Diamond Light Source Ltd

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DLSITT0408

Specification for the

Diamond Light Source

Front End B10

This document and any associated Annexes is classified as “**COMMERCIAL IN CONFIDENCE**”. Information provided herein should be used solely for the purposes of the tender exercise and any subsequent contract for the supply of goods and/or services to Diamond Light Source Ltd. Information should not be disclosed to third parties, other than for strictly related purposes, without the prior written consent of Diamond Light Source Ltd.

This specification will be an integral part of any subsequent contract. The tenderer must indicate whether each individual clause is accepted, and if not give a full explanation. Where alternative design features or manufacturing procedures are proposed by the tenderer, this must always be in addition to a bid that fully meets the existing specification.

Section 9 of this specification lists the information required with the tender. It is essential that this accompanies the tender reply. In the absence of this information the bid may be rejected as non-compliant.

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***Contents***

1. INTRODUCTION AND SCOPE 6

1.1 Introduction 6

1.2 Scope 6

1.3 Deliverables 7

*1.3.1* *Equipment* 7

*1.3.2* *Reports and Documentation* 7

1.4 Components Supplied by DLS 7

1.5 Timescales 8

1.6 Guarantee 8

2. GENERAL 9

2.1 Supplier’s Responsibilities 9

2.2 Contract Management 9

*2.2.1* *Contract Engineer* 9

*2.2.2* *Programme and Progress Reports* 9

*2.2.3* *Inspections* 10

*2.2.4* *Technical and Progress Meetings* 10

*2.2.5* *Approval Prior to Manufacture* 11

*2.2.6* *Approval before Delivery* 11

*2.2.7* *Final Acceptance* 11

*2.2.8* *Deviation from the Specification* 11

*2.2.9* *Subcontracts* 12

2.3 Reliability and Maintenance 12

2.4 Norms and Standards 12

2.5 Quality Assurance 12

2.6 Safety and Hazard Management 12

2.7 Drawings 13

*2.7.1* *‘As-Built’ Drawings* 13

2.8 Manuals 13

3. DETAILED SPECIFICATION 14

3.1 Overview 14

*3.1.1* *Coordinate System* 14

*3.1.2* *Front End Assembly General Requirements* 14

*3.1.3* *Support Frames* 15

3.2 Front End Components (DRG No. 1147461) 15

*3.2.1* *First Aperture & Absorber Module (DRG No. 1147462)* 15

*3.2.2* *XBPM Spool Piece Module (DRG No. 1148830)* 16

*3.2.3* *The 1st Gate Valve Module (DRG No. 1148800)* 16

*3.2.4* *The 1st Transition Pipe Module (DRG No. 1149855)* 17

*3.2.5* *Pumping Module (DRG No. 1147475)* 17

*3.2.6* *The 2nd Transition Pipe Module (DRG No. 1147463)* 17

*3.2.7* *Slits, Diagnostics and 2nd Gate Valve Module (DRG No. 1147465)* 17

*3.2.8* *Water Service & Flow Meter Assembly (DRG No. 1149910)* 19

4. GENERAL MECHANICAL REQUIREMENTS 20

4.1 Fasteners, Fittings and Water/Air 20

4.2 Construction Materials 21

4.3 Mountings and Stands 21

4.4 Services 21

*4.4.1* *Water cooling* 21

*4.4.2* *Pneumatics* 22

4.5 Guarding and Safe Design 22

4.6 Acoustic noise 22

4.7 Lifting Arrangements 22

5 ELECTRICAL SYSTEMS SPECIFICATION 23

5.1 Introduction and Scope 23

5.2 Electrical Equipment Specification 23

*5.2.1* *Motion Control Tables* 23

*5.2.2* *Temperature measurement* 24

*5.2.3* *Water Flow Switches* 25

*5.2.4* *Paddle Wheel Flow Sensor* 25

*5.2.5* *Junction Boxes* 25

*5.2.6* *Local Ion Pump Connections* 25

*5.2.7* *Inverted Magnetron (Cold Cathode) Gauges* 26

*5.2.8* *Residual Gas Analysers* 26

*5.2.9* *Bakeout System* 26

5.3 Design Constraints 26

*5.3.1* *Pneumatically Actuated Devices* 26

*5.3.2* *Cable Management* 26

*5.3.3* *Labelling* 27

*5.3.4* *Cabling* 27

*5.3.5* *Electrical Standards and EMC* 27

5.4 Subcontractors 28

5.5 Electrical drawings 28

6. VACUUM SYSTEMS 29

6.1 Vacuum Performance 29

6.2 Bakeout 29

*6.2.1* *Bakeout Parameters* 29

*6.2.2* *Bakeout Plan* 29

*6.2.3* *Bakeout System* 29

7. PACKING AND DELIVERY 31

7.1 Packing 31

7.2 Lifting 31

7.3 Shipped condition 31

8. QUALITY ASSURANCE AND TESTING 32

8.1 Quality Assurance Program 32

8.2 Welding Quality Assurance and Testing Requirements 32

8.3 Material Traceability 32

8.4 Documentation to be Supplied With Shipment 32

8.5 General arrangements for tests 32

8.6 Factory Acceptance Tests 33

*8.6.1* *Vacuum Tests* 34

*8.6.2* *Mechanical* 34

*8.6.3* *Cooling water circuit* 35

*8.6.4* *Electrical Acceptance Tests* 35

*8.6.5* *Other tests* 36

8.7 Visual Checks 36

9. TENDERING 37

9.1 Pre-tender Clarifications 37

9.2 Basis of the contract 37

9.3 Tender Evaluation 37

9.4 Information Required with the Tender 37

*9.4.1* *Forms to be completed* 38

*9.4.2* *Acceptance of DLS documents* 38

*9.4.3* *Detailed Information* 38

*9.4.4* *Cost Breakdown* 38

*9.4.5* *Delivery and Installation* 39

LIST OF APPENDICES 45

LIST OF ANNEXES 45

APPENDIX A. 46

APPENDIX B 49

APPENDIX C 52

# INTRODUCTION AND SCOPE

## Introduction

Located on the Harwell Science and Innovation Campus in Oxfordshire, Diamond is a leading facility for science, engineering and innovation.  It is the largest science facility to be built in the UK for 40 years and produces ultra-violet, infra-red and X-ray beams of exceptional brightness. This document specifies on the design of a front-end located entirely within the Diamond storage ring shield wall and located on B10. This front-end is part of a test facility that will improve Diamond’s knowledge of non-evaporable getter (NEG) materials. The front-end is intended to be used in conjunction with a test end station in Diamond storage ring. In particular, the photon stimulated desorption characteristics of NEG coated vessels will be investigated. The development of future NEG coatings and the vacuum performance of any components of interest are of direct concern for future Diamond machine upgrades.

The term ‘Front End’ refers to the section of the synchrotron that runs between the Storage Ring and the Shield Wall (refer to drawing 1147458). The Front End conditions the beam in preparation for use on the test End Station.

## Scope

The scope of the contract is to design, manufacture, test, and deliver:

1off Bending Magnet Front End (Drawing No. 1147461)

and includes the following:

Design

Contract Terms and Conditions

Supply and purchasing of materials

Procurement of commercial components

Quality Assurance (see section 8)

Manufacture of 1off Front End

Inspection

Cleaning (Ref Annex document TDI-VAC-QUA-SPC-0001)

Assembly

Vacuum Bakeout (see section 6.2)

Testing (see section 8.5 and 8.6)

Packing (see section 7.1)

Delivery (see section 7.3)

The drawings issued with this specification are offered as a reference design. They have been produced, during the Front End Feasibility Study, to validate the practicality of the Front End design. Therefore, although these drawings and associated data are available for use by the supplier, the supplier will be responsible for the adopted designs meeting the required performance criteria and for producing the necessary drawings required for manufacturing. A list of available DLS drawings can be found at the end of this specification.

The supplier is encouraged to comment on any aspect of the design and to identify possible modifications that could lead to either improved quality or reduced cost (without compromising the performance specification).

It is acknowledged that different suppliers will have different preferences and techniques for manufacturing so it is anticipated that a series of detailed design meetings will take place to agree a definitive design of the Front End. The supplier will then produce a set of detailed drawings to present to DLS for final approval prior to commencing manufacture.

If the required performance can be met or exceeded using alternative designs, technologies or materials, then these will not be excluded from consideration as long as sufficient information is supplied to justify the proposed solution. If some of the technical specifications cannot be met then this should be made clear. While it is strongly preferred that all technical specifications be achieved or exceeded, proposals that do not meet every technical specification will not necessarily be rejected.

## 

## Deliverables

The Front End will be procured as a single turnkey unit, subject to this performance specification. The system comprises:

### *Equipment*

1. One complete Front End.
2. All cabling, cable management features, and connections to junction boxes and bulkheads located on the Front End.
3. Sufficient spare parts to guarantee system operation with minimum down-time for a period of at least two years from the date of final acceptance. A table of essential spare items is listed in Appendix C. The Supplier should add to this list as appropriate.

The Front End is to be supplied ultra-high vacuum clean in accordance with Section 6 and conditioned and in a state ready for immediate installation into the Diamond Storage Ring. It is to be shipped as described in Section 7.3.

### *Reports and Documentation*

1. Kick-off meeting documentation and minutes (see 2.2.4.1)
2. Preliminary design review documentation and minutes (see 2.2.4.2)
3. Initial quality assurance assessment (see 2.2.4.1)
4. Final design review documentation and minutes (see 2.2.4.4)
5. Factory Acceptance Test Procedure
6. Factory Acceptance Test Reports
7. Full set of drawings for all supplied equipment including ‘as built’ mechanical and electrical drawings. (see 2.7)
8. Full support documentation for all items of equipment, including all installation, operation and maintenance manuals, including components supplied by a third party (see 2.8)
9. A list of any further recommend spare parts not included in the contract to guarantee long-term operation
10. Safety reports (see 2.6 )
11. C.E. Declarations of Conformity / Incorporation, as appropriate.
12. Quality assurance documents for the completed device with copies of all specified material certificates, details of all quality control checks, intermediate tests and results and Factory and On-Site Acceptance Tests procedures and results (see 8).

All documentation must be supplied in English unless otherwise agreed.

## Components Supplied by DLS

A detailed list of the proposed free-issued equipment is given in Appendix B.

Any additional equipment required from DLS must be identified in the tender response, the cost of transport, insurance and any damage to additional equipment must be covered by the supplier.

## Timescales

Following the award of the contract, the design stage shall not exceed three calendar months in length unless mutually agreed in writing. A full design review must take place within this time period. In the event of the design being incomplete after four calendar months and extension is not mutually agreed, the contract shall terminate.

DLS requires that Delivery and commissioning will commence no later than nine months after the placement of the order. The system will be installed complete and commissioned, available for operation, within twelve months of the date of placement of the order.

