010 PERFORMANCE OBJECTIVES**

The performance objective of this section is to replace the existing chiller controls with new ones under the dictates of new equipment and schedules. The Contractor is to allow for close collaboration with the Consulting Engineers, chiller manufacturer and TREND controls during the final software development phase. A detailed control strategy is to be developed by the Contractor in conjunction with the TREND and consulting engineers for the scope of works described in this Section.

During the process the Consulting Engineers met with the TREND field department who is the current controls suppliers and discussed the project in greta depth.

### **PART 2 GENERAL AND STANDARD REQUIREMENTS**

#### **200.010 GENERAL REQUIREMENTS**

The automatic controls for all refurbished and new mechanical services are to be supplied, installed, commissioned and demonstrated under this contract. The control systems are to be generally electronic/electric.

All control valves, actuators, linkages, sensors, controllers, relays, etc., necessary for fully operational systems are to be provided under the Contract, unless specifically otherwise stated. All controls are to be selected by the Controls Sub-Contractor to ensure stable and accurate operation.

The Contractor is to arrange for the Controls Sub-Contractor's schematic and wiring drawings to be forwarded in duplicate to the Consulting Engineers for comment in reasonable time before manufacture or installation proceeds. Irrespective of any comments, it is the responsibility of the Controls Sub-Contractor, through the Contractor, to ensure that the finished installation performs as specified in this Section.

The new control panel and modifications to existing control panels are to be supplied and installed under this contract. Wiring of motors, equipment, sensors, valves, dampers, etc., from the outgoing terminals of the control panel is to be carried out by the Contractor. The Contractor is to ensure that the outgoing terminals are sized to suit the cables concerned.

External wiring diagrams for the control panels, detailing terminal numbering, cable sizes and number of cores, are all to be provided by the Controls Sub-Contractor under this Contract in good time to allow the work to be carried out.

The reference codes adopted in the Schedules at the end of this Section are to be followed throughout the project, indicated on all drawings, and included on engraved Traffolyte labels permanently fitted to the relevant item at the completion of the project by the Controls Sub-Contractor.

The Contractor is to check with the manufacturers of all mechanical plant and equipment that the motor and the electrical equipment sizes stated in this Specification are correct, and is to inform the Consulting Engineers in the event of an alteration. The Contractor is also to ensure that the details of the controls and wiring of all plant and equipment are made available to the Controls Sub-

Contractor. The Controls Sub-Contractor is responsible for ensuring that his control systems are fully compatible with the requirements of all plant and equipment.

The Contractor is to prepare drawings confirming the exact locations of all items to be wired, before electrical installation work is started.

The new control panels must be delivered to site to suit the Contract programme. Panel design and wiring diagrams must proceed in sufficient time to allow any comments necessary to be made and incorporated prior to manufacture of the panel.

The new control panels to be of sheet steel, painted with primer, undercoat, and topcoat of oil-based paint to an approved colour. They are to have front access hinged doors for maintenance. All lamps, gauges, manual controls, etc., are to be arranged in a logical array on the front face of the panels, at a convenient height, with 'Traffolyte' labels to indicate their function. To be arranged for top entry of all cables unless otherwise stated. Externally-mounted control panels must be weatherproof, and constructed from GRP.

Unless otherwise stated, all controls, starters, etc., for plant are to be located in the control panels. Refer to Control Panel Schedule for the number and location of each panel.

The Automatic Controls components covered by this Section are to incorporate the products of the TREND manufacture who is also responsible for maintenance of the existing control system.

The selected manufacturer's products must be used throughout, except where inappropriate or where otherwise specified later.

The controls subcontractor is to be responsible for modifications and amendments to the existing BMS graphics so all new equipment is included.

The programmable controllers are to be manufactured by Trend.

The automatic control system design, engineering, including, control panels, actuators, isolators, valves, Sensors and controls wiring, supply, BMS Graphics etc shall be provided and commissioned by the incumbent automatic control specialist:-

**London Field Services Department**  
**Trend Control Systems Ltd**

Albery House  
Springfield Road  
Horsham  
West Sussex  
RH12 2PQ  
Tel: 01403 22691

Contact: James Dauncey  
Mobile: +44 (0)7794622089  
email: james.dauncey@trendcontrols.com

The Contractor shall hold a current manufacturer certificate of authorisation for supply and installation of the specified works.

All site operatives shall be trained to industry standard and hold current certificate of competence for installation of specified BEMS.

All site operative shall hold a certificate that demonstrates competence for safe isolation of electrical circuits in accordance with the Electricity at Work Regulations 1989.

The Contractor is to provide details of compliance with the Waste Electronic and Electrical Equipment Regulations 2006

All certification to be produced prior to works commencing.

#### Training

Training is to be provided on the BEMS operation for site engineers and client.

#### 200.020 STANDARD REQUIREMENTS

The control panels are to incorporate the standard requirements of this Clause, unless specifically otherwise stated.

- (a) Starters are to be provided for the motors of all equipment associated with each control panel.

Each DOL starter is to be contactor-type, complete with suitably rated HRC fuses of the "Motor Starting" type, and thermal overloads with protection against single-phasing. The coils of all starters are to be rated for 24 Volts A.C. and all operating and interlock circuits are to be at this voltage. Overloads are to be set to suit the motor. A Red "Trip" lamp and a Green "Run" lamp are to be provided for each starter. Auxiliary contacts are to be provided as necessary. Manual control switches are to be as specified in the appropriate clause. All Run and Trip statuses are to be monitored by the B.M.S. Alarms are to be signalled for trip and read-back occurrences.

Each Star-Delta starter is to be of the multi-contactor type, with suitable interlocks between the contactors, and a suitable automatic timer to control the closing of the Delta contactor. Each Star-Delta starter is to start the associated motor in "Star", however the start is initiated. Each Star-Delta starter is to be de-energised whenever the isolator local to the motor is opened. An auxiliary pole is to be provided on the isolator of each Star-Delta motor for this purpose. In other respects, the starter is to be equipped as for DOL starters specified above.

Where auto-changeover is specified, each motor is to have its own starter or VFD and associated lamps, switches, fuses, etc., all as specified above. An additional

"No. 1/No. 2/Duty Sharing" lead motor selector switch is to be fitted. In the event of the selected motor tripping, the 'trip' lamp for that motor is to illuminate, and control is to be transferred to the other motor.

The run and trip status of each starter/contactors/VFD is to be monitored by the B.M.S.

With ELV control circuits, it may be necessary to have a low current control relay within the remote control circuit to prevent voltage drop affecting the main starter operation. It is the Control Sub-Contractor's responsibility to determine and supply this relay if it is required.

Where a manual switch with 'Duty Sharing' is specified, the 'lead' motor of a pair of duty/standby motors is to be alternated automatically each time the plant is run, when the switch is at "Duty Sharing". If the motor is required to run continuously, then the Duty/Standby motor is to be alternated automatically every 7-days at a time suitable to the operation of the plant.

Where variable speed control of motors is required, they are to be provided with Variable Frequency Drives (VFD) as follows:

Each motor is to be controlled by a dedicated VFD which is also to provide motor protection for overcurrent and loss of phase along with the normal facilities provided by the manufacturer as standard. The VFD is to have the facility to control the motor speed in response to a 0 to 10V signal from the B.M.S. Run and Trip lamps are to be provided on the panel fascia and the operating status is to be monitored by the B.M.S. An "ON/OFF/AUTO" selector switch is to be provided for each motor on the control panel fascia. When at "AUTO", the motor is to be started and stopped by the B.M.S. Each VFD is to be provided with a T.P.& N. contactor-controlled power supply from the control panel.

The motor speed is to be monitored by the B.M.S.

When at "ON", the motor is to run at a speed which is to be manually adjustable at the VFD's keypad.

The VFDs are to be as manufactured by Danfoss Ltd., and are to be provided by the Controls Sub-Contractor. They are to be suitable for either panel or field mounting as specified later.

(b) Sequenced Starting

Where the instantaneous starting currents of all motors, etc., connected to a control panel would exceed the capacity of the fuses provided on the electrical supply to the control panels, delay timers are to be provided to reduce the maximum instantaneous current as necessary, when started under automatic control, or by the Fireman's switches.

Sequential starting is to be provided also to ensure that the plant starts in an orderly and safe manner and the correct conditions are met before starting plant.

(c) Thermal Controls

Unless otherwise later specified in any particular instance, every control circuit which automatically controls temperature, humidity, etc., in any air or water system, (other than 2-position control loops), is to incorporate a proportional- plus-integral-plus-differential modulating controller mounted in the control panel of the plantroom concerned. Setpoints are all to be fully adjustable. Proportional band, integral action rate and differential rate are to be adjusted to optimum settings to match the characteristics of the plant concerned. If the Controls Sub-Contractor considers that superior control will be achieved by an integral action controller, then this may be offered as an alternative; it should have fully adjustable setpoint and integral action rate.

Where individual controllers are used for the various control functions, they are to be flush-mounted onto the face of the control panels. Where a composite programmable controller is used, a keyboard and back-lit display for monitoring and adjusting the operation of the systems that are controlled are to be permanently mounted on the front of each control panel.

All thermostats, sensors, actuators, control valves, etc., are to be individually labelled with 'Traffolyte' labels using the reference numbers contained within this Specification.

All settings of all controls are to be fully adjustable.

(d) Electrical Work

Every control panel is to have an isolator on each incoming feeder.

Relays, delay timers, H.R.C. control circuit fuses, etc., are to be provided to ensure fully functional systems.

All internal wiring is to be neatly loomed, with numbered ferrules at both ends of every wire, corresponding to the numbering on the Controls Sub-Contractor's wiring diagram.

All external connections are to be via numbered "Klippon" clamp type terminal blocks, or equal.

Any wiring and equipment which could remain live when panel doors are open is to be shrouded and provided with warning labels. All internal starters, relays, timers, etc., are to be identified with "Traffolyte" labels. All work is to comply with the I.E.T. Regulations, 17th Edition.

Equipment and wiring within Control Panels is to be segregated into two categories:

1. Control circuits operating at voltages at which the I.E.T. Regulations permit bodily contact. Wherever possible, control equipment is to be in this category.
2. Control circuits necessarily operating at higher voltages. 400/230 Volt power distribution circuits. Starters and Contactors.

Category 1 is to be accessible without shutting down the Control Panel, and without risk of contact with equipment operating at high voltages.

Category 2 is to be protected by a door-interlocked isolator and/or is to have fully shrouded terminals, fuseholders, etc., so that there is no risk of electric shock by inadvertent contact for an electrician working within the control panel. Relays are to be of the plug-in replaceable type.

All Control Panels are to have control circuits operating at 24 Volt 50 Hz. Where this is not possible, then all control circuits greater than 50 Volts must be on the same phase, to prevent interconnections from giving rise to a presence of

415 Volts at, say, a Fireman's Control Panel.

Control circuit transformers are to be manufactured to B.S.3535/EN 60742.

Control circuits within the panel are to be sub-fused to ensure operating integrity of sections of plant and restrict a single fault shutting down large amounts of Plant.

Discrimination is required between the sub-circuit fuses and control circuit transformer protection fuses.

Where a Form 4 Panel is supplied each compartment will have its control circuit separately fused and both poles isolated by the door interlocked isolator.

The circuits of any contacts which signal to other panels or equipment, and which are energised from outside the control panel, or any other items which are energised from outside the control panel, are to be either:

- (i) Appropriately shrouded, and fitted with warning notices, or

- (ii) Located in the Category 2 area, and isolated by auxiliary poles on the main control panel isolator, or
- (iii) If the voltage is sufficiently low, located in the Category 1 area.

Indication lamps are to be flush-mounted on the panel fascia, be a minimum of

22 mm diameter and have a multi-segment LED lamp of sufficient intensity to be easily visible under normal ambient light conditions. The lamps are to be replaceable from the panel fascia without the need to shut the panel down. All lamps are to operate at 24 Volt maximum.

(e) Time Switches

Any time switches, unless otherwise specified, are to have a 7-day dial, sub-divided into hours, or the electronic equivalent. They are to have a 36-hour battery reserve which is self recharging. To have two 'ON' and 'OFF' settings for each day.

(f) Emergency Stop Facilities

Each control panel is to be provided with an integral twist-to-reset Red emergency stop button, clearly identified. The button is to drop out a relay in the control panel, which is to stop all plant controlled from that control panel, and where the outgoing power supply is derived from the control panel to disconnect all supplies greater than 50 Volts. Attention is drawn to the requirements of the I.E.E. Regulations and the European Machines Directive in respect of wiring of emergency stop circuits.

Additional remote emergency stop button(s) are to be provided within any Plantroom adjacent to each entry and are to be wired to any control panels controlling equipment/plant in the relevant Plantroom, to provide the same functions as the stop button described above.

(g) Alarms and Warnings

Alarms and Warnings are to be relayed to the B.M.S. supervisor.

'Alarms' are for occurrences which require immediate attention, namely:

- Motor or Equipment trips, where there is no standby, or where the standby is also tripped.
- Any dangerously low or high room or pipe temperatures.
- Any other items specified later.
- 'Warnings' are for less urgent occurrences, namely:
  - Motor or Equipment trips, where there is an operational standby
  - Any other items specified later.

The status of all alarms and warnings are to be recorded on the P.C's hard disc.

Alarms are also to be auto-dialled via the modem, to the remote monitoring station.

(h) Spare Ways

Each Control Panel is to have two spare T.P.& N. outgoing ways, fitted with 32 Amp H.R.C. fuse-holders and Neutral Links.

(i) Valve Exercise

Where a B.M.S. system is specified, the outstation strategies are to be programmed to automatically exercise all control valves once per week to prevent sticking.

Each control valve is to be driven fully open and fully closed twice during the exercise.

The valve exercise routine is not to initiate any other automatic functions related to the valve position.

The routine is not to be carried out on plant that is running under normal automatic control.

The routine is to be carried out at a time when the minimum amount of plant is running.

(j) Pipe Line Equipment

All pipe line equipment associated with the water services in the building is to have a normal pressure rating no less than 10.0 bar.g.

### **PART 3 CONTROLS DESCRIPTION SPECIFIC TO THIS PROJECT**

#### **300.010 EXISTING CHILLERS STRATEGY CONTROL**

The existing system operation is controlled and maintained by on site TREND engineer. The chillers operate in stages trying to match the required cooling loads. The controls have got 4 different stages where the chillers are operational as follows:-

Stage 1 – One small chiller operational

Stage 2 – One large chiller operational

Stage 3 – Two large chillers operational

Stage 4 – All chillers operational

When changing from one stage to another sequence may appear different until a chiller has fully shut down. A simplified description of change in sequence is as follows:-

#### Unloading

A chiller stage is unloaded when the common chilled water flow temperature is less than 7.5°C and the difference between the common flow and return temperature sensors (delta T) is less than the parameter set (usually set to 3°C). If these parameters remain for the duration of the chosen time set (usually set to 30 minutes), the chiller stage will change to a lower number.

#### Loading

To increase a chiller stage, the common chilled water flow temperature must be above 7.5°C and remain above this value for the duration of the chosen time set, once this time has elapsed the chiller stage will change up to a higher number.



### Manual Adjustment

A manual adjustment of the chiller staging is possible if necessary by adjusting the timer on the settings so the time set is reduced from 30 minutes to 3 minutes. It is necessary to always ensure that the timer value is reset to 30 minutes immediately following the chiller stage change taking place, failure to act swiftly may lead to further stage changes taking place unexpectedly.

The delta T can be changed to a higher value to ensure the required parameter to unload is met sooner, again remember to reset all parameters back to their original values once the operation has been completed.

### 300.020 NEW CHILLER STRATEGY CONTROL

The existing Trend BMS system will be modified to suit the operation of the new chillers and pumps which will require fairly extensive changes to the chiller and pump operation strategy. The chillers will run under their own internal control regime, but additional strategies will be required to make sure the chillers run at optimum efficiency.

The control strategy will remain largely as existing throughout the project until the last of the old chillers is de-commissioned and replaced; the system will remain a constant volume system. The new controllers, chillers and chilled water pumps are to be configured initially to operate in the same manner and in conjunction with the old system. This would require the frequency drives on the new chillers and chilled water pumps to be set as existing until the very last chiller installation and its testing and commissioning.

### Scope of Works

- Old and new control systems are to be changed over in stages to allow the old and new plant to operate together through each of the project stages.
- Recover from the existing site system the required strategy and plant operation information and verify all inputs, outputs and sensor requirements.
- Make safe electrical supplies and provide system for maintaining critical site plant during the works.
- Existing panel control sections are to be modified to allow parallel operation of the old and new control systems.
- Starter controls, contactors and timers are to be removed or modified to accommodate the new variable speed pump systems. The existing controllers are to be removed and disposed of in accordance with environmental and electronic equipment regulations. Provide details of compliance with obligations, such as Environment Agency waste permit or licensed disposal facility.
- Interfacing with existing Hand-Off-Auto and run and fault lamps is to be modified to accommodate the new variable speed pumps.
- A temporary control panel is to be manufactured, installed and commissioned to provide basic control and monitoring of the temporary chiller.
- Chiller interfaces will utilise BACnet over MSTP protocol. One interface/controller per chiller is to be used to avoid a single point of failure.
- New sensors, valve actuators and controls are to be installed in the chiller plant room to replace the aging existing equipment.
- Seasonal commissioning (minimum two visits) to be included

- Update the operations strategy to current required software standard and provide strategy drawings for all BMS controllers for prior approval by client engineer.

#### Primary Chillers Operation

The main electrical power supply to each chiller is to be separate from the Plantroom Control Panel, and is to be T.P.& N. The operation of each chiller is to be initiated by closing voltage-free contacts in the Control Panel, and are to be stopped by opening the same contacts. A "HAND/OFF/AUTO" switch for each chiller is to be incorporated on the Control Panel. Each chiller incorporates a "LON" communication card. The B.M.S. is to be provided with a compatible device in order to monitor the chillers' operating conditions on the B.M.S. supervisor.

When operating, the chilled water temperature is maintained at the required setpoint by the chiller's integral controls. The leaving water setpoint is to be automatically re-set via the "LON" data link on a schedule as follows:

The base setting shall be as follows:-

Chilled Water Flow Temperature	6.7 deg C
Chilled Water Return Temperature	13.3 deg C
A minimum flow rate through chiller evaporator	25.5 litres/s
Base flow rate through chiller evaporator	90.5 litres/s
Base flow rate through chiller condenser	90.5 litres/s

all settings to be fully adjustable.

Chillers are to be staged to maintain, as close as possible, a 40% to 60% load on the chillers where their COP is most favourable.

The chillers are provided with variable speed drives that would turn down the chillers based on the temperature difference. The TREND system is to monitor the chillers' variable frequency drives and send a signal to pumps to match the chiller frequency drive value in order to increase/decrease the chilled water flow rate. The TREND system is to monitor the chiller operation and unload/load the chiller base on the COP value, so the maximum efficiency on the chiller is achieved. On increasing load the chiller is to operate up to 75% output, prior to signalling the next chiller operation. The reason for this is to ensure that the operating chillers do not trip when another chiller is loaded. During a low cooling load requirement it is necessary to ensure that a minimum flow rate of chilled water is maintained across the operating chiller, therefore the chilled water pumps would never drop below the set value.