DLS requires the following timescales to be met:

|  |  |
| --- | --- |
| Milestone | Weeks/Months after start of contract |
| Start of contract | 0 |
| Kick-off Meeting and report | 3 weeks |
| Preliminary Design Review (PDR) | 7 weeks |
| Welding Fabrication & Process Review | 8-10 weeks |
| Final Design Review (FDR) | 11 weeks |
| Sign off of FDR Documents and Approval Prior to Manufacture | 13 weeks |
| Factory acceptance test of Front End | 7 months |
| Receipt of Delivery of Front End | 8months |
| Contract Completion | 10 |

In the event that the Supplier cannot meet these timescales, the best alternative offer should be put forward.

## Guarantee

The equipment shall be guaranteed for eighteen months following the date of delivery, or twelve months from the date of Final Acceptance, whichever is the later.

# GENERAL

## Supplier’s Responsibilities

The Supplier is responsible for meeting all the requirements of this specification and for all aspects of the performance of the device: mechanical, electrical, vacuum, thermal, as well as safety aspects, including testing and certification.

The Supplier will be responsible for the final design, the production methods and the correct performance of all the items he supplies, irrespective of whether they have been chosen by the Supplier or suggested by DLS. Any approval by DLS of the design and components does not release the Supplier from his responsibilities in this respect.

The Supplier must provide all materials required for the manufacture of the Goods as well as any necessary tooling, jigs and fixtures. He must also provide all test equipment and measuring instruments required to certify the performance of the device.

The Supplier will be required to work in close contact with DLS at all stages of the contract in order to resolve any technical issues or problems that arise in the most timely and efficient manner.

Where reference is made, within the specification or any associated document, either to a standard, a trade name or product, DLS will consider a demonstrably compatible alternative or equivalent. The Supplier is responsible for providing evidence of equivalent performance if their tender offers a compatible alternative or equivalent.

## Contract Management

### *Contract Engineer*

At the start of the contract the Supplier shall assign an engineer (the Contract Engineer) who will be responsible for all reporting to, and contact with DLS, including the production of all meeting minutes and reports. The supplier will also identify engineers responsible to cover Electrical, Mechanical and Vacuum design.

### *Programme and Progress Reports*

Within 3 weeks of the commencement of the contract the Supplier must issue a detailed programme covering the design, manufacturing, installation and testing phases in sufficient detail to allow regular progress monitoring.

Thereafter, and throughout the contract, the Contract Engineer shall supply a written report to DLS every two weeks detailing progress with respect to the programme. This report must contain as a minimum a list of activities and milestones achieved since the previous report, any slippages or technical issues which are likely to affect the performance or the schedule and any proposals to address these slippages or technical issues and an updated schedule and/or milestone list.

The Contract Engineer shall supply a backup of the CAD models and drawings with each progress report, this can take the form of either native ProEngineer Creo4 files or neutral CAD data exchange format files (stp, xt, iges etc). The models shall be placed in a zipped folder with the date of the backup as the title; this should be either emailed to the DLS engineer responsible or uploaded to the DLS FTP server.

Where slippage of more than two weeks against any milestone in the agreed program is anticipated the Supplier will both inform DLS immediately in writing, and make available evidence of all corrective action being undertaken to mitigate the impact on the contract deliverables.

### *Inspections*

DLS reserves the right to carry out periodic and/or spot contract inspections at the Supplier's premises and where deemed necessary that of its subcontractors. Contract inspections will be concerned with all contract compliance issues including programme, quality and performance.

In line with providing DLS with a detailed programme the Supplier will propose a schedule of relevant evidence, physical and documentary, that will assist to demonstrate actual monthly progress at the Supplier's premises throughout all contract stages and status in line with programme milestones.

### *Technical and Progress Meetings*

#### Kick off meeting

Within the first three weeks after the start of the contract a kick-off meeting shall take place at which the Supplier will present the plan for the execution of the contract and a Quality Assurance plan. Any plan for changing DLS reference design fundamentally should be notified to DLS. A programme of technical and progress meetings will also be agreed between the Supplier and DLS.

An agreed set of minutes will be produced following the meeting accurately recording the agreements and actions.

#### Preliminary Design Review (PDR)

Within 7 weeks of the start of the contract, a PDR will be held with the Supplier at Diamond House. At this review the Supplier will present their proposed design solution along with a functional block diagram or process and instrumentation diagram and a preliminary list of third party components. DLS and the Supplier must agree that the solution proposed is suitable and can proceed to a full design. The Supplier will also present a plan for the execution of the contract and a quality assurance plan.

An agreed set of minutes will be produced by the Supplier following the PDR accurately recording the state of the design work as well as all agreements and actions.

#### Welding Fabrication and Process Review Meeting

A meeting shall be held at the Suppliers premises prior to the final design review to approve the UHV vessel fabrication and process procedures. This will include a full review of the welding documentation, detailed drawings (including the weld design and joint details), welding equipment and environment, process gas, cleaning and storage.

#### Final Design Review (FDR)

Within 11 weeks of the start of the contract, DLS and the Supplier must agree the final design at the FDR meeting to be held at Diamond House. At the FDR the Supplier must present to DLS and any representatives the detailed final design, including:

* The mechanical layout including vacuum components
* The electrical design which includes full production circuit schematics (inclusive of all pin-out and wiring termination details) and general arrangement drawings.
* Vacuum schematics and calculations where appropriate.
* An outline of maintenance, operating and hazard management documents
* A complete list of components
* The production drawings
* Finite element analysis (FEA) report (if required)
* Complete, dimensioned assembly and component drawings of the support structure and all service manifolds
* A detailed manufacturing, installation and testing programme, with regular milestones to allow progress to be monitored
* Details of handling and cleaning of UHV vacuum parts
* The inspection and test schedules, including the plan for factory tests and a full test specification.
* Full details of factory, site and final acceptance testing.
* A Weld Plan (this is a drawing that uniquely identifies each weld and cross-references it to a supporting Weld Procedure Specification. The format of the Weld Plan will be left to the Supplier’s discretion, but must contain all the necessary information in order that the correct controls are exercised).
* The Weld Procedure Specifications.
* Welder Qualification Records (These are documents that prove that the welder/operator has the ability to produce an acceptable weld when using a WPS. Ref. BS EN 287-1, or equivalent).

The Supplier must issue the final design report detailing the proposed design, as well as a set of CAD drawings, five working days in advance of the meeting to enable inspection by DLS.

An agreed set of minutes by the supplier will be produced following the FDR accurately recording whether all aspects of the design listed above have been completed, as well as all agreements and actions.

### *Approval Prior to Manufacture*

Unless otherwise agreed in writing, DLS must approve the final design presented at the FDR within two weeks after the FDR before the Supplier proceeds to order of any materials, components or equipment required to fulfil this contract.

### *Approval before Delivery*

Delivery to DLS shall not commence until successful completion of all Factory Acceptance Tests and after written authorisation by DLS.

### *Final Acceptance*

The Final Acceptance will be complete when the Goods have been delivered to DLS and have satisfactorily completed the Testing Procedures, demonstrating full compliance with this specification. It is a condition of Final Acceptance that all supporting documentation, hazard management, maintenance and operating manuals, quality assurance documents, mechanical and electrical drawings have been received and accepted by DLS.

### *Deviation from the Specification*

During the construction, all proposed deviations from the specification must be submitted to DLS in writing; DLS will give its approval or refusal also in writing.

### *Subcontracts*

Before placing any subcontracts in excess of £10,000 the Supplier must submit to DLS details of the work to be subcontracted, the name of the subcontractor and the type and location of the subcontractor’s premises. DLS must have right of access to the subcontractor’s premises for the purpose of inspection and witnessing any tests.

## Reliability and Maintenance

All equipment shall be manufactured in accordance with the best existing techniques and recognised good engineering practices available at the time of construction. All systems shall be designed and constructed with an expected operational lifetime of greater than twenty years. Subassemblies shall be designed for repair rather than replacement.

Systems shall be designed and constructed for continuous use with minimal maintenance no more often than twice per year for periods not exceeding ten days. Maintenance outside of these periods shall not be required.

## Norms and Standards

The system must comply with the relevant EU directives. CE marking is required where appropriate. Please see annexed document MENG-GEN-STD-0002, “Standards to which all electrical and mechanical equipment supplied to DLS must comply” for further details.

It is Diamond’s preference to use harmonised standards as a means of compliance with EU directives. If harmonised standards are not used then the supplier must provide documentation detailing how the equipment supplied meets the requirements of any EU directives along with test procedures and reports.

## Quality Assurance

The Supplier shall follow a quality assurance program compliant with ISO-9001 for the design, manufacture and testing of all systems and equipment provided by them, which includes carrying out all relevant inspections and tests as detailed in Section 8.

No acceptance or approval by DLS of any procedure or test result shall release the Supplier from his responsibility in fulfilling the terms of this contract.

## Safety and Hazard Management

The Supplier shall carry out a safety assessment of the equipment and its operation. This shall be fully documented in the corresponding manuals. Any safety and risk assessments carried out as part of the CE marking shall be supplied to DLS.

DLS requires Suppliers to employ hazard management techniques to reduce the risk of personnel becoming injured as a result of interaction with their equipment.

Consideration should be made of hazards that exist at all stages of the life of the equipment, including installation, commissioning, operation, maintenance, repair, decommissioning and disposal. The analysis should include hazards that may occur during fault conditions and should include all potentially hazardous materials. The hazard management system should:

1. Identify hazards
2. Reduce severity
3. Mitigate likely hazards
4. Predict casualty rates.

A hazard database, identifying all hazards associated with the equipment, should be provided by the Supplier in outline at the design review. Any residual hazards remaining after the system has been delivered must be highlighted, identified and procedures recommended in order to mitigate the hazard as part of the hazard database which will form part of Final Acceptance documentation. The format of the document will be specified by DLS.

## Drawings

The Supplier shall provide two full set of electronic copies of the manufacturing mechanical and electrical drawings in both Autocad .dwg and Acrobat .pdf formats on a CD or DVD or provide a means of electronic file transfer such as a secure ftp file server. Details of drawing and format requirements are given in the annexed document MENG-GEN-STD-0001.

If 3D CAD is used to generate 2D drawings for the front end, the 3D models should also be provided. DLS prefers native ProEngineer Creo4 files. If the Supplier uses another 3D-software package then the model files should be exported to PTC CREO format. Additionally a spreadsheet will be required which contains the correct attributes to allow DLS to import the files into PDMLink. If this is not possible then a universal 3D file (IGES or STEP) can be offered. DLS can supply a spreadsheet template in Microsoft Excel format as shown below. If the Supplier wishes to utilise DLS drawing numbers, blocks of numbers will be issued to the Supplier on request.