On the condenser water side the pumps are to be set to operate under the dictates of the set point temperature in conjunction with the cooling towers.

Motorised control valves are provided on chilled and condenser water flow to each chiller and are to be used only for full isolation of the chiller.

The new chillers are to be set on Sequencing of the chillers to rotate weekly to a new lead chiller.

A Green "Run" lamp is to be provided on the control panel for each chiller and is to be lit when the chiller is operating. A Red "Trip" lamp is to be provided on the control panel and is to be lit when the

alarm contact, which is integral with the chiller, signals a fault condition. Alarms and warnings are to be signalled as detailed in Standard Conditions.

The operating condition of each chiller is to be monitored by the B.M.S. and all available data is to be displayed on the B.M.S. Graphic.

#### Chiller Demand

The positions of all selected primary and secondary chilled water control valves in the building are to be monitored by the B.M.S. Whenever any of the valves is open to its pre-set set point and, providing that at least one zone of the building is in occupation, it is to be deemed that chilled water is required, and the chilled water plant is to be started, noting that there is always a cooling demand for the secondary circuit.

Whenever all of the valves are less open than pre-set set point, it is to be deemed that chilled water is not required and the chilled water plant is to be shut down. Whenever it is shut down under these conditions, the pumps are to run on for a period of one hour.

Time delays and position dead bands are to be provided to prevent short cycling of the chillers.

#### Chilled Water Primary Pump Operation

4 No. chilled water circulating pumps are to vary the chilled water flow rate to match the chiller load. The pumps' own controls are to be incorporated into the existing control system and to be controlled in such a manner that when the chiller load changes the pump would automatically change its operation based on the signal from TREND controls. It is proposed to operate the pumps on the number of operating chillers, ie if only one chiller is running, only one pump is in operation. During the uploading process it is proposed that the control system would first give a signal to the pump to increase the flow rate through the operating chiller which would make the water flow switch before the second chiller energises. Similarly, this is to be followed in reverse order during the unloading process. Once a second chiller is in operation another pump is to be brought into operation. The pump sequencing is to be set in a manner so they maximise their efficiency. The sequencing of the pumps is to be set up so that they rotate weekly to a new lead pump.

The pumps are to be set in such manner that when there is no demand for the cooling load the pumps are to maintain a minimum flow required by the chiller through a chilled water bypass.

The chilled water primary pumps are each to be provided with a "HAND/OFF/AUTO" switch. Each pump is to have a DOL starter as set in Standard Conditions.

The chilled water pumps and the chillers are to be shut down immediately (without pumpset run-on) if a pressure alarm is relayed from the pressurisation unit.

The pumps to have dpt (differential pressure transducers) fitted across the flow and return connections for BMS fault monitoring.

Each chiller and the pump are to be mutually interlocked so that:

- The chiller is to shut down if the pump's starter does not signal that it is running.
- The chiller will not operate unless the chiller's water flow switch is "made" thereby assuming water flow is maintained

- The pump is to “run on” for a period of 10 minutes (adjustable) after the chiller is shut down. The pump is to re-start immediately if the chiller is re-started.
- The chiller and pump are to stop immediately if an Emergency Stop button is pressed.

Standard Warning and Alarm signalling is required.

#### Condenser Water Pump Operation

The condenser water pumps are to maintain fixed speed at all times. The pumps are to operate when the chiller operates and to be stepped in conjunction with the chiller operation and any minimum flow requirements of the cooling tower system.

The condenser water primary pumps are each to be provided with a “HAND/OFF/AUTO” switch. Each pump is to have a DOL as set in Standard Conditions.

The condenser water pumps and the chillers are to be shut down immediately (without pumpset run-on) if a pressure alarm is relayed from the pressurisation unit.

The pumps to have dpt (differential pressure transducers) fitted across the flow and return connections for BMS fault monitoring.

Each chiller and the pump are to be mutually interlocked so that:

- The chiller is to shut down if the pump’s starter does not signal that it is running.
- The pump is to “run on” for a period of 10 minutes (adjustable) after the chiller is shut down. The pump is to re-start immediately if the chiller is re-started.
- The chiller and pump are to stop immediately if an Emergency Stop button is pressed.

Standard Warning and Alarm signalling is required.

#### Chilled Water Bypass

The operation of the chilled water bypass is to be priced as an additional option as it yet is to be determined new bypass is to be installed or the existing bypass is to be reused.

##### Option 1 – Existing chilled water bypass

If an existing bypass is to be reused, the Contractor is to allow for replacement of the existing double regulating valve on the chilled water bypass and allow for an installation of new metering station. The Contractor is to

##### Option 2 – Installation of new chilled water bypass

Installation of new chilled water bypass in between the chilled water flow and return pipework will ensure that the required minimum chilled water flow rate is always provided to the chillers, no matter what the requirement is for the air handling units. The bypass is to be fitted with a 2 port valve and with an accurate flow meter on the primary chilled water flow. If the cooling load reaches a minimum level and the two-port valves around the building close and reduce the chiller flow-rate to a minimum level, then a bypass valve will be opened to maintain a minimum chiller flow.

#### Condenser System

It is intended to retain the system operation as existing, however, in order to make the most of the new chillers and new refrigerant the temperature set point on the outlet water temperature will be changed from 23.9 °C to a variable minimum figure of 13.5 ° C. The Contractor is to allow for a new external wet bulb temperature sensor that is to be linked to the control system. The temperature set point is to be set so it varies with the external wet bulb temperature. The above works are to be undertaken after the final chiller replacement has taken place.

#### Temporary Chiller

The temporary chiller is to be available to run at night and during weekend shutdowns as required. The chiller is to be provided with it's own control panel in the generator room. The chiller is required to run under its own individual controls.

The main electrical power supply to the chiller is to be separate from the Main Control Panels, and is supplied from the new control panel in the generator room. The operation of the chiller is to be initiated by closing voltage-free contacts in the Control Panel, and is to be stopped by opening the same contacts. A "HAND/OFF/AUTO" switch for the chiller is to be incorporated on the Control Panel. The BMS. Is to be provided with a compatible device in order to monitor the chillers operating conditions on the BMS supervisor.

When operating, the chilled water temperature is maintained at the required setpoint by the chiller's integral controls. The leaving water setpoint is to be automatically re-set via the "LON" data link on a schedule as follows:

The base setting shall be as follows:-

Chilled Water Flow Temperature	6.7 deg C
Chilled Water Return Temperature	13.3 deg C

all settings to be fully adjustable.

A Green "Run" lamp is to be provided on the control panel for each chiller and is to be lit when the chiller is operating. A Red "Trip" lamp is to be provided on the control panel and is to be lit when the alarm contact, which is integral with the chiller, signals a fault condition. Alarms and warnings are to be signalled as detailed in Standard Conditions.

The operating condition of each chiller is to be monitored by the B.M.S. via the "LON" link and all available data is to be displayed on the B.M.S. Graphic.

#### Shunt Pump

A new fixed speed circulating pump is to be incorporated into the existing control system by utilising two existing spare ways, where each pump is to be fed from a separate panel.

Each shunt pump is to be provided with a "HAND/OFF/AUTO" switch. Each pump is to have a DOL as set in Standard Conditions. The condenser water pumps and the chillers are to be shut down immediately (without pumpset run-on) if a pressure alarm is relayed from the pressurisation unit.

The pumps to have dpt (differential pressure transduces) fitted across the flow and return connections for BMS fault monitoring.

Standard Warning and Alarm signalling is required.

### Monitoring

The B.M.S. is to monitor the following in addition to all control inputs and outputs:

- Common primary chilled water flow temperature on main chillers.
- Common primary chilled water return temperature on main chillers.
- Common primary chilled water flow temperature on temporary chillers.
- Common primary chilled water return temperature on temporary chillers.
- Common secondary chilled water flow temperature.
- Common secondary chilled water return temperature.
- Common primary chilled water flow rate on main chillers.
- Common primary chilled water flow rate on main chilled water flow

### Trace Heating

A contactor and fused supply are to be provided in the Temporary Chiller Control Panel for the trace heating of the chilled water pipework in the temporary chiller compound. There is to be an associated "HAND/OFF/AUTO" switch on the Plantroom Control Panel. When at "AUTO", the heating is to be 'ON' below 0°C (adjustable) external temperature, if the chilled water pumpset is not running. An Amber "Trace Heating On" lamp is to be lit whenever the contactor is closed.

## 300.030 OPERATIONAL RISK MANAGEMENT

**Operational Risk Assessment** – A written operational risk assessment is to be carried out to analyse each stage of the project to identify high probability, high impact risks and contingency.

**Daily Checks** – During and in between each project phase all chilled water systems are to be checked daily for correct operation and performance. Records are to be taken and reported weekly.

**24Hr/7Day Cover** – During and between each project phase a maximum 4hr BEMS engineer on-site response is to be provided for project related break-down cover.

## 300.040 EXISTING MOTOR CONTROL PANELS

The existing 2 No. Motor Control panels (MCCA and MCCB) are to be retained on site and only the relevant sections of the control system are to be refurbished in line with the new equipment.

The section of the MCC's which contains the Trend controller is to be refurbished, with replacement of the controller and associated relays and control equipment, this will need to be carried out item by item as there is no available space in the existing cabinet nor adjacent to the existing panel, alternatively a chassis could be manufactured which would sit over the existing controls with the necessary control equipment attached, built in such a way to enable removal of existing equipment as it becomes redundant.