E.g. Excel Spreadsheet sample layout

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Drg Name** | **Drg No** | **Title\_1** | **Title\_2** | **Title\_3** | **Rev** | **Drn By** | **Drn Date** | **Ckd By** | **Ckd Date** | **App By** | **App Date** |
|  |  |  |  |  |  |  |  |  |  |  |  |
| xxxxxxx.pdf | xxxxxxx | XXXX | XXXX | XXXX | A | XX | ####### | XX | ####### | XX | ######## |

In addition to the sets of final drawings described above, the Supplier shall make drawings available for technical and progress meetings as detailed in 2.2.4, for DLS inspection and approval.

All labelling and documentation must be in English.

### *‘As-Built’ Drawings*

Where deviations from the information or dimensions contained in the manufacturing drawings is authorised by DLS during manufacture, the Supplier must note the changes. A final set of ‘as-built’ drawings and inspection reports must be provided in the same manner as for the manufacturing drawings described above.

## Manuals

Detailed installation, operation and maintenance manuals shall be prepared for the system. Included in the manual shall be detailed assembly/disassembly and alignment instructions, routine maintenance requirements, fault diagnosis instructions, start-up and conditioning procedures. Supporting these requirements shall be appropriate mechanical and electrical schematic drawings and diagrams, and process & instrumentation diagrams.  
The maintenance schedule shall include a description and justification for each operation, the conditions under which it must be performed and an estimate of the time required.

Manuals must meet the requirements detailed in any EU directives / harmonised standards applied.

# DETAILED SPECIFICATION

## **3.1** Overview

### *Coordinate System*

Y

Z

X

Inboard

Outboard

Upstream

(towards source)

Downstream

(away from source)

Yaw

Pitch

Roll

In the following text the X-axis is horizontal and perpendicular to the beam pointing away from the centre of the Storage Ring, the Y-axis is vertical and perpendicular to the beam and the Z axis is in the direction of the beam.

### *Front End Assembly General Requirements*

The location of this equipment provides very limited access between the adjacent shielding wall and accelerator components. **The supplier must maintain the space envelope between the Shield Wall, Storage Ring Girders, Dipole Cable Tray in B10 front end area and the Front End defined in sheet 1 of drawing 1147458 and Creo Model 1147460, including all mechanical and electrical services.**

To aid the assembly of the Front End at DLS each module must be prepared so that it can be re-assembled in any order. This can only be achieved by allowing adequate space between each module to facilitate the removal of blanking flanges and the making of vacuum joints. The supplier must include bellows support bars for compressing the bellows and, where necessary, the bellows must be removed and shipped separately.

All 500 l/s ion vacuum pumps must be mounted with a method of locking the position during transport, and must be mounted in a manner allowing quick and simple removal from the module once installed (telescopic rails or similar).

The 1st Aperture & Absorber Module should have a levelling T-piece, while Slits Module should have a pair of levelling T-piece placed at opposite ends of the module. If the design cannot accommodate this it should be agreed with the DLS project engineer.

All flange supports (if required) must include adjustment in all planes and rotation about X, Y & Z axis (Pitch, Yaw & Roll).

### *Support Frames*

The Front End is sited in a restricted area so it must be capable of continuous operation over long periods without maintenance. The support frames must be rigid construction and constructed so that they minimise the effects of ground vibrations. The support frames of all modules are fixed to the floor by welded floor plates with jacking screws. **The positions of floor plates of all modules in Diamond reference design have been surveyed in the storage ring and confirmed to suit the existing installations in the ring.**

**The nominal beam height is 1400mm from the floor. The floor height varies ± 15mm from its nominal height. All support frames are required to be adjustable for floor height variations.**

## Front End Components (DRG No. 1147461)

The individual components that make up the Front End are described in detail below in the order they appear working “downstream” from the connection to the Storage Ring Beamport.

### *First Aperture & Absorber Module (**DRG No. 1147462)*

* + - 1. *Pumping Tee & 1st Aperture Assembly (DRG No. 1148880)*

This assembly contains a pumping Tee sized for a 500 l/s Ion pump (free issue). Bellows have been included as part of the pumping Tee to allow sufficient movement to take place during alignment of the 1st Aperture. The Ion pump is to be mounted on sliding mounts to allow easy removal/replacement.

The 1st Aperture is constructed from an OFHC copper body with cooling channels machined within the body which are connected, externally, by vacuum brazed copper or stainless steel connection pipes and stainless steel inlet and outlet pipes. The OFHC copper body is brazed to stainless steel flanges. Both the First Aperture and the pumping tee are mounted on a support system that has translational and rotational adjustments. They are positioned manually by the use of translation adjusters mounted within the support system and aligned using survey spheres mounted on the upper surface.

Two PT100-type temperature sensors with Ø3mm probe inserted into the aperture body will enable monitoring of the temperature. It is expected the end of the PT100 probe is 8mm from the internal heated surface of the First Aperture.

#### Absorber & Pumping Tee Assembly (DRG No. 1148860)

The Absorber prevents exposure of the all-metal pneumatic gate valve, located downstream, to synchrotron radiation. It must therefore be fitted with switches to indicate whether the absorber is open or closed. The signal obtained from closing the absorber will be used to allow closure of the vacuum valve. The time taken to close the Absorber must not exceed 2 seconds and it must have a smooth and vibration free operation so that it does not impart vibration to other components in the Front End. The switches must be separate mechanical switches. Magnetically operated types are not acceptable.

The Absorber plate is constructed from OFHC copper and is prevented from overheating by the attachment of copper, or stainless steel, cooling water pipes. The cooling pipe connects to the front end water service using Swagelok union fittings. The copper pipe is more prone to damage when making connections of the fittings. If a copper pipe is used, a pipe protection design should be provided to prevent the damage of the pipe.

A pneumatic actuator provides the movement that is required to position the absorber body and must be controlled by a solenoid operated valve with spring return. The valve must be of a type that does not require lubrication. The pneumatic circuit must include an air pressure switch that acts to close the absorber in the event that a significant pressure drop in the pneumatic system occurs, as described in TDI-EENG-DSGN-0002 Electrical and Control Systems Interfacing Standard.

The absorber body has two positions, it allows the beam to pass when it is in its upper position, or, it is in the path of the beam when it is in its lower position.

The absorber should fail in the closed position in the event of foreseeable failures of the absorber mechanism, or of external services such as compressed air or electrical power.

This assembly also contains a pumping tee sized for a 150 l/s ion pump (free issue).

The cooling water supply pressure will be approximately 9 bar but the return pressure will be at approximately 3 bar, so the cooling system pipework must be designed carefully to achieve the required flow velocity of 4.5 m/sec given the available pressure difference of 6 bar.

### *XBPM Spool Piece Module (DRG No. 1148830)*

The XBPM Spool Piece is used to make up the vacuum space between the First Aperture & Absorber Module and the 1st Gate Valve Module. It is a spare assembly from DLS. The vessel, its support stand and its bellows (DRG No 1006617, 1148833, 1119348 & 1148831) are free issue items.

### *The 1st Gate Valve Module (DRG No. 1148800)*

The DN100 Series 48 valve (free issue) is an all-metal pneumatic valve that is remotely actuated in the event of vacuum failure either on the Front End or on the test end station. The absorber protects it from exposure to synchrotron radiation, and must, therefore, be interlocked to it. The valve must fail in the closed position, after closure of the absorber, in the event of foreseeable failures of external services such as compressed air or electrical power.

There is a connection beam Pipe Piece (1148802) upstream of the 1st Gate Valve so that the Gate Valve could be positioned away from the access ladder of I11 Front End to avoid any clashing.

The DN100 Series 77 fast closing valve (free issue) is an all-metal pneumatic valve that is remotely actuated in the event of vacuum failure either on the Front-end or on the test end station. This valve provides a restriction to a shock wave propagating, towards the storage ring, from a vacuum leak downstream, in the Front-end or test end station, hence, preserving vacuum on the storage ring and vice versa. There is no protection offered to this valve so its closure must have the necessary links to the control system to initiate a beam dump. It must be fitted with position sensors linking it to the control system. It will be automatically triggered by pressure sensors located in the vacuum system and will employ a dual line system so that the incidences of false beam dumps are minimised. The dual line system uses two pressure inputs, both of which must be activated before the flap is activated.

### *The 1st Transition Pipe Module (DRG No. 1149855)*

This module consists of a beam pipe mounted on support brackets that have translational and rotational adjustments. The pipe is positioned manually by the use of the adjusters within the support system and aligned using survey spheres mounted on the upper surface.

### *Pumping Module (DRG No. 1147475)*

The Pumping Module contains a pumping tee and a 500 l/s Ion pump (free issue). Pumping tee is mounted on a support system that has translational and rotational adjustments. The Ion pump is to be mounted on sliding mounts to allow easy removal/replacement. The module is aligned using survey spheres mounted on the upper surface.

### *The 2nd Transition Pipe Module (DRG No. 1147463)*

This module consists of a beam pipe mounted on support brackets that have translational and rotational adjustments. The pipe is positioned manually by the use of the adjusters within the support system and aligned using survey spheres mounted on the upper surface.

### *Slits, Diagnostics and 2nd Gate Valve Module (DRG No. 1147465)*

* + - 1. *Slits Submodule (DRG No. 1147466)*

*a) Overview*

The Slit Submodule consists of an Upstream Slit Block, a Middle bellow assembly (welded fabrication of two DN100 x 175mm bellows) and a Downstream Slit block. Each slit block is mounted on motorised stages enabling motion in the X-axis and capable of supporting the loads generated by the mass of the slit block and vacuum forces. Two identical DN100 x 175mm bellows mounted at either side of the Slits Submodule allows sufficient movement to take place during alignment and operation. The Middle bellows connect two slit blocks. The Middle bellows is braced back to the top plate of the frame, isolating the forces of one slit from the other. The module shall be designed to be a highly stable unit so that the beam edges do not move with time.

*b) Operation*

The slits can be moved from a maximum opening, allowing a beam fan of 1.59mrad through, to a fully closed position blocking the whole beam. When the slits are fully closed, both upstream and downstream slit blades have a 0.7mm overlap to beam axis, the bellows are in neutral positions. The slits shall also be capable of a horizontal scanning operation, where the slit blocks are opened a set amount, and then driven through the beam in a horizontal motion. At the extreme ends of this scan, the upstream slit will be driven inboard taking a beam fan of 2.2mRad (~176W); the downstream slit will be driven outboard taking a beam fan of 2.6mRad (~208W).

*c) Slit block*

The apertures are manufactured from OFHC copper, and have an inclined face wire eroded into the block. The design should allow a sharp crisp edge to define the beam edges but eliminates sharp corners that increase thermal stresses. There are water cooling channels machined within the body which are connected, externally, by vacuum brazed copper or stainless steel pipes. The body is vacuum brazed to stainless steel flanges.

A tungsten blade on the beam defining edge is required to provide increased edge definition. It is fitted to the downstream end of the copper block. The blade shall be fitted so that the tungsten edge protrudes 200µm above the edge defined by the inclined absorber. The blade must be removable from the copper block. The supplier shall determine a method of fastening these tungsten blades. Each tungsten blade should have a knife edge with a 2 degree trailing edge. The knife edge should be straight to within <10microns and a surface roughness better than Ra 0.2µm.