## **SECTION 8.00 – Sundry Works in Connection with Engineering Services**

### **PART 1 TESTING AND COMMISSIONING**

Detailed description of testing and commissioning for each part of installation

#### Temporary chiller

After the installation and mechanical testing of the temporary chiller and the circulating pumps the Contractor is to allow for the thorough Testing and Commissioning of the temporary chiller and associated equipment. The temporary chiller is to be controlled from its own control panel located in the generator room and the Contractor is to allow for detailed testing of the temporary chiller controls.

#### Installation of first and second chiller

Upon the completion of installation of the first chiller, chilled and condenser water pumps, the whole system is to be tested and commissioned. The system is proposed to run in the same manner as existing which would require the frequency drives on both chiller and pumps to be set on fixed speed until the last testing and commissioning.

#### Installation of third chiller

Upon the completion of the last phase of the installation, the new controls for the pumps and all three chillers shall be incorporated into the existing BMS and control system. New primary chilled water pumps shall be reprogrammed to run on a variable speed in line with the chillers. The whole of the installation shall be commissioned, examined, performance and pressure tested based on the full load operation. All of the existing drawings and records shall be amended as necessary, however, new operation and maintenance manuals shall be produced for the chiller and control operation.

Once commissioned, a 12 month monitoring of the installed equipment shall commence together with a site visit to monitor the on-going planned preventative maintenance of the chiller installation and its performance. The Contractor is to allow for seasonal commissioning to be carried out as part of the contract.

As part of this monitoring an energy efficiency audit shall be undertaken to ensure that the cooling system performance and the energy saving measures have been achieved, ensuring that a reliable and efficient system is in operation.

## **PART 2 BUILDERS WORK**

### Scope of Works

- Forming holes through existing walls to accommodate new services.
- Making good existing holes made redundant by the removal of existing services.
- Forming new plinths for equipment on the roof.
- Provide paving slabs beneath pipework supports.
- Removal of all rubble and waste from site.
- Holes Through Structure
- Existing Holes to be made good
- Equipment Bases
- Provide temporary/permanent anti vibration pads beneath pumps and temporary chiller mountings.

### Holes through Structure

Holes through the structure shall be to suit the new routes of services and equipment. The approximate number of holes shall be as follows:

- 2 No 200mm DIA holes through internal walls.
- 2 No 300mm DIA hole through external walls.
- 1 No 180mm DIA hole through external walls.

The Contractor shall allow for making good and any re-decorating required for making good around all new holes.

### Equipment Bases

The Contractor shall allow for extension of the existing bases for the new chillers in the chiller plant room which shall be cast onto the existing structure. The sizes for the bases are to match the requirements of the new chillers.

The Contractor is to allow for new base for the temporary chilled water pump at the mezzanine level.

The Contractor is to allow for temporary tyco pad mats to protect the existing pavement tiles externally.

### Temporary Chiller Compound

The Contractor is to allow for building an enclosure for the temporary chiller compound as per the tender drawings. The enclosure is to be also provided with a crash deck above the temporary chiller (suitable for continual chiller use without affecting performance).

On the location shown on the tender drawings the Contractor is to allow for modifications to the generator room louvre section to enable temporary chiller chilled water pipework routing. The existing louvre is to be modified and prefabricated dummy louvre section shall be installed



around the new temporary chiller pipework. Once the whole replacement works are complete and the Contractor remove the temporary chiller and the chilled water pipework. The Contractor is to also allow for sealing of the holes through the structure and making the existing louvre good, so it matches the existing, however this is to be agreed with the Bank's representatives prior to commencing of the works.

## APPENDICES

### APPENDIX A

#### Schedule of Tender Drawings

The following drawings are indicative only and are produced to provide the Contractor with an overview of the various areas of the building.

They are not intended to be design drawings and shall not be used as such.

Drawing Number	Title	Scale
E4340 – 1001 Rev B	Temporary Chiller Location	1:50
E4340 – 1002	Temporary Chiller Installation	1:50
E4340 – 1003	Chiller Plantroom- Proposed Modifications to Chilled Water and Condensate Pipework Layout	1:50
E4340 – 1004	Proposed Chilled Water Schematic	NTS
E4340 – 1005	Proposed Controls and valve Schedule Drawing	NTS
E4340 – 1013	Chiller Plantroom- Existing Chilled Water and Condensate Pipework Layout	1:50
E4340 – 1014	Existing Building Air Conditioning Schematic	NTS
E4340 – 1015	Existing Chilled Water Plantroom Schematic and Valve Schedule	NTS
E4340 – 3001	Proposed LV Schematic	NTS
E4340 – 3003	Proposed Electrical Services	1:200

## APPENDIX B

### SUMMARY OF TENDER

#### SUMMARY OF TENDER FOR THE MECHANICAL SERVICES

(TO BE COMPLETE BY THE TENDERER)

The following Summary of Tender must be completed and returned with the completed tender documents.

Failure to complete this summary will not permit the Tenderer to be considered.

The Tenderer is required to break down the Tender into the following items.

These values shall include the cost of all materials, labour, overheads and profit and shall be complete in all respects.

#### Enabling Package – Mechanical

.001	Pipe Freezing	£
.002	New shunt pumps	£
.003	Pipework, valves, insulation, etc	£
.004	Automatic controls/BMS	£
.005	Installation of temporary chiller (inc. mark up for Contractors attendance, handling charges, coordination, etc.)	£
.006	Chilled Water Bypass	
	Modification to the existing bypass	£
	Installation of new bypass	£
.007	Crash deck	£
.008	Craneage/material handling	£
.009	Removal of redundant plant and equipment	£

#### Enabling Package – Electrical

.001	Main HV/LV Panel Works	£
.002	Remote Distribution Board	£
.003	Cable Installation	£
.004	Isolators	£
.005	Containment	£
.006	Labour (extra over for of hours working)	£
.007	Testing and Commissioning	£

#### Main Works - Mechanical

.001	CHWS & Cond. Water pumps	£
.002	Pipework, Valves, insulation, etc.	£
.003	Automatic Controls/BMS	£
.004	Installation of chillers (inc. mark up for Contractors attendance, handling charges, coordination, etc.)	£
.005	Craneage/material handling	£

.006	Removal of redundant plant and equipment	£
.007	Testing, commissioning and proving	£

**Main Works - Electrical**

.001	Main HV/LV Panel Works	£
.002	MCC Panel Modifications	£
.003	Pump Isolators Replacement	£
.004	Small Chiller Cable Installation	£
.005	Containment	£
.006	Lighting	£
.007	Labour (extra over for of hours working)	£
.008	Testing and Commissioning	£

<b>Sub Total</b>	£
Main Contract Preliminaries	£
Main Contractor OH&P	£
Contingency	£ 100,000.00
<b>GRAND TOTAL</b>	£

**SUMMARY OF TENDER**

For the Mechanical Services .... Continued

(To be completed by Tenderer)

The Contractor shall indicate below the percentages additions required for variations on a daywork basis and quotations based on time/material.

**Quotations**

+ ..... % Labour

+ ..... % Material

+ ..... % Plant

**Dayworks**

+ ..... % Labour

+ ..... % Material

+ ..... % Plant

SIGNED

FOR AND ON BEHALF OF

ADDRESS

DATE

Checked:	SGJ
Date:	June 2012

FHPP

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# **APPENDIX C**

## **Project Programme**

(to be attached to the final pdf document)

# EBRD - Chiller Replacement IMPLEMENTATION PROGRAMME



ID	Task Name	Duration	Start	Finish	Predecessors	Aug '12	Sep '12	Oct '12	Nov '12	Dec '12	Jan '13	Feb '13	Mar '13	Apr '13	May '13					
1						06/13/20	27/03/10	17/24/01	08/15/22	29/05/12	19/26/03	10/17/24	31/07/14	21/28/04	11/18/25	04/11/18	25/01/08	15/22/29	06/13/20	27/03/03
2	IMPLEMENTATION OF MAIN WORKS	208 days	Mon 13/08/12	Wed 29/05/13																
3																				
4	Appoint Contractor	0 days	Mon 13/08/12	Mon 13/08/12		13/08														
5	Lead in / Familiarisation Period	25 days	Mon 13/08/12	Fri 14/09/12	4															
6	Pre-contract Meeting	0 days	Fri 17/08/12	Fri 17/08/12	4FS+5 days	17/08														
7	Risk Workshop with Contractor	0 days	Fri 31/08/12	Fri 31/08/12	5SS+15 day	31/08														
8	Stakeholder Liaison	5 days	Mon 10/09/12	Fri 14/09/12	5SS+20 day															
9	Pre-start meeting	0 days	Tue 18/09/12	Tue 18/09/12	5SS+27 day	18/09														
10																				
11	Enabling Works	47 days	Tue 18/09/12	Wed 21/11/12																
12																				
13	Preparatory Works	24 days	Tue 18/09/12	Fri 19/10/12	5FS+1 day															
14	First Shutdown	2 days	Mon 22/10/12	Tue 23/10/12	13															
15	Enabling works	14 days	Wed 24/10/12	Mon 12/11/12	14															
16	Second Shutdown	2 days	Tue 13/11/12	Wed 14/11/12	15															
17	Handover	5 days	Thu 15/11/12	Wed 21/11/12	16															
18																				
19	Main Works	135 days	Thu 22/11/12	Wed 29/05/13																
20																				
21	Installation of Chiller One	25 days	Thu 22/11/12	Wed 26/12/12	17															
22	Proving period	30 days	Thu 27/12/12	Wed 06/02/13	21															
23	Installation of chiller Two	25 days	Thu 07/02/13	Wed 13/03/13	22															
24	Proving Period	30 days	Thu 14/03/13	Wed 24/04/13	23															
25	Installation of Chiller Three	25 days	Thu 25/04/13	Wed 29/05/13	24															

Checked:	SGJ
Date:	June 2012

FHPP

## APPENDIX D

### Schedule of Valves

VALVE SCHEDULE						
Existing valves						
LABEL REF. NO	SIZE	EXISTING TYPE	NEW TYPE		DESCRIPTION	ACTION
C.W.S. G/33	250	M.V.	-		C.W.S. to Flat Plate Heat Exchanger HX3-1	To be removed
C.W.S. G/34	250	D.R.V.			C.W.S. from Flat Plate Heat Exchanger HX3-1	
C.W.S. G/35	250	M.V.			C.W.S. to Flat Plate Heat Exchanger HX3-2	
C.W.S. G/36	250	D.R.V.			C.W.S. from Flat Plate Heat Exchanger HX3-2	
C.W.S. G/37	400	I.V.	IV	970G Butterfly valve gear operated ALI BRZ disc	C.W.S.	To be replaced
C.W.R. G/38	400	I.V.	IV	970G Butterfly valve gear operated ALI BRZ disc	C.W.R.	
C.W.S. G/39	400	M.V.	-		C.W.S. Bypass	To be retained
C.W.S. G/40	250	M.V.	MV	HiLok Fully Lugged c/w IP2	C.W.S. to Refrigeration Machine RM3-1	To be replaced
C.W.S. G/41	250	D.R.V.	DRV+MS	M2000PN16 S/S + 4983 DI B/FLY DRV G/OP PN25	C.W.S. from Refrigeration Machine RM3-1	
C.W.S. G/42	250	M.V.	MV	HiLok Fully Lugged c/w IP2	C.W.S. to Refrigeration Machine RM3-2	
C.W.S. G/43	250	D.R.V.	DRV+MS	M2000PN16 S/S + 4983 DI B/FLY DRV G/OP PN25	C.W.S. from Refrigeration Machine RM3-2	
						Hattersley
						Keystone
						Hattersley
						Keystone
						Hattersley



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Date:	June 2012

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C.W.S. G/44	250	M.V.	MV	HiLok Fully Lugged c/w IP2	C.W.S. to Refrigeration Machine RM3-3		Keystone
C.W.S. G/45	250	D.R.V.	DRV+MS	M2000PN16 S/S + 4983 DI B/FLY DRV G/OP PN25	C.W.S. from Refrigeration Machine RM3-3		Hattersley
C.W.S. G/46	250	I.V.	IV	970G Butterfly valve gear operated ALI BRZ disc	C.W.S. to Cond. Water Pump P3-17		
C.W.S. G/47	250	D.R.V.	DRV+MS	M2000PN16 S/S + 4983 DI B/FLY DRV G/OP PN25	C.W.S. from Cond. Water Pump P3-17		
C.W.S. G/48	250	I.V.	IV	970G Butterfly valve gear operated ALI BRZ disc	C.W.S. to Cond. Water Pump P3-4		
C.W.S. G/49	250	D.R.V.	DRV+MS	M2000PN16 S/S + 4983 DI B/FLY DRV G/OP PN25	C.W.S. from Cond. Water Pump P3-4		
C.W.S. G/50	250	I.V.	IV	970G Butterfly valve gear operated ALI BRZ disc	C.W.S. to Cond. Water Pump P3-5		
C.W.S. G/51	250	D.R.V.	DRV+MS	M2000PN16 S/S + 4983 DI B/FLY DRV G/OP PN25	C.W.S. from Cond. Water Pump P3-5		
C.W.S. G/52	250	I.V.	IV	970G Butterfly valve gear operated ALI BRZ disc	C.W.S. to Cond. Water Pump P3-6		
C.W.S. G/53	250	D.R.V.	DRV+MS	M2000PN16 S/S + 4983 DI B/FLY DRV G/OP PN25	C.W.S. from Cond. Water Pump P3-6		
C.H.W. G/54	250	D.R.V.		-	C.H.W. from Flat Plate Heat Exchanger HX3-1	To be removed	
C.H.W. G/55	250	M.V.			C.H.W. to Flat Plate Heat Exchanger HX3-1		
C.H.W. G/56	250	D.R.V.			C.H.W. from Flat Plate Heat Exchanger HX3-2		
C.H.W. G/57	250	M.V.			C.H.W. to Flat Plate Heat Exchanger HX3-2		
C.H.W. G/58	250	M.V.	MV	HiLok Fully Lugged c/w IP2	C.H.W. to Refrigeration Machine RM3-1	To be replaced	Keystone
C.H.W. G/59	250	D.R.V.	DRV+MS	M2000PN16 S/S + 4983 DI B/FLY DRV G/OP PN25	C.H.W. from Refrigeration Machine RM3-1	To be replaced	Hattersley
C.H.W. G/60	250	M.V.	MV	HiLok Fully Lugged c/w IP2	C.H.W. to Refrigeration Machine RM3-2	To be replaced	Keystone

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C.H.W. G/61	250	D.R.V.	DRV+MS	M2000PN16 S/S + 4983 DI B/FLY DRV G/OP PN25	C.H.W. from Refrigeration Machine RM3-2	To be replaced	Hattersley
C.H.W. G/62	400	M.V.		-	C.H.W. Heat Exchanger Bypass	To be retained	
C.H.W. G/63	250	M.V.	MV	HiLok Fully Lugged c/w IP2	C.H.W. from Refrigeration Machine RM3-3	To be replaced	Keystone
C.H.W. G/64	250	D.R.V.	DRV+MS	M2000PN16 S/S + 4983 DI B/FLY DRV G/OP PN25	C.H.W. from Refrigeration Machined RM3-3	To be replaced	Hattersley
C.H.W. G/65	250	M.V.	MV	HiLok Fully Lugged c/w IP2	C.H.W. to Refrigeration Machine RM3-3	To be replaced	Keystone
C.H.W. G/66	400	I.V.	IV	970G Butterfly valve gear operated ALI BRZ disc	C.H.W. Supply	To be replaced	Hattersley
C.H.W. G/67	400	I.V.	IV	970G Butterfly valve gear operated ALI BRZ disc	C.H.W. Return		
C.H.W. G/72	250	I.V.	IV	970G Butterfly valve gear operated ALI BRZ disc	C.H.W. to C.H.W. Pump P3-1G		
C.H.W. G/73	250	D.R.V.	DRV+MS	M2000PN16 S/S + 4983 DI B/FLY DRV G/OP PN25	C.H.W. from C.H.W. Pump P3-1G		
C.H.W. G/74	250	I.V.	IV	970G Butterfly valve gear operated ALI BRZ disc	C.H.W. to C.H.W. Pump P3-1		
C.H.W. G/75	250	D.R.V.	DRV+MS	M2000PN16 S/S + 4983 DI B/FLY DRV G/OP PN25	C.H.W. from C.H.W. Pump P3-1		
C.H.W. G/76	250	I.V.	IV	970G Butterfly valve gear operated ALI BRZ disc	C.H.W. to C.H.W. Pump P3-2		
C.H.W. G/77	250	D.R.V.	DRV+MS	M2000PN16 S/S + 4983 DI B/FLY DRV G/OP PN25	C.H.W. from C.H.W. Pump P3-2		
C.H.W. G/78	250	I.V.	IV	970G Butterfly valve gear operated ALI BRZ disc	C.H.W. to C.H.W. Pump P3-3		
C.H.W. G/79	250	D.R.V.	DRV+MS	M2000PN16 S/S + 4983 DI B/FLY DRV G/OP PN25	C.H.W. from C.H.W. Pump P3-3		
C.H.W. G/80	50	I.V.	IV	970G Butterfly valve gear operated ALI BRZ disc	C.H.W. (Future)		

#### New Valves

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CHW/12/01	250	-	IV	970G Butterfly valve gear operated ALI BRZ disc	CHW from Refrigeration Machine 3-1	To be installed new	Hattersley
CHW/12/02	250		IV	970G Butterfly valve gear operated ALI BRZ disc	CHW from Refrigeration Machine 3-2		
CHW/12/03	150		IV	970W DI B/FLY VVE L/OP	CHW Bypass		
CHW/12/04	150		MV	HiLok Fully Lugged c/w IP2	CHW Bypass		Keystone
CHW/12/05	150		Autoflow	A/FLOW 2050 PN16 D/IRON BAL VVE	CHW Flow to buffer vessels		Hattersley/Oventrop or equal and approved
CHW/12/06	150		IV	970W DI B/FLY VVE L/OP	CHW Flow to buffer vessels		
CHW/12/07	150		IV	970W DI B/FLY VVE L/OP	CHW Flow from buffer vessels		
CHW/12/08	100		IV	970W DI B/FLY VVE L/OP	CHW to temporary chiller pump		
CHW/12/09	100		IV	970W DI B/FLY VVE L/OP	CHW to temporary chiller pump		
CHW/12/10	100		DRV + MS	M2000PN16 S/S + 4983 DI B/FLY DRV L/OP PN25	CHW from temporary chiller pump		
CHW/12/11	100		DRV + MS	M2000PN16 S/S + 4983 DI B/FLY DRV L/OP PN25	CHW from temporary chiller pump		
CHW/12/12	150		IV	970W DI B/FLY VVE L/OP	Temporary Chiller bypass		
CHW/12/13	100		DRV + MS	M2000PN16 S/S + 4983 DI B/FLY DRV L/OP PN25	CHW from temporary chiller		
CHW/12/14	100		IV	970W DI B/FLY VVE L/OP	CHW to temporary chiller		
CHW/12/15	100		IV	970W DI B/FLY VVE L/OP	CHW from temporary chiller		
CHW/12/16	100		IV	970W DI B/FLY VVE L/OP	CHW to temporary chiller		
CHW/12/17	150		IV	970W DI B/FLY VVE L/OP	CHW Flow to buffer vessels		
CHW/12/18	150		IV	970W DI B/FLY VVE L/OP	CHW Return from buffer vessels		
CHW/12/19	100		IV	970W DI B/FLY VVE L/OP	CHW to temporary chiller		
CHW/12/20	100		IV	970W DI B/FLY VVE L/OP	CHW from temporary chiller		
CWS/12/01	250		IV	970G Butterfly valve gear operated ALI BRZ disc	CWS to Refrigeration Machine 3-1		
CWS/12/02	250		IV	970G Butterfly valve gear operated ALI BRZ disc	CWS to Refrigeration Machine 3-2		