During operation of the unit the blade edge pairs must remain parallel to within 80microns.

Each slit shall be fitted with a PT100 temperature sensor (as shown on the body detail drawing).

*d) Motion*

Each slit is fitted to motorised linear X stage. The stage must have mechanical stops to prevent the un-cooled surfaces of the slit assembly being driven into the path of the beam and over stretch bellows connected to the slits. The hard stops are required to be adjustable to have flexibility for future adjustments of hard stop positions. The stage must also have a means to manually move the stage, such as a hand wheel adjuster. The stage will have vernier scales on its axis to give visual indication of the stages position. The stages should be orientated to allow easy access to manual hand wheels on both sets of slits. The stage should allow easy access for limit switches.

The preferred stage supplier is Huber due to existing spares and knowledge at Diamond. The relevant calculations showing gravitational and vacuum loads on the stages must be submitted at the first design review.

**Slit Axis and Motion Stages**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Motion Range From Beam Centre Axis (mm) | Accuracy | Repeatability | Encoders | Manually Move\* | Adjustable Hard Stop From Beam Centre Axis (mm) |
| Axis | X | X | X | X | X | X |
| US Slit | ±9.38 Beam Fan Posn +8.68 | ±10µm | ±3µm | Yes | Yes | ±10.2 |
| DS Slit | ±9.57 Beam Fan Posn -8.87 | ±10.2 |

\*Vernier scales on axis to give visual indication of the stages position

* + - 1. *Fluorescent Screen Module (DRG No. 1148841)*

The Fluorescent Screen Assembly (model number is 1091550) is identical to the one that has been used by Diamond B24 beamline. It is supplied by CINEL and CINEL model number is F9AN6600. The fluorescent screen has two positions, it allows the beam to pass when it is in its upper position, or, the beam is at the centre of the screen when it is in its lower position.

The Fluorescent Screen Assembly (model number is 1091550) is mounted on a pumping Tee sized for a 500 l/s Ion pump (free issue).

DLS will order the Fluoresent Screen Assembly (1091550) from CINEL and free issue to the supplier to fit on the pumping Tee vessel for FAT test.

It is planned that Diamond will assemble the YAG screen after having the delivery of the Front End.

* + - 1. *Orifice Submodule (1148810)*

The Orifice at downstream of the front end is used to regulate the conductance for the test end station. It is manufactured from OFHC copper, and has a tapered aperture with a Ø28mm entrance and a Ø30mm exit. There are water cooling channels machined within the body which are connected, externally, by vacuum brazed copper or stainless steel pipes. The body is vacuum brazed to stainless steel flanges.

The Orifice is aligned to beam axis by survey spheres mounted on the upper surface. This is to prevent accidental illumination of the Orifice internal surfaces that could cause unwanted outgassing and ruin measurement of the vacuum test.

* + - 1. *The 2nd Gate Valve Module (DRG No. 1149861)*

The DN100 Series 48 valve (free issue) is an all-metal pneumatic valve that is remotely actuated in the event of vacuum failure either on the Front End or on the Test End Station. The absorber protects it from exposure to synchrotron radiation, and must, therefore, be interlocked to it. The valve must fail in the closed position, after closure of the absorber, in the event of foreseeable failures of external services such as compressed air or electrical power.

### *Water Service & Flow Meter Assembly (DRG No. 1149910)*

The water cooling pipe work in the reference design has been routed to the required components along the outline of component frames. Supplier should follow the water service routes defined in the reference design to avoid clashing with existing installations such as dipole cable tray and cable trunks in the storage ring.

Flexible hoses are used to connect the water channels of the Aperture, Absorber, Slits, Fluorescent screen and Orifice to the water service of the Front End. The flexible hose loop connections on fixed components are preferred to be made vertically where is possible as the space between the front end components and the shielding wall is limited. On moving component, the hose loops are required to be in-line with the travel directions of actuators or motion stages.

General water service requirements are in section 4.4.1.

* 1. **Survey and Alignment**

The Front End must be designed so that nothing obstructs the surveying of the module survey mounts.

For alignment and survey purposes, two levels of adjustments are required. The first level is adjustment of the individual components and the second level is adjustment of the support frame or the support table.

For the first level of alignment, if not specified individually, each component must be supported on three kinematic mounts and must be designed to allow minimum movement of ±7.5mm in any direction and be capable of being positioned to within ±0.1mm.

For the second level of alignment, the support frames and tables must also be designed to allow minimum movement of ±7.5mm in X and Z direction. The movement is ±15mm in Y direction to cover floor variations and be capable of being positioned to within ±0.1mm.

The height reference for the Front End will be transferred from one of the Storage Ring survey monuments. Co-linear alignment of the Front End with respect to the incoming straight will be established by mounting a Laser Tracker on a storage dipole magnet. Tilt of the Front End will be measured using a bubble level, with an accuracy of 0.1mm/m, placed across the top surface of the survey sphere monuments, or the levelling T-pieces on the frames/ tables.

The components must be pre-aligned on the support frames/tables before installation in the tunnel. This will make the process of installation straightforward because when the support frames are surveyed into position all the Front End components will be correctly aligned.

The nominal beam height is 1400mm from the floor and is 124396mm from mean sea level.

The concrete floor has a minimum level specification of 5mm/3000mm.

Survey fixtures must be provided on the support structures for the DLS standard survey mount (DRG No. 1002244), the proposed positon of each mount must be approved by DLS during the FDR. Where possible all survey points should be kept at a constant level relative to the concrete floor. The survey fixtures must be fiducialised to the beam axis of the vacuum vessels sufficiently accurately to allow the vessels to be installed to the following tolerances:

Displacement tolerance (x, y, z) ± 0.25 mm

Angular tolerance (pitch, yaw) ± 1 mrad

Angular tolerance (roll) ± 2 mrad

# GENERAL MECHANICAL REQUIREMENTS

## Fasteners, Fittings and Water/Air

All in vacuum and conflate flange fasteners must be silver plated austenitic stainless steel ISO metric type. All other equipment shall use austenitic stainless steel ISO metric fasteners, nuts and washers throughout. If this is not possible, then each deviation from this shall be notified by the Supplier, detailing position, thread form, size, etc. The Supplier will be required to supply spare fasteners for each case of using non ISO metric fasteners, nuts or washers; the quantities are to be agreed with DLS.

All equipment shall use metric tube for water, air, etc. throughout.

Details of the fasteners and fittings required for vacuum assembles are given in the DLS Standard Vacuum Requirements Annex (TDI-VAC-QUA-SPC-0001).

## Construction Materials

Details of the construction materials required for vacuum vessels and components are given in the DLS Standard Vacuum Requirements Annex (TDI-VAC-QUA-SPC-0001).

## Mountings and Stands

All stands and supports are to be painted in RAL1014 dark Ivory - smooth, not textured.

## Services

### *Water cooling*

The operating inlet pressure of the deionised water cooling system is 9.5bar g, and the return pressure is 3.0bar g. The maximum pressure drop the system can provide is 6.5bar.

The water connections to the main water supply are on the upstream side of the Front End where the pipes terminated on the vertical section shown in reference design. It is not required to supply fittings here.

The Supplier is responsible for distributing cooling water, and fitting any flow control and monitoring equipment required, having agreed this installation with DLS. The Front End frames will be fitted with clamps to allow mounting of the cooling water circuits. Each circuit will contain flow and return mains water supply connections and other fittings necessary to distribute balanced cooling water supplies to the required Front End components.

The water cooling pipe work must be designed to minimise noise and vibration as much as possible, this should include but not limited to; bleed points for trapped air removal, large pipe bend radii and minimise abrupt cross section changes.

Flow may require restriction to achieve a minimum flow velocity of 4.5m/sec through the cooled components, but this should be reduced to 1-2 m/sec in the supply and return pipe work as close to the cooled component as possible. PT100-type temperature sensors inserted into the copper bodies will allow monitoring of the temperature.

The cooling system must have sufficient drain valves to enable complete and easy draining. This facilitates the purging of the system in preparation for the bakeout process.

The cooling water circuit schematic is referenced in drawing list at the end of this specification.

Details of the flow switches are given in section 5.2.3. Stauff test points (SKK20 G1/4 EB) are fitted to the main feed pipe and each return circuit of flow meter assembly attached to a module fame.

DLS will provide George Fischer VA flow meters with two magnetic limit switches, the transition taper unions (1015857), the orifice parts (1086151) and Swagelok unions connecting to the orifice stems. The supplier should adhere to the George Fischer recommendation for the lengths of straight tubing before and after the flow switches.

The water cooling circuits must only have demineralised water passed through them. A permanent supply, or a sufficient stored quantity and pressurising equipment must be available to hydrostatically test the completed water system.

Hydrostatic test Pressure for water circuit(s) = 1.5MPa (15 bar) gauge internal pressure.

Water tubes must be stainless steel grade AISI 304 wherever possible. Small water tubes must use Swagelok metric twin ferrule compression fittings throughout. Manifolds and pipe work must be welded assemblies wherever possible. **PTFE (or similar) sealing tapes must not be used**. Loctite® 5772 radiation grade thread locking compound should be used where appropriate.

The Supplier must ensure that any brazed joints, valves or pipes are compatible with demineralised water.

There must be NO aluminium in contact with the demineralised cooling water.

If the temperature control requirements cannot be met using the supplied cooling water circuits alone, then it will be the responsibility of the Supplier to propose, and detail, an alternative method at tender.

### *Pneumatics*

A single compressed air supply (oil-free 5 bar, 10µm filtration) is provided for operating valves etc. The Supplier must state his requirements for any specific pressures or equipment (e.g. dryers) required.

PTFE (or similar) sealing tapes must not be used.

## Guarding and Safe Design

In addition to mandatory requirements detailed in the EU machinery directive (2006/42/EC) machinery guarding and safe design must be carried out to DLS satisfaction.

## Acoustic noise

The level of acoustic noise for the equipment shall not exceed 60 dBA at 1m.

## Lifting Arrangements

How equipment is going to be transported, assembled, installed and maintained must be considered from the earliest stages in the design, including arrangements for lifting.

All equipment supplied must comply with the Provision and Use of Work Equipment Regulations (PUWER) and the Lifting Operations and Lifting Equipment Regulations (LOLER).

Diamond has appointed a LOLER Competent Person and the supplier must provide information on proposed lifting arrangements and method statements for approval at Final Design Review (FDR).

# ELECTRICAL SYSTEMS SPECIFICATION

## Introduction and Scope

This section defines the Instrument and Electrical requirements for the equipment located on the Front End devices.

This includes:-

1. Installation and commissioning of all Electrical and Instrumentation devices on the Front End Mechanical Structures.

2. Supply of motors and encoders, required for the functionality of the Front End Slits.

3. All electrical cable, the routing of circuits (including cable tray/trunking) and all terminations required to connect the Instrumentation mounted on the Front End structure, to the local junction boxes/bulkheads (supplied and mounted on the Front End Modules).