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CWS/12/03	250		IV	970G Butterfly valve gear operated ALI BRZ disc	CWS to Refrigeration Machine 3-3		
Strainers	910PN16 CI Y-STRAINER TAP & DRILLED C/W TEST POINTS						
Non return valves	850PN16 CO CHECK VVE WFER PATT						
Drain Cocks	15mm 81HU BZE GLAND COCK						
IV	Isolating Valve						
DRV	Double Regulating Valve						
MS	Metering Station						
MV	Motorised Valve						
CHW	Chilled Water						
CWS	Condenser Water						

Note:

This Valve Schedule is to be read in conjunction with the M & E Technical specification and tender drawings.

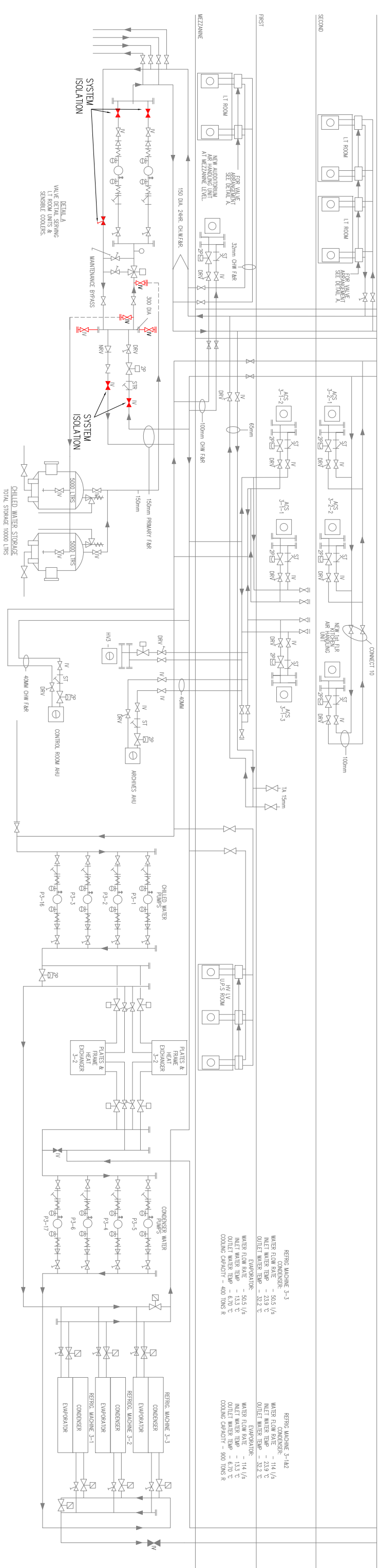
## **APPENDIX E**

### **Phasing Drawings**

(to be attached to the final pdf document)

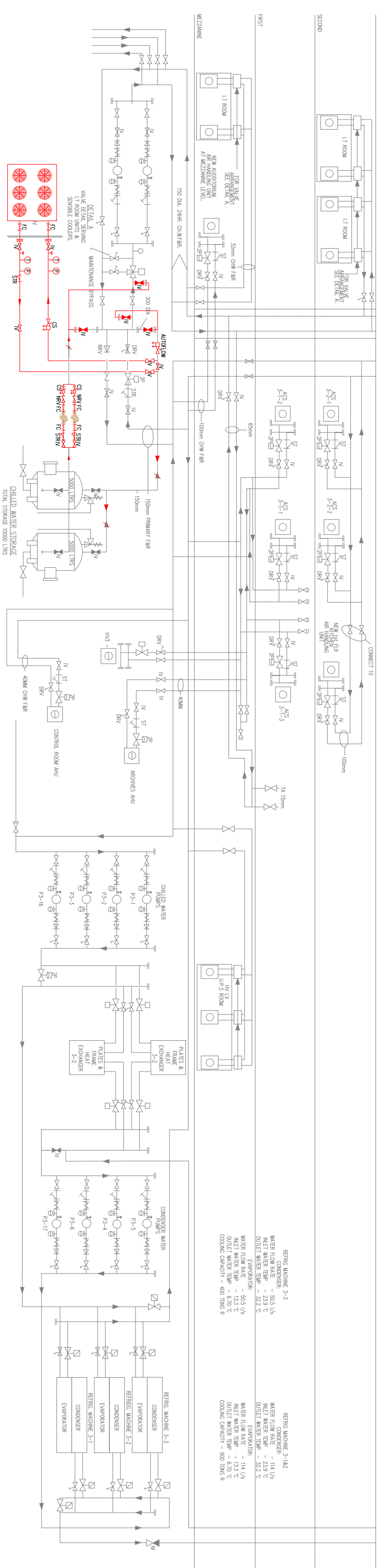
ENABLING PACKAGE  
FIRST WEEKEND SHUTDOWN – Secondary System Only

- PREWORK FREEZING
- NEW VALVES
- CLOSED VALVES
- NEW/OPEN VALVES
- EXISTING PREWORK
- STRIP/OUT
- NEW PREWORK
- NEWLY INSTALLED PREWORK



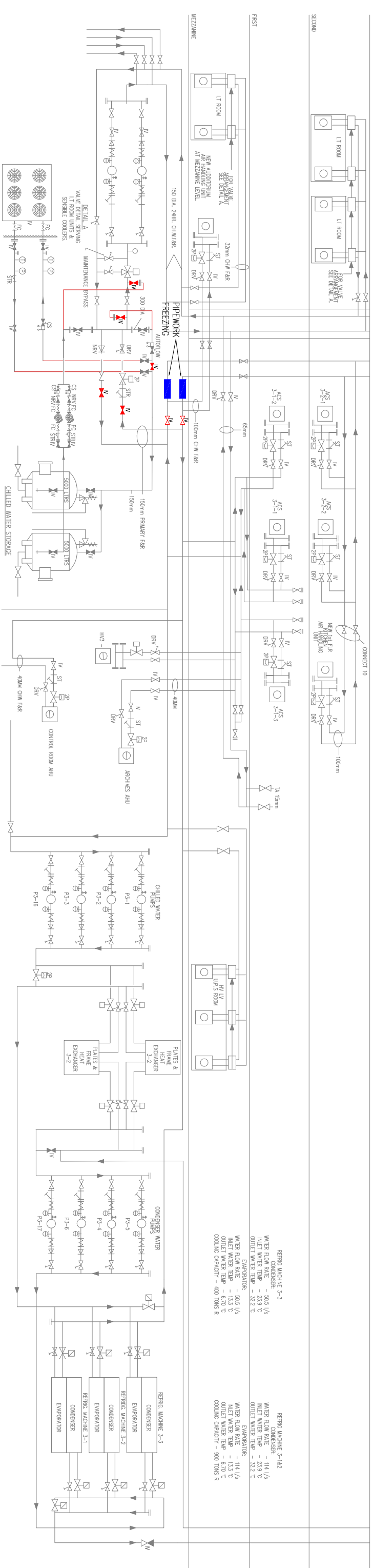
ENABLING PACKAGE  
POST WEEKEND WORKS – Normal working hours

- PREWORK FREEZING
- NEW VALVES
- CLOSED VALVES
- NEW/OPEN VALVES
- EXISTING PREWORK
- STRIP/OUT
- NEW PREWORK
- NEWLY INSTALLED PREWORK



ENABLING PACKAGE  
SECOND WEEKEND SHUTDOWN – Primary system shutdown, secondary system running via temporary chiller

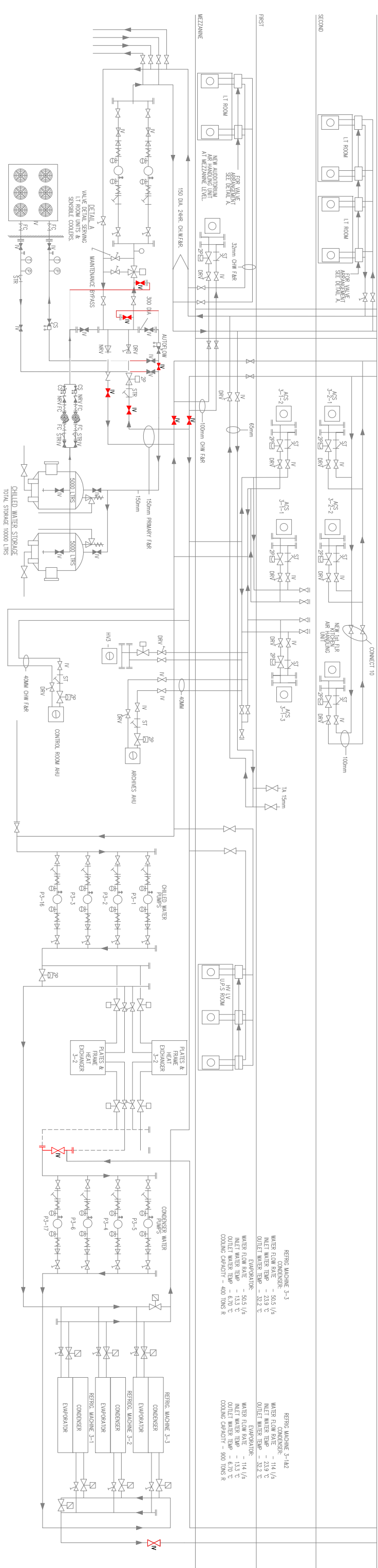
- PREWORK FREEZING
- NEW VALVES
- CLOSED VALVES
- NEW/OPEN VALVES
- EXISTING PREWORK
- STRIP/OUT
- NEW PREWORK
- NEWLY INSTALLED PREWORK