4. All the design documentation to enable any subsequent Front End to be tendered for and built.

5. All electrical equipment must comply with the TDI-EENG-DSGN-0003 Machine Wiring Standard.

## Electrical Equipment Specification

This section details the technical requirements for the Electrical/Instrumentation items located in the Storage Ring, which are associated with the Front End.

NOTE:

The Axis Names, Tag Names and bulkhead connections in the following tables and sections begin FEnn where FE is an abbreviation for Front End, and nn will be replaced by the particular number associated with the Front End. Refer to drawing 1151980 for tag names.

Connection details for each circuit shall be to DLS standard Front End design. DLS Standard Front End drawings describe the usual arrangements which must be modified at the design stage by the Supplier and agreed by DLS at the Design Review.

All electrical equipment, including but not limited to switches, should be easily accessible.

The Electrical/Instrumentation equipment on the Front End is to be delivered as part of the mechanical structure. This comprises of:

### ***Motion Control Tables***

This section details the specifications for the mechanical stages, motors, encoders, limit switches and associated cabling.

#### Mechanical Tables

See Table 1 in Appendix A for axis details.

#### Motors

All axes are to be fitted with stepper motors with connectors fitted to the linear tables. Terminations to the connections to be approved by DLS during the design phase.

#### Encoders

All axes are to be fitted with Rennishaw incremental linear encoders, with connectors fitted to the linear stages. The selection of encoders is to be approved by DLS. The encoder’s specified resolution and repeatability should be achievable immediately after a power off situation. The selected encoder must be capable of maintaining the stated accuracy and repeatability with cable distances of up to 30 metres between the encoder and the controller. Terminations to the connectors to be approved by DLS during the design phase. The encoder and motor connections are to be separate from each other, and use different connectors to prevent incorrect hook-up occurring. All encoder read heads should be easily accessible and adjustable.

#### Limit Switches

Other than pneumatically operated devices, all axes are to be fitted with precision Home and Limit switches compatible with system accuracy, and connectors fitted to the linear tables. Terminations to the connectors to be approved by DLS during the design phase. Limit switches must be normally closed. All Low limit switches must be high precision models, with a repeatability of <10µm.

#### Cables

Any cables supplied for the Motors, Encoders and Limit Switches are to be Low Smoke Zero Halogen with an overall braided screen. Best practice is demanded in the selection, layout and routing of all cabling and containments to maximise EMC performance as described in TDI-EENG-DSGN-0003.

#### Cable routing

The location of this equipment provides very limited access between the adjacent shielding wall and accelerator components. Therefore the provision of cable trays and other cable management features to eliminate trailing cables and maximise the access space is a very important aspect of the design. This includes the management and protection of cables running on the floor leading up to the Front End components. No part of the Front End shall occupy the space between the Shield Wall and the Front End components defined in drawing 1122270, including all mechanical and electrical services. The proposed cable routes will be an important feature of the design review.

### *Temperature measurement*

See Appendix A for details of the requirements for the temperature measurement associated with the Aperture, Absorber and Slits. These temperature sensors must not be obstructed by surrounding components, and should be easily accessible. Temperature sensors should not be bent.

### *Water Flow Switches*

The flow switches supplied by DLS are from the George Fischer SK range. They are made of Polysulphone and are sized according to expected flow rate. There are Variable Area flow meters with a visual scale; two magnetic limit switches (GK11) can be attached on a slider on the outside of the site glass.

See Appendix A for details of the electrical requirements for the Water Flow Switches on the cooling water supply.

### *Paddle Wheel Flow Sensor*

A George Fischer 2536-T0 paddle wheel flow sensor (free issue) is mounted downstream of the main return circuit. This sensor and flow meter body are all free issued by DLS.

### *Junction Boxes*

A junction box is to be fitted to the Absorber Module to terminate all the temperature measurements, water flow switches and the water flow meter for the Fixed Aperture and the Absorber. All Junction boxes must be easily accessible when installed and their positions must be agreed during the FDR.

#### General Arrangement.

The junction box general arrangement can be found on drawings 1033389.

#### Termination details

The termination details for the junction boxes can be found on electrical drawing 1127065. This drawing shows the termination details and cable numbers for the water flow instruments and temperature measurements on the Front End. Terminal blocks must be indirect screw clamp types and all wires must be terminated with ferrules. Junction boxes should connect to cables from the bottom face of the enclosure. Connectors must use crimp pins of the machined-contact variety. Stamped pins are not to be used.

### *Local Ion Pump Connections*

There is a requirement to mount the free-issued HV bakeable ion pump cables local to each ion pump on the Front End. DLS will supply a drawing for a bracket to accommodate the ion pump cables (Drawing No 1032573).

DLS will supply the ion pump heater cable between an ion-pump-mounted high temperature terminal block and bulkhead-mounted connector (Hirschmann STAK 3N). The connectors are not free-issue items but safety covers for the connector terminals (SK0147) will be supplied. The cables are to be connected to 230V locally by the supplier via junction boxes using the mating cable connector (Hirschmann STAS 3N).

References: - Gamma Vacuum MPC Ion Pump Manuals and DLS Electrical drawing 1151980, the current version can be confirmed by DLS before contract placement.

### *Inverted Magnetron (Cold Cathode) Gauges*

There is a requirement to mount the free-issued SHV and BNC bakeable inverted magnetron gauge cables and connectors, local to each inverted magnetron gauge on the Front End. DLS will supply a drawing for a bracket to accommodate the IMG cables (Drawing No 1032573).

References: MKS Vacuum Gauge Manuals.

### *Residual Gas Analysers*

The Residual Gas Analyser (RGA) consists of a probe, cable with bakeable adaptor and control unit. There is one RGA probe to be fitted to the Front End.

References: MKS RGA manuals and drawing LM76-093-C, and DLS electrical drawing 1151980.

### *Bakeout System*

The bakeout jackets mains cable connector - Hirschmann STAS 3.

Thermocouple connector - sub mini K-type thermocouple plug.

Three core fiberglass insulated oversheath cable shall be used for the wiring of the bakeout system (Section 6.2). Any cabling or components not compatible with bakeout must be clearly identified and must be easily removed.

## Design Constraints

In producing the design of the control system the following constraints must be adhered to:

### *Pneumatically Actuated Devices*

To harmonise the control philosophy and electrical connection of all the Pneumatically Actuated Devices around the DLS machine each pneumatically actuated device is to be fitted with the following equipment: -

1. A 24V DC solenoid operated valve mounted on the actuator body. Power to open.

2. Two (2) open limit switches and two (2) closed limit switches mounted on the actuator.

3. An air pressure switch, monitoring the air supply to the solenoid valve, mounted on the actuator body. The air pressure switch shall be wired to be fail safe and set at 4.5 bar falling.

All the actuator equipment is to be terminated in a valve mounted junction box and will be connected to the control system via a 12-way series plug and socket.

The solenoid operated valve, air pressure switch and limit switches shall be wired into the junction box in the same configuration as the equipment supplied on the free issue VAT Vacuum valves. For typical arrangement see DLS drawing 1005251.

### *Cable Management*

The supplier will be responsible for providing a cable management system for any cables associated with the Electrical Instrumentation devices on the Front End. Cable containment information is detailed on the various Front End Module drawings. Any cable management system that is installed must comply with the associated standards and guidelines listed in Annex C.

The space between Front End components and the ratchet wall is extremely limited. The layout of mechanical components as well as mechanical and electrical services must cause absolute minimum obstructions in this region. The supplier must maintain the space envelope between the Shield Wall and the Front End defined in sheet 1 of drawing 1122270, including all mechanical and electrical services.

Due to the modular construction of the Front End, consideration must be given to the design of the cable management system, to accommodate practical assembly and disassembly of the individual Front End modules, for installation and maintenance purposes. The mounting of any cable tray or trunking must not interfere with the access around the Front End, once the complete device is installed into the Storage Ring. Any design must be approved by DLS during the design phase. The entry and exits from the junction boxes must be oriented to minimise the space requirements of the plug or termination.

Any cable crossing the plane of radiation at 1400mm +/- 150mm from floor level will suffer radiation damage. Therefore all cables should avoid this plane where possible. If crossing this plane is unavoidable, then precautions must be taken to minimise insulation damage, or the cables should be easily replaceable. Where possible, cables should be routed on the side of the equipment adjacent to the ratchet wall.

### *Labelling*

All equipment is to be clearly labelled with appropriate safety warning labels, both inside and outside serviceable enclosures. The labelling material is to be durable, offering resistance to abrasion, smudging, heat (-45 to 155ºC), moisture and solvents. The fixing method is to be permanent allowing adhesion to textured surfaces. The text format and labelling convention is to be agreed with DLS at, or before, the Final Design Review.

### *Cabling*

All cable and wiring must be LSOHFR (Low Smoke, Zero Halogen, Fire Retardant) unless specifically agreed otherwise, complying with IEC 60754-1 and IEC 60332. The oxygen index must be higher than 28 and acid gas emission less than 4% for the outer sheath. PVC compound must not be used. Wire and cabling sizes and colours are to meet the requirements of DLS and the current edition of the IEE Regulations. Where movement is required, cable must be highly flexible, having minimal effect on mechanical performance, but offering suitable mechanical protection. The equipment is to be suitably earthed with all sub-assemblies and components bonded to a main earth terminal.

All Cables are to be identified at both ends using cable markers applied to the cable by using a carrier strip and cable ties. All visible cores of the cable are to be identified such that they can be related to their associated multi-pair cable. Cable numbers required for any electrical or measurement device fitted to the FE structure are shown on 1127065.

### *Electrical Standards and EMC*

Electrical safety and Electromagnetic Compatibility are very important to DLS. However the Supplier is required only to provide a very limited part of the electrical installation and their responsibility is only for good practice in fitting those parts.

The provisions of the Machine Wiring Standard should be observed. The detailed design of DLS Standard Front End installation should be applied so far as practical and modifications should be implemented to the same standard. Documentation should also be to the same standard.

All modules should have an earth stud fitted, typically a 6mm stud surrounded by an unpainted area of metal 25mm diameter (must be shown on models and drawings).

Cable containment must be provided on the modules for both local wiring provided by the supplier and provision for field wiring cables to be installed by DLS. The cable containment must be electrically bonded to the module structures.

The various modules will have to be split for transport to DLS and installation in the Storage Ring. All cables must be secured and no loose cable over 200mm long is permitted.

More details on the required EMC performance can be found in the documents TDI-EENG-DSGN-0003.

## Subcontractors

Any electrical subcontractors used must be familiar with UK electrical installation practices and standards and will be subject to DLS approval.

## Electrical drawings

The electrical drawings issued with this specification are offered as a reference design. They have been produced, during the Front End Feasibility Study, to validate the practicality of the Front End design. Therefore, although these drawings and associated data are available for use by the supplier, the supplier will be responsible for the adopted designs meeting the required performance criteria. A list of available DLS electrical drawings can be found in LIST OF DRAWINGS.

Electrical drawings must be provided in AutoCAD 2D format to the requirements detailed in MENG-GEN-STD-0001, Issue 1 Drawing and Format Requirements.

Full maintenance information must be provided, sufficient to locate faults down to individual electronic component level, including but not limited to:

1. System block diagram and General Assembly drawings

2. Sub-assembly drawings including component layout and electrical schematics

3. Setting up, calibration or configuration instructions, if required.

# VACUUM SYSTEMS

Details of the vacuum system requirements are given in the DLS Standard Vacuum Requirements Annex (TDI-VAC-QUA-SPC-0001).

## Vacuum Performance

The complete vacuum system must meet the following vacuum requirements.

|  |  |  |
| --- | --- | --- |
| Pressure | < 5.0·10-10 | mbar |
| Leak Rate | < 1.0·10-10 | mbar·l/s |
| Outgassing Rate | < 1.0·10-12 | mbar·l/s·cm-2 |

Post-bake RGA scans must show the complete vacuum system meets the following requirements.

|  |  |
| --- | --- |
| Suitably well baked | AMU 2 > x 5 AMU 18 |
| Leak tight | AMU 28 > x 4 AMU 32 |
| AMU 14 < AMU 16 |
| General Contaminants  (as defined in the DLS Standard Vacuum Requirements Annex, TDI-VAC-QUA-SPC-0001) | < 0.1 % |
| Chlorine Residue  (sum of AMUs 35 & 37) | < 0.05% |
| Hydrocarbon Residue  (sum of AMUs 69 & 77) | < 0.05% |
| Fluorocarbon Residue  (sum of AMUs 19, 31, 50 & 59) | < 0.05% |

## Bakeout

All vacuum components, including vacuum gauges and valves are to be included in the bakeout system hot zone.

### *Bakeout Parameters*

Bakeout of the complete system to 250°C ± 20°C for a minimum of 24 hrs at the maximum temperature is required. Throughout the bakeout the rate of change of temperature must not exceed 20°C/hr and any ion pump heaters must be on during the bakeout. The bakeout temperature must be controlled until the system cools below 50°C

All vacuum equipment (pumps, gauges, RGAs) must be degassed at 80°C, when the system is cooling down.

### *Bakeout Plan*

Prior to the commencement of the bakeout, a bakeout plan must be submitted to DLS and approved in writing. This should be a step-by-step procedure, detailing each stage of the factory bakeout process

### *Bakeout System*

The following points should be considered in the design and supply of the bakeout system.

1. The system shall be installed without hindering the function of the Front End or preventing reasonable access to the Front End for maintenance and replacement of components. The system shall be robust enough to last at least 20 years, for an unlimited number of bakes, and must not deteriorate due to radiation damage.
2. All vacuum vessels and vacuum components should be fitted with heaters fixed to the vessels. It is only necessary to fit tailored thermal insulated jackets to the Fast Valve and the Gate Valves. All other heated surfaces should be wrapped with a suitable Aluminum Foil over the heaters, uncovered heaters are not permitted. Adhesive tape must not be used to attach the bakeout system.
3. Thermal insulated jackets, where specified, shall ensure the maximum external surface temperature of the Front End does not exceed 50°C during any bakeout up to 270°C. All insulating materials shall be capable of an unlimited number of bakeouts at temperatures of up to 270°C without deterioration or fiber shedding. The bakeout system must not contain loose fibers or powders. Glass fiber insulation is not permitted.
4. The entire bakeout system is to be divided into a maximum of 12 zones, with a maximum total power of 3.5 kW per zone. It is the responsibility of the Supplier to prove to DLS that each zone of the Front End has been heated to and maintained at a temperature within the specified limits. Each zone is to have at least two K type thermocouples fitted for temperature control and monitoring. Bakeout zones must not cross the vacuum sections defined by the gate valve. Individual bakeout zones should be allocated to each XBPM Spool piece and for the Shield Wall vessel.
5. Cables for the bakeout zones shall be grouped together into local junction boxes for ease of use and must meet the requirements outlined in section 5.3.4 of this specification.
6. The entire bakeout system, including the design, operation, installation and details of all components must be approved by DLS prior to the purchasing or manufacture of any bakeout system components.
7. The internal surfaces of all copper components exposed to air, which form part of the bakeout system, must only be exposed to a clean and dry oxygen free environment (e.g. dry nitrogen gas) throughout the duration of the bakeout.
8. Heaters and thermocouples shall be connected via a number of junction boxes. A generic standard arrangement for Front End bakeout circuits is supplied. This should be modified to meet the actual requirements of this Front End and the changes agreed at the design review. A detailed, as fitted, electrical drawing of the bakeout system must be supplied with delivery of the equipment
9. The bakeout system cabling shall be fitted with in-line connectors for the power cables and thermocouples to allow quick and easy disassembly and reassembly for shipping.

# PACKING AND DELIVERY

## Packing

The Supplier shall ensure that all equipment within the extent of this supply is fully and satisfactorily protected during handling and transportation. Packing cases must be robust and suitable for lifting and transportation without damage. Internal packing must be adequate to prevent movement or vibration during transportation.

Shock and tilt indicators must be fitted to reveal evidence of any mishandling between the Supplier’s premises and DLS.

The Supplier shall detail at tender the largest dimensions and weights of individual components to be delivered.

Individual items weighing more than 30kg shall be provided with sufficient lifting hooks and/or be compatible with fork-lift trucks. If special lifting jigs are required, these shall be provided by the Supplier

The items should be delivered fully assembled and robustly supported inside wooden crates. These must be capable of preventing damage or contamination during transit, and allow storage of the crated items for a period of 3 months in an indoor environment at DLS Ltd.

Returnable packing cases are permitted provided these are returned at the Supplier’s cost. Where returnable packing cases are proposed the total quantity of packing cases included must be stated in the tender response. Packing cases must be suitable for lifting using a forklift truck or a crane.

The following must be clearly displayed on the outside of the container:

1. Contact Name
2. Delivery Address.
3. The DLS contract number.
4. The weight of the loaded container
5. Support points for transport and lifting.

Each packing case must contain a copy of the packing list and customs invoice (if applicable).

## Lifting

All packages must be supplied with lifting hooks and be compatible with fork-lift trucks. The supplier will be responsible for providing special purpose lifting equipment if necessary.

## Shipped condition

Items must be shipped in the vacuum condition described in the DLS Standard Vacuum Requirements Annex (TDI-VAC-QUA-SPC-0001).

The exact shipping condition will be defined by DLS, at the final design review.

Details of the shipment procedures and associated equipment must be approved by DLS before any shipments are made.

# QUALITY ASSURANCE AND TESTING

## Quality Assurance Program

The Supplier shall follow a quality assurance program compliant with ISO-9001 for the design, manufacture and testing of all systems and equipment provided by them.

The Supplier must provide a Quality Assurance document for the supplied equipment, certifying that it conforms to the specification and the supplied engineering drawings, and containing all material certificates, the results of all inspections and tests, and the procedures used.

Details of the required vacuum quality assurance and testing are given in the DLS Standard Vacuum Requirements Annex (TDI-VAC-QUA-SPC-0001).

## Welding Quality Assurance and Testing Requirements

Details of the required welding quality assurance and testing are given in the DLS Standard Vacuum Requirements Annex (TDI-VAC-QUA-SPC-0001).

## Material Traceability

Explosion-bonded material, if used, must be 100% ultrasonically tested to prove that the bond is complete over the entire material interface.

All fasteners, washers, gaskets and other fittings must have a certificate of conformance to the agreed specifications.

## Documentation to be Supplied With Shipment

All procurement documentation for materials and bought-in items.

Certificates of Conformance or Material Certificates as appropriate.

All test, inspection and acceptance test reports

A complete set of the quality control documentation in electronic format.

Full set of ‘as built’ drawings for all supplied equipment where any changes or concessions subsequent to the design review have been agreed in writing by DLS

Full support documentation for all items of equipment, including all installation, operation and maintenance manuals, including components supplied by a third party

Safety reports and C.E. Declarations of Conformity / Incorporation, as appropriate

## General arrangements for tests

The tests at the factory and on-site together must establish that all items of the manufactured equipment completely meet the performance requirements as described in this specification.

Testing shall conform at all times to the local safety codes. DLS reserves the right to require additional or more extensive tests to be conducted in the event of marginal design or performance.

The Supplier must formulate acceptance test procedures for all systems and will provide the facility and instrumentation to perform all relevant tests to ensure compliance with this specification. Additionally, diagnostic equipment that is free issued to the Supplier and that is incorporated with the design must be used during tests when appropriate. The acceptance test procedures must include, but not be limited to all of the testing procedures specifically outlined in this document, but also those necessary to prove compliance with this specification and DLS standards as specified in the list of annexes. These test procedures are subject to DLS review and acceptance. DLS will reserve the right to witness all tests and will be the sole arbiter as to the results being satisfactory.

Review and acceptance by DLS does not release the Supplier from its responsibility to correct errors, oversights and omissions to ensure conformance to the specifications in this document and DLS standards as specified in the list of annexes.

DLS and its authorised representatives must have access to the premises of the Supplier for the purposes of inspection and witnessing of tests. DLS must be entitled to witness all tests defined in this specification and must be notified at least 10 working days in advance of any test date to allow the necessary travel arrangements to be made.

All tests must be undertaken with equipment and procedures approved by DLS.

All tests must be properly recorded on test certificates and results submitted to DLS.

DLS reserves the right to reject any material or component not completely fulfilling the conditions laid down in this specification.

No component failing any specified test may be used in manufacture except with the written permission of DLS.

In the event of any test failure, and subsequent rectification work, DLS reserves the right to repeat any previously unsuccessful tests.

Dimensional inspection reports are required for component parts. Assembly of the vacuum system must not commence until approval is given, by DLS, for the manufactured component parts following receipt of all inspection reports. However, DLS approval does not release the Supplier from his responsibilities described in this specification.

The vacuum system must be fully assembled, aligned and tested as a complete assembly at the Suppliers site prior to shipping.

## Factory Acceptance Tests

The Front End must be fully assembled, aligned and tested at the Suppliers site prior to shipping.

DLS and its authorised representatives must have access to the premises of the Supplier for the purposes of inspection and witnessing of tests. DLS must be entitled to witness all tests defined in this specification and must be notified at least 10 working days in advance of any test date to allow the necessary travel arrangements to be made.

All tests must be undertaken with equipment and procedures approved by DLS.

All tests must be properly recorded on test certificates and results submitted to DLS.

DLS reserves the right to reject any material or component not completely fulfilling the conditions laid down in this specification.

No component failing any specified test may be used in manufacture except with the written permission of DLS.

In the event of any test failure, and subsequent rectification work, DLS reserves the right to repeat any previously unsuccessful tests.