ENABLING PACKAGE  
SUBSEQUENT WEEKEND SHUTDOWN-REPLACEMENT OF MAIN ISOLATION VALVES ON CONDENSER WATER SIDE-Primary system shutdown, secondary system running via temporary chiller

- PREWORK FREEZING
- NEW VALVES
- CLOSED VALVES
- NEW/OPEN VALVES
- EXISTING PREWORK
- STRIP/OUT
- NEW/PRERANKED PREWORK
- NEWLY INSTALLED PREWORK





















## **APPENDIX F**

### **Temporary chiller and Main Chiller technical details**

(to be attached to the final pdf document)

Our Ref: RETRO\6808\DW\11204.5\Op1

2<sup>nd</sup> May 2012

EBRD  
One Exchange Square  
London  
EC2A 2JN

For the attention of Mr G Card

Dear Graeme,

Re: European Bank – Water Cooled Chiller Supply

Further to your recent request for information would you please accept our revised proposal to design, manufacture & supply the chillers as detailed in your tender documents ref: PUR1108/23, Option 1.

New Equipment

3 x York manufactured YKHDFVP85ENG, 2500kW, R134a, Water Cooled Variable Speed Driven Liquid Chillers with Centrifugal Compressor.

Inclusive of: Compressor/motor assembly, PED Heat Exchangers, Oil Management System, Optiview Micro Computer Control Centre, Variable Speed Drive (VSD) & Harmonic Filter.

Additional Options & Accessories

Cooler Flow Switch, Condenser Flow Switch, 19mm Cooler Insulation, Evaporator Marine Water Boxes 10bar, Evaporator Connection Flanges DN250, Condenser Marine Water Boxes 10bar, Condenser Connection Flanges DN250, Compressor Isolation Valves, Form 7 Shipment, R134a Refrigerant, Spring Anti-Vibration Mounts, P&I Diagram & General Arrangement Drawings.

Additional Scope of Work

Factory Performance Testing (3 persons + 1 JCI), Decommissioning of the existing YT Machines, R123 Disposal, Removal/Disposal of YT machines, Setting New YK Chillers in Place, YK Chiller Rebuild, Storage of 2 YK Chillers, Extended Warranties, Maintenance & Commissioning.

Technical Data

A full description of the chiller equipment offered can be found on [www.johnsoncontrols.com](http://www.johnsoncontrols.com)

## Design Data



### Unit Type and Size

Model		<b>YKHDFVP85ENG</b>
Number and Type of Compressor	(No / Type)	1 / Centrifugal
Number of refrigerant circuits per Unit	(No)	1
Capacity steps per chiller	%	10-100 VSD

### Technical Data

Refrigerant Type		R134a
Cooling Capacity	(kW)	2500
Power Input Compressor	(kW)	364
Full Load (COP)		6.869
NPLV		9.726

### Evaporator

Number and Type	(No / Type)	1 / Shell and Tube
Passes		2
Entering / Leaving Fluid Temperature	(°C)	13.3 / 6.7
Fluid Flow Rate	(L/s)	90.5
Pressure Drop	(kPa)	53
Fouling Factor	(m²K/kW)	0.01761
Diameter of Fluid Connections	(in)	10

### Condenser

Number and Type	(No / Type)	1 / Shell and Tube
Passes		2
Entering / Leaving Fluid Temperature	(°C)	23.8 / 31.57
Max / Min Entering Fluid Temperatures	(°C)	32 / 12
Fluid Flow Rate	(L/s)	87.4
Pressure Drop	(kPa)	52.4
Fouling Factor	(m²K/kW)	0.04403
Diameter of Fluid Connections	(in)	10

### Electrical Data

Mains Supply	(V/Ph/Hz)	400 / 3 / 50
Number of Panels		2
FLA.	(A)	582
Min Circ Amps	(A)	728
Max C.B	(A)	1200

### Weights and Dimensions

Shipping Weight	(kg)	15760
Operation Weight	(kg)	16965
Refrigerant Charge (R134a)	(kg)	779
Oil Charge	(L)	75.7
Overall Length	(mm)	5650
Overall Width	(mm)	2210 *
Overall Height	(mm)	2794 *

\* based on no AVMS fitted.

## Prices

Our prices exclusive of VAT to supply / deliver equipment & carry out the scope of works below would amount to:

3 x York manufactured YKHDFVP85CNG, 2500kW, R134a, Water Cooled Variable Speed Driven Liquid Chillers with Centrifugal Compressor, Inclusive of: Compressor/motor assembly, PED Heat Exchangers, Oil Management System, Optiview Micro Computer Control Centre, Variable Speed Drive (VSD) & Harmonic Filter = £505,563.00 + vat

### Options & Accessories included in the above Price

Cooler Flow Switch  
 Condenser Flow Switch  
 19mm Cooler Insulation  
 Evaporator Marine Water Boxes 10bar  
 Evaporator Connection Flanges DN250  
 Condenser Marine Water Boxes 10bar  
 Condenser Connection Flanges DN250  
 Compressor Isolation Valves  
 Form 7 Shipment  
 R134a Refrigerant  
 P&I Diagram & General Arrangement Drawing

### Additional Prices & Scope of Work

Factory Performance Testing, 100% / Part Load / Min Load (3 persons + 1 JCI) Inclusive of Travel Arrangements / Accommodation etc. = £16,878.00  
 Decommissioning of the existing YT Machines/R123 Disposal = £17,580.00  
 Removal/Disposal of YT machines - £9,843.00  
 Storage of 2 Chillers from Oct 2012 to June 2013 - £1,785.00  
 Setting New Chillers in Place & Rebuilding = £35,724.00  
 Commissioning - £3,915.00  
 Maintenance as Requested - £ 10,246.00  
 Warranty as Requested - No Additional Charge  
 Extended 2 Year Maintenance - £8,868.00  
 Extended 2 Year Warranty - £18,660.00

### Delivery

Delivery periods will be confirmed in our acknowledgement of your official order. However, for your guidance, we estimate that delivery of your equipment will be **15-16 Working weeks** from receipt of your official order.

**Please allow an additional 2 weeks if a factory witness test is required.**

All delivery times are based on current production schedules; stock position and order backlog and are from the date of receipt of your order with full and final instructions enabling us to proceed.

### Warranty

Please note that the standard warranty period ends 18 months after dispatch from the factory.

Meanwhile, we trust the quotation is in accordance with your requirements and assure you of our continued attention to your further instructions.

Yours faithfully,

*David Wilson*

Senior Sales Engineer  
Building Efficiency  
**Johnson Controls**

Our Ref: RETRO\6808\DW\11249/Op2

9<sup>th</sup> January 2012

The European Bank for Construction & Development  
1 Exchange Square  
London  
EC2A 2JN

For the attention of Mr G Card

Dear Graeme,

Re: European Bank – Temporary Air Cooled Chiller Supply

Further to your recent request for information would you please accept our proposal to design, manufacture, supply and Commission the following York manufactured Air Cooled Liquid Chiller.

New Equipment

1 x York manufactured YLAA HE 0260, 266kW, R410A, Air Cooled Liquid Chiller.

Inclusive of: R410A Refrigerant Charge, Single Point Non Fused Disconnect Switch, Low Ambient Kit, Bacnet Communication, Micro Channel Condenser Coil, PED CE Standard, Single Speed Condenser Fans.

Additional Options & Accessories

Soft Start, Power Factor Correction, Pressure Relief Dual Kit, Flow Switch, Full Unit Enclosure Wire, Compressor Acoustic Enclosure, Spring Anti-Vibration Mounts, Commissioning.

Technical Data

A full description of the chiller equipment offered can be found on [www.johnsoncontrols.com](http://www.johnsoncontrols.com)

General Comments

The inclusion of some optional accessories can affect standard performance data and/or unit weight/dimensions. Should you wish to incorporate any extras or other available accessories, please contact the writer to establish if there would be any changes in the capabilities of the equipment quoted.

### General Description of the Unit



YORK TEMPO is a fully packaged air-cooled liquid chiller, with scroll compressors, designed to be located outside on the roof of a building or at ground level.

There are two levels of operating efficiency:

Standard efficiency SE models & High efficiency HE models

Standard SE and HE chillers have normal speed fans and no compressor enclosure.

Each efficiency level has a selection of acoustic options:

Two speed fans

Acoustically lined compressor enclosure

Acoustically lined compressor enclosure and two speed fans

Low sound (LS) models with acoustically lined compressor enclosure and fixed low speed fans

### Economical operating costs year round

The incorporation of multiple scroll compressors results in high full and part load efficiencies. As each compressor represents a cooling capacity step there is no efficiency reduction when the chiller operates at part load. As the cooling capacity demand falls the available condenser surface increases, in comparison to the load demand, and therefore the part load efficiency exceeds the full load efficiency.