Dimensional inspection reports are required for component parts. Assembly of the Front End must not commence until approval is given, by DLS, for the manufactured component parts following receipt of all inspection reports. However, DLS approval does not release the Supplier from his responsibilities described in this specification.

It will be a condition of final acceptance that the Supplier must have provided to DLS’s satisfaction, full documentation as noted throughout this specification, to cover all systems embodied within this contract.

### *Vacuum Tests*

Details of the required vacuum tests are given in the DLS Standard Vacuum Requirements Annex (TDI-VAC-QUA-SPC-0001).

### *Mechanical*

#### **Dimensional checks**

Where geometric tolerances are requested on the drawings, these must also be measured and recorded. If any of the specified dimensions on the manufacturing drawings are not achieved, no rectification is to be made without prior approval from DLS.

The First Aperture, Absorber, Beam Pipe Assembly, Pumping Module and Slits Module all require fiducialisation. To enable fiducialisation, the reference design specifies the internal datum points, and dimensional tolerances, relative to the surfaces on which the survey monuments are mounted. At an appropriate stage before assembly, the Supplier must demonstrate that the individual components have been manufactured to within those tolerances.

With the fully assembled system the 3-D spatial location of each component must be defined in a manner consistent with the alignment procedures employed by the DLS Survey and Alignment Group. The preferred survey features/alignment references are detailed below:

1. Two survey monuments positioned at each end of the component directly above the beamline datum. The monument is for mounting a 3.5" Taylor Hobson Spherical Target. A Laser Tracker will be required for this aspect of the alignment.

2. Two height references, one at each end of the component, will be used to set the height and tilt along the beam axis using a Laser Tracker.

3. A horizontal reference surface to mount a bubble level for roll axis alignment.

With each fully assembled system check all key dimensions, including alignment, before and after bakeout, and record them.

Check that vacuum sealing faces are within the prescribed tolerances.

#### Pneumatic

Operation of all pneumatic systems will be tested for correct functionality. Pneumatic circuits will be pressure tested at 10 bar, and a bubble leak test performed on all joints.

#### Motion Tests

The range, resolution and repeatability of all motor driven systems will be measured with the system under vacuum.

#### Other Tests

Effectiveness of physical stops

Accessibility for operational and maintenance purposes

### *Cooling water circuit*

#### Flow Test

Water must be connected at 9.5 to 10 bar, and approximately 22°C, to enable testing of the cooling water circuit. It must be shown that the flow of water through the system is sufficient to provide effective cooling. A record of the valve settings and flow rates achieved must be provided.

#### Hydrostatic Test

The water circuit requires a hydrostatic leak test at 1.5 MPa (15 bar) gauge pressure. The test pressure must be maintained for 1 hour with no visible leaks or drop in pressure. The cause of any leaks in the system must be determined and rectified to the satisfaction of the DLS representative. The test pressure corresponds to 1.5 x the design pressure of 1 MPa (10 bar) gauge. The cooling water should be filtered to 10μm, with a conductivity of <0.1μS/cm3 and a dissolved oxygen content of less than 10ppb (parts per billion)

### *Electrical Acceptance Tests*

The tests are to be defined by the Supplier at the design review, and may include any or all of the tests specified in the individual preceding sections of this specification, including:

1. Electrical safety tests:

* Continuity of protective bonding circuit.
* Insulation resistance tests.
* Protection against residual voltages.

1. Control and operation
2. Demonstration of axis accuracy, resolution and repeatability
3. Visual inspection
4. Accessibility assessment
5. External connections evaluation
6. Continuity and resistivity checks
7. Functional test of temperature sensors.
8. Compliance to DLS standards as specified in the list of annexes.

The supplier shall provide any control equipment necessary to exercise the front end and verify its performance.

### *Other tests*

Other tests may include any or all of the tests specified in the individual preceding sections of this specification, including:

1. Accessibility assessment

2. Health & Safety Risk Assessment

3. Failure Modes, Effects and Criticality Analysis (see BS 5760-5 1991).

## 

## Visual Checks

DLS will check for damage during transport.

The visual checks described in the DLS Standard Vacuum Requirements Annex (TDI-VAC-QUA-SPC-0001).

# TENDERING

## Pre-tender Clarifications

If interested Suppliers do not fully understand the requirements and implications of the specification or some doubt exists as to its interpretation then they should contact DLS to obtain clarification.

Technical enquiries or commercial/contractual issues may be made at any reasonable time during the tender period via:

Diamond Procurement Department

Email: [procurement@diamond.ac.uk](mailto:procurement@diamond.ac.uk)

Telephone: +44 (0) 1235 778167

Postal address:

Diamond Light Source Ltd  
Diamond House

Harwell Science and Innovation Campus  
Chilton, Didcot  
Oxfordshire OX11 0DE, UK.

If such a clarification results in a modification of the specification or other tender documents then this information will be distributed to all interested Suppliers.

## Basis of the contract

Any eventual contract will be based on the following documents:

1. This specification DLSITT0408
2. All other documents issued with this Invitation to Tender.
3. DLS’s Standard Conditions of Contract
4. Any amendments to Item 1 issued by DLS during the tender period
5. The Supplier’s tender proposal
6. Any post-tender clarifications between the Supplier and DLS

Strict compliance with these contract documents is required unless otherwise specifically agreed in writing.

Once the contract has been awarded details of the successful tenderer (including contract value) will be published on TED and Contracts Finders as a Contract Award Notice.

## Tender Evaluation

DLS will evaluate the bids taking into consideration the cost, delivery time, the technical aspects, as well as the Supplier’s quality assurance procedures and relevant experience. Full details of the evaluation criteria and their weightings can be found in the OJEU notice.

## Information Required with the Tender

NB. At least one copy (in either electronic or hard copy) must reach DLS by midnight on the day of the deadline. **The project team require 3 hard copies of your tender return for evaluation purposes.** Any tender received after this time will be deemed late and as such not receivable.

The Supplier shall provide with the tender documents sufficient information to allow an informed choice of Supplier, as detailed below. It is essential that this information accompanies the Tender response; otherwise, the bid may be rejected as non-compliant.

### *Forms to be completed*

* Form C7
* Supplier Evaluation Questionnaire.

### *Acceptance of DLS documents*

A clear statement of acceptance of all articles of the following documents

* DLS Specification
* DLS Standards, as specified in the list of annexes.
* DLS Standard Terms and Conditions

If full acceptance of these documents is not possible, a list of exceptions with full details and alternative proposals must be provided

### *Detailed Information*

* A project plan, showing the principal design, ordering and manufacturing, testing, installation and commissioning phases of the principal components.
* Supporting technical information indicating that the requirements have been considered and understood and that appropriate solutions are proposed
* The preliminary design, as appropriate.
* Description of layout, as appropriate.
* List of hardware required to be free issued by DLS
* Clear indication of the effort to be supplied by the Supplier during the installation at the DLS site (if applicable), including the number of staff and the time spent on site.
* Clear indication of the effort and resources by DLS during delivery/installation.

### *Cost Breakdown*

Please submit a firm price in pounds sterling for the total project.

Prices in other currencies may be considered but this may be taken into account in the evaluation.

Unless otherwise indicated prices should include delivery to DLS site under incoterms DDU (Delivered Duty Unpaid).

A breakdown of costs with details and options as requested:

* Design cost of the Front End
* Manufacturing cost of the Front End
* Itemised costs of essential spares to be supplied as part of the contract
* The supplier shall provide a price option for further identical Front Ends to be purchased within two years of the final acceptance.

### *Delivery and Installation*

* Details of the proposed delivery arrangements:
* Description of any handling requirements during installation, testing and commissioning
* Details of the largest dimensions and weights of individual components to be installed
* Details of required manpower to be supplied by DLS during delivery and installation

LIST OF DRAWINGS (to subassembly level only):

|  |  |  |
| --- | --- | --- |
| **Description** | **Drawing Number** | **Issue** |
|  |  |  |
| **Electrical Drawings** |  |  |
|  |  |  |
| Front End Field Equipment Hook Up | 1151980 | A |
| Slits Motion Control Junction Box GA | 1151979 | A |
| JB01, JB02 TEMP & FLOW SW. Junction Box | 1151977 | A |
| Front End 10B Control System GA | 1147699 | A |
| Front End 10B Control System Hook-up | 1147700 | A |
| Front End 10B Control System Rack Labels | 1147701 | A |
| Front End Control System Bakeout Junction Box 1 (3 zones) | 1053791 | E |
| Front End Control System Bakeout Hook-up drawings (3 zones) | 1053790 | C |
| Hirschmann adaptor (safety cover) | SK0147 |  |
|  |  |  |
|  |  |  |
| **General Layout** |  |  |
| Vacuum R&D Front End General Layout And Ray Trace | 1147458 | C |
| Vacuum R&D Front End GA (3D Model Only, provided after order) | 1147460 | A |
| **Assembly Drawings** |  |  |
| Front End Top Level | 1147461 | A |
|  |  |  |
| **First Aperture & Absorber Module**  **ule** |  |  |
| First Aperture & Absorber Module | 1147462 | A |
| Pumping TEE and 1st Aperture Assembly | 1148880 | A |
| Absorber and Pumping Tee Assembly | 1148860 | A |
| Frist Aperture Frame and Bracketry Assembly | 1148850 | A |
| Pumping Elbow DN60 With Lifting Lug | 1000521 | E |
| RGA Assembly | 1016709 | B |
|  |  |  |
|  |  |  |
| **PBPM Spool Piece Assembly Module** |  |  |
|  |  |  |
| PBPM Spool Piece Assembly | 1148830 | A |
| Photon Beam Position Monitor Spool Piece | 1006617 | D |
| Adjuster Plate | 1148833 | A |
| Spool Support Stand (XBPM Spool) | 1119348 | A |
| Bellows DN100CF X160 Free Length | 1148831 | A |
|  |  |  |
| **First Gate Valve and Fast Valve Module** |  |  |
| First Gate Valve and Fast Valve Module | 1148800 | A |
| First Gate Valve and Fast Valve Assembly | 1148801 | A |
| First Gate Valve and Fast Valve Frame | 1148820 |  |
|  |  |  |
|  |  |  |
| **First Transition Pipe Weld Assembly** |  |  |
| First Transition Pipe Weld Assembly | 1149855 | A |
|  |  |  |
| **Pumping Module** |  |  |
| Pumping Module | 1147475 | A |
| Pumping Assembly | 1148816 | A |
| Pumping Module Frame | 1148815 | A |
|  |  |  |
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|  |  |  |
| **2nd Transition Pipe Weld Assembly** |  |  |
| 2nd Transition Pipe Weld Assembly | 1147463 | A |
|  |  |  |
| **Slits, Diagnostics And Second Gate Valve Module** |  |  |
| Slits, Diagnostics And Second Gate Valve Module | 1147465 | A |
| Slits Submodule | 1147466 | A |
| Fluorescent Screen Submodule | 1148841 | A |
| Orifice Submodule | 1148810 | A |
| Slits Frame | 1148843 | A |
| Second Gate Valve Module | 1149861 | A |
|  |  |  |
|  |  |  |
| **Water Services** |  |  |
| Water Service | 1149910 | A |
|  |  |  |
| **Other** |  |  |
|  |  |  |
| VAT DN63 RAV Assembly | 1032589 | B |
| MKS IMG Head and Pirani Gauge Assembly | 1028203 | B |
| Survey Monument | 1002244 | C |
| Ion Pump and IMG Gauge Bakeable Cable Bulkhead Connector Panel | 1032573 | C |
| Water Schematic | 1147471 | C |
| Vacuum Schematic | 1144757 | C |
| Bulkhead Connector Panel | 1014941 | B |
|  |  |  |
|  |  |  |