### Specifically designed for low sound operation

Most major cities today have rigorous noise control legislation and many applications such as medical, educational, hotels and theatres are extremely noise sensitive. In such situations a chiller must not only meet sound level requirements during the day, when background noise levels often mask chiller sound levels, but also during evenings and at night when legislated levels are more stringent and background levels are diminished.



The TEMPO LS chiller has been specifically designed for low sound operation, to satisfy these varied requirements, by incorporating slow speed fans and arranging all the compressors together in one location and enclosing them in an acoustically treated chamber.

#### Suits locations where space is restricted

TEMPO has a compact design to suit locations where space is restricted.

#### Fast and easy installation

TEMPO has a single electrical power connection and optional, factory fitted, water circulating pump(s), water filter and flow switch to provide fast and easy installation.

#### Buffer tank not normally required

TEMPO requires a minimum water volume to satisfy only one minute of chiller operation at minimum cooling capacity. Therefore on standard air-conditioning systems, such as Fan-Coil etc. a buffer tank is not normally required.

#### Heat Recovery

An additional dual refrigerant circuit plate heat exchanger provides warm water up to 50°C. Suitable for air driven heating systems and domestic hot water preheat.

#### Tested for operating reliability

Every TEMPO chiller is fully factory tested before being shipped in order to ensure trouble free installed operation.

#### Dual refrigeration circuits

TEMPO dual refrigerant circuits and multiple scroll compressors provide system stand-by security.

#### Plain language 40-character display

TEMPO has a microprocessor controller with a 40-character, plain language, display of temperatures, pressures, operating hours, number of starts and start stop/holiday times. Control functions include accurate leaving liquid temperature, compressor lead/lag, system safety protection and integral circulating pumps.

#### Efficient low sound fans

TEMPO has aerodynamically designed low sound fans located in separate compartments to prevent air Re-circulation and to reduce inefficient fan start/stop operation.

#### All aluminium condenser coils

The incorporation of micro-channel aluminium coils provide improved heat transfer, reduced fan power, require less refrigerant and eliminates the possibility of galvanic corrosion, caused by the contact between dissimilar metals. The coil headers, tubes and fins are all aluminium. Coils can be easily pressure washed (100bar maximum), saving time and sustaining efficiency.

#### High Efficiency Evaporator

All models have high efficiency evaporators to provide high cooling capacities and low water pressure drops.

## Design Data

### Unit Type and Size

Model		<b>YLAA HE 0260</b>
Number and Type of Compressor	(No / Type)	4 / Scroll - hermetic
Number of refrigerant circuits per Unit	(No)	2
Capacity steps per chiller	%	17 / 35 / 67 / 100

### Technical Data

Refrigerant Type		R410A
Cooling Capacity	(kW)	266
Power Input Compressor	(kW)	76
EER		3.5
ESEER		4.72
Sound Pressure @ 1m * (Single Speed Fan)	(dBA)	71

\* Parallel surface method, in free field, without reflection

### Evaporator

Number and Type	(No / Type)	1 / Shell and Tube
Total Fluid Content	(L)	193
Fluid Concentration	(% EG)	11
Entering / Leaving Fluid Temperature	(°C)	13.3 / 6.7
Fluid Flow Rate	(L/s)	10
Pressure Drop	(kPa)	19
Fouling Factor	(m <sup>2</sup> K/kW)	0.044
Diameter of Fluid Connections	(in)	6

### Condenser (Air Cooled)

Air Inlet Temperature	(°C)	30
Air Flow Rate	(m <sup>3</sup> /s)	28
No. of Fans		4
Total Fan Motor Power	(kW)	6.7
Altitude	(m)	0

### Electrical Data

Mains Supply	(V/Ph/Hz)	400 / 3 / 50
Number of Panels		1
Nom. Current Unit	(A)	142
Max. Current Unit (for cable sizing)	(A)	181
Starting Current Compressor 1 / 2 / 3 / 4	(A)	310 / 141 / 310 / 141 *
Max. Instant Current Unit	(A)	293 *
Single-Point Non-Fused Disconnect Switch with Power Factor Correction		

\* Soft Start

### Weights and Dimensions

Shipping Weight with Micro Channel Coil	(kg)	2394
Operation Weight with Micro Channel Coil	(kg)	2588
Refrigerant Charge (R410A)	(kg)	49
Overall Length	(mm)	2911
Overall Width	(mm)	2242 *
Overall Height	(mm)	2508 *

\* based on no AVMS fitted.

### Prices

Our prices (exclusive of vat) to supply & deliver equipment would amount to the sum of:

1 x YLAA HE 0260 Standard Chiller Inclusive of R410A Refrigerant Charge,  
Single Point Non Fused Disconnect Switch, Low Ambient Kit, Bacnet Communication,  
Micro Channel Condenser Coil, PED CE Standard, Single Speed Condenser Fans.

### Additional Options & Accessories

Soft Start, Power Factor Correction, Pressure Relief Dual Kit, Flow Switch, Full Unit Enclosure Wire,  
Compressor Acoustic Enclosure, Spring Anti-Vibration Mounts, Commissioning.

### Delivery

Delivery periods will be confirmed in our acknowledgement of your official order. However, for your guidance, we estimate that delivery of your equipment will be **8 Working weeks** from receipt of your official order.

### Terms and Conditions of Sale

EBRD Terms and Conditions apply with Amendments as requested.

### Warranty

Please note that the standard warranty period ends 12 months after dispatch from the factory.

Yours faithfully,

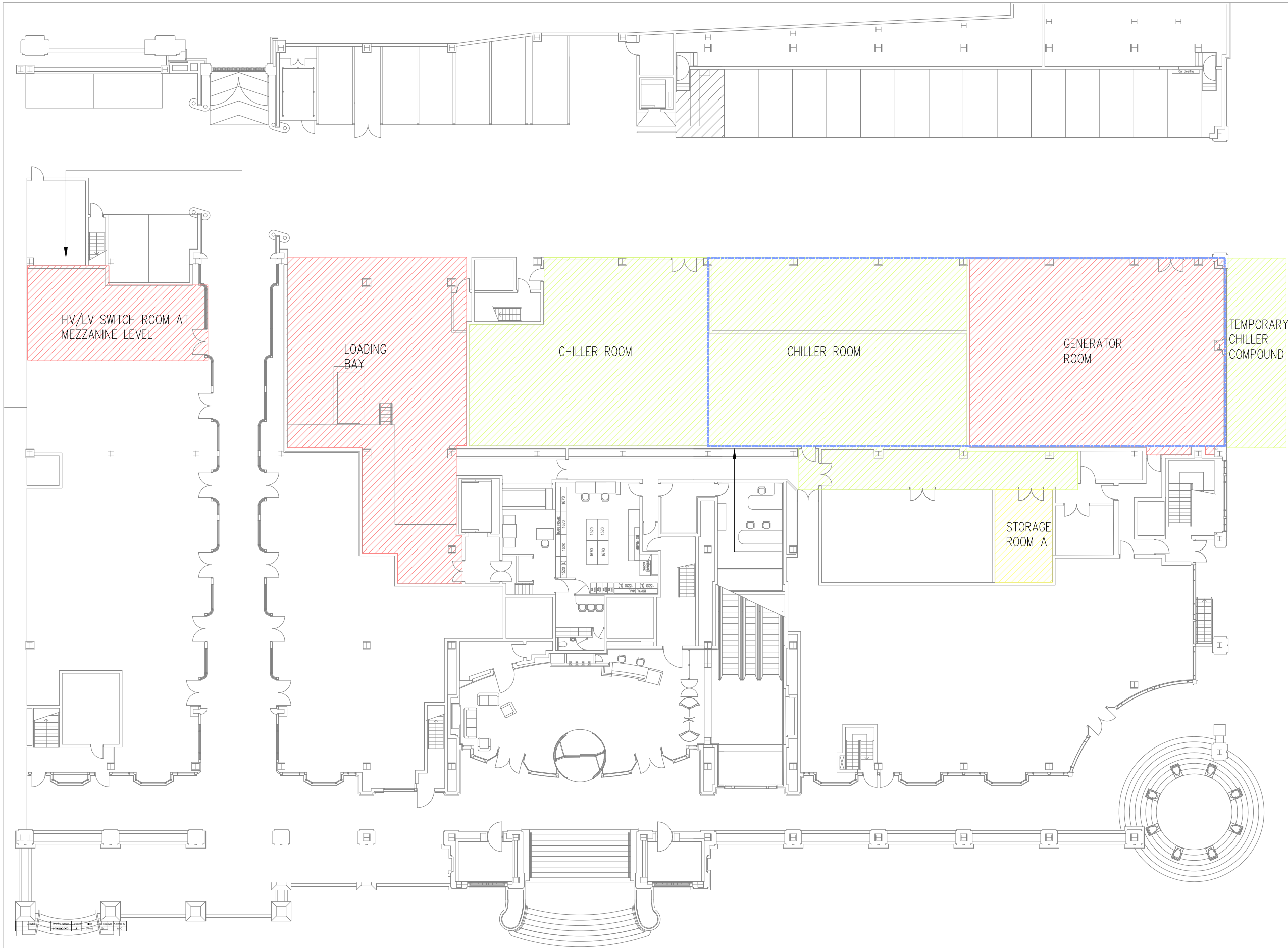
*David Wilson*

Senior Sales Engineer  
Building Efficiency  
**Johnson Controls**





## **APPENDIX G**

### **Working Area and Contractor's Facilities**

(to be attached to the final pdf document)



APPENDIX G  
Working Area and Contractor's  
Facilities

- LEGEND
-  Contractor's Working Area
  -  Working in this area is subject to working permit
  -  Contractor's Facilities
  -  Working in this areas is to subject to Event Schedule