FULL LIST OF DRAWINGS (ascending drawing numbers):

|  |  |  |  |
| --- | --- | --- | --- |
| DRG No. | Description | Issue | Status |
| 1000419.ASM | DN40CF ELBOW 80 x 300 | J.3 | Approved |
| 1000521.ASM | PUMPING ELBOW DN160 WITH LIFTING LUG | E.3 | Approved |
| 1001296.ASM | DLS STANDARD CONFLAT FLANGE | E.1 | Approved |
| 1001516.ASM | SURVEY MONUMENT | A.8 | Approved |
| 1002244.PRT | SURVEY MONUMENT - 89.45 | C.2 | Approved |
| 1002458.PRT | FOOT PLATE 50 x 50 x 6 | B.1 | Approved |
| 1002462.PRT | STUD M12 X 170 LONG | A.9 | Approved |
| 1006617.ASM | XBPM SPOOL PIECE | E.1 | Approved |
| 1007879.ASM | PIRANI, CCG & RAV ASSEMBLY | C.2 | Approved |
| 1012996.PRT | TEST POINT ADAPTOR (G1/4) | C.4 | Approved |
| 1014150.ASM | CONNECTING PIPE DETAIL | B.3 | Approved |
| 1014941 | BULKHEAD CONNECTOR PANEL | B | Approved |
| 1015857.PRT | WELD CONNECTOR 18 OD TUBE TO SK100 UNION | D.0 | Approved |
| 1016709.ASM | RGA ASSEMBLY | B.2 | Approved |
| 1016765.PRT | ABSORBER PLATE DETAIL | D.2 | Approved |
| 1021360.ASM | RGA SLEEVE | C.1 | Approved |
| 1021361.ASM | DN40 4 WAY CROSS | A.2 | Approved |
| 1028203 | MKS IMG Head and Pirani Gauge Assembly | B | Approved |
| 1032573 | ION PUMP AND IMG GAUGE BAKEABLE CABLE BULKHEAD CONNECTOR PANEL | C | Approved |
| 1032589 | VAT DN63 RAV Assembly | B | Approved |
| 1052536.PRT | BASE PLATE | A.2 | Approved |
| 1052539.PRT | SLIDE PLATE | A.1 | Approved |
| 1052540.PRT | PUSHER BLOCK | A.2 | Approved |
| 1052541.PRT | ADJUSTING WASHER | A.1 | Approved |
| 1070670.ASM | DN040 FIXED CONFLAT 38 BORE | A.4 | Approved |
| 1053790.drw | Front End Control System Bakeout Hook-up Drawings | C | Approved |
| 1053791.drw | Front End Control System Bakeout Box 1 (3 Zones) | E | Approved |
| 1070682.ASM | DN160 ROTATABLE CONFLAT 153 BORE | A.1 | Approved |
| 1075250.PRT | SLIT BLADE | A.4 | Approved |
| 1078092.ASM | SURVEY MONUMENT ASSEMBLY | A.1 | Approved |
| 1086151.PRT | ORIFICE STEM | D | Approved |
| 1104544.PRT | FOOT PLATE WASHER (10.5X30X4) | A.1 | Approved |
| 1119348.ASM | SPOOL SUPPORT STAND (XBPM SPOOL) | A.5 | Approved |
| 1119363.ASM | US & DS SLITS BELLOWS | A.6 | Approved |
| 1123830.ASM | DN100-DN100 DOUBLE BELLOWS x 450 LG | A.9 | Approved |
| 1124158.PRT | LOWER JAW | A.6 | Approved |
| 1124159.PRT | UPPER JAW | A.6 | Approved |
| 1124179.PRT | BELLOWS STUD LOCKING SLEEVE | A.4 | Approved |
| 1124204.ASM | SWAGELOK 20mm ELBOW ASSY | A.3 | Approved |
| 1138571.PRT | VALVE MOUNT ASSEMBLY - C | A.0 | Approved |
| 1138572.PRT | VALVE MOUNT ASSEMBLY - A | A.4 | Approved |
| 1144757 | VACUUM SCHEMATIC | C | Approved |
| 1147458.DRW | VACUUM R&D FRONT END GENERAL LAYOUT AND RAY TRACE | B | Approved |
| 1147461.ASM | FRONT END TOP LEVEL | A.53 | Approved |
| 1147462.ASM | FIRST APERTURE AND ABSORBER MODULE | A.19 | Approved |
| 1147463.ASM | 2ND TRANSITION PIPE WELD ASSEMBLY | A.35 | Approved |
| 1147465.ASM | SLITS, DIAGNOSTICS AND SECOND GATE VALVE MODULE | A.39 | Approved |
| 1147466.ASM | SLITS SUBMODULE | A.19 | Approved |
| 1147471 | WATER SCHEMATIC | C | Approved |
| 1147475.ASM | PUMPING MODULE | A.34 | Approved |
| 1147476.ASM | SECOND TRANSITION PIPE WELD ASSEMBLY | A.22 | Approved |
| 1147699 | FRONT END 10B CONTROL SYSTEM GA | A | Approved |
| 1147700 | FRONT END 10B CONTROL SYSTEM HOOK-UP | A | Approved |
| 1147701 | FRONT END 10B CONTROL SYSTEM RACK LABELS | A | Approved |
| 1148800.ASM | FIRST GATE VALVE AND FAST VALVE MODULE | A.26 | Approved |
| 1148801.ASM | FIRST GATE VALVE AND FAST VALVE ASSEMBLY | A.26 | Approved |
| 1148802.ASM | CONNECTING PIPE WELD ASSEMBLY | A.19 | Approved |
| 1148803.ASM | VALVE MOUNT ASSEMBLY | A.8 | Approved |
| 1148804.PRT | PIPE SUPPORT | A.9 | Approved |
| 1148805.PRT | FAST VALVE SUPPORT BRACKET | A.4 | Approved |
| 1148810.ASM | ORIFACE SUBMODULE | A.16 | Approved |
| 1148812.ASM | ORIFICE DETAIL | A.12 | Approved |
| 1148813.PRT | ORIFICE COPPER BODY | A.14 | Approved |
| 1148815.ASM | PUMPING MODULE FRAME | A.19 | Approved |
| 1148816.ASM | PUMPING ASSEMBLY | A.12 | Approved |
| 1148820.ASM | FIRST GATE VALVE AND FAST VALVE FRAME | A.14 | Approved |
| 1148830.ASM | XBPM SPOOL PIECE MODULE | A.11 | Approved |
| 1148831.ASM | BELLOWS DN100CF x 160 FREE LENGTH | A.4 | Approved |
| 1148833.ASM | ADJUSTER PLATE | A.2 | Approved |
| 1148841.ASM | FLUORESCENT SCREEN SUBMODULE | A.14 | Approved |
| 1148842.ASM | PUMPING TEE VESSEL | A.8 | Approved |
| 1148843.ASM | SLITS FRAME | A.18 | Approved |
| 1148845.ASM | BELLOWS CLAMP ASSEMBLY | A.4 | Approved |
| 1148846.ASM | BELLOWS CLAMP ASSY STAND | A.5 | Approved |
| 1148850.ASM | FIRST APERTURE AND ABSORBER FRAME | A.8 | Approved |
| 1148851.ASM | FIRST APERTURE AND ABSORBER FRAME WELD ASSEMBLY | A.12 | Approved |
| 1148855.ASM | SLITS STAGE ASSEMBLY | A.10 | Approved |
| 1148857.PRT | SLITS MOUNT PLATE | A.5 | Approved |
| 1148858.PRT | ADJUSTABLE HARDSTOP BLOCK | A.5 | Approved |
| 1148860.ASM | ABSORBER AND PUMPING TEE ASSEMBLY | A.19 | Approved |
| 1148861.ASM | PUMPING TEE DETAIL | A.7 | Approved |
| 1148863.ASM | BELLOWS DETAIL | A.7 | Approved |
| 1148875.ASM | FLEXIBLE PUMPING TEE | A.5 | Approved |
| 1148876.PRT | LEVELLING T-PLATE | A.3 | Approved |
| 1148880.ASM | PUMPING TEE AND 1ST APERTURE ASSEMBLY | A.17 | Approved |
| 1148882.ASM | FIRST APERTURE ASSEMBLY | A.18 | Approved |
| 1148883.PRT | COPPER BODY | A.12 | Approved |
| 1148884.PRT | 1ST DEFINING APERTURE SUPPORT | A.4 | Approved |
| 1148885.PRT | ADJUSTER BASE | A.5 | Approved |
| 1148886.PRT | ADJUSTING STUD M16 X 1.5 PITCH | A.3 | Approved |
| 1148887.PRT | ADJUSTER DRIVE BLOCK | A.4 | Approved |
| 1148890.ASM | VACUUM INSTRUMENTATION | A.4 | Approved |
| 1148895.ASM | PUMPING MODULE CROSS WELD ASSEMBLY | A.18 | Approved |
| 1149830.ASM | US SLIT ASSEMBLY | A.7 | Approved |
| 1149831.ASM | BRAZED US SLIT ASSY | A.4 | Approved |
| 1149832.PRT | US SLIT COPPER BODY | A.8 | Approved |
| 1149833.PRT | SURVEY MOUNT | A.4 | Approved |
| 1149840.ASM | SLIT MOUNT | A.2 | Approved |
| 1149841.ASM | DS SLIT ASSEMBLY | A.6 | Approved |
| 1149842.ASM | BRAZED DS SLIT ASSY | A.3 | Approved |
| 1149843.PRT | DS SLIT COPPER BODY | A.5 | Approved |
| 1149850.ASM | SUPPORT STAND | A.6 | Approved |
| 1149852.ASM | VACUUM INSTRUMENTATION | A.2 | Approved |
| 1149855.ASM | FIRST TRANSITION PIPE MODULE | A.11 | Approved |
| 1149856.ASM | FIRST TRANSITION PIPE WELD ASSEMBLY | A.11 | Approved |
| 1149861.ASM | SECOND GATE VALVE MODULE | A.11 | Approved |
| 1149870.PRT | ORIFICE STAND | A.4 | Approved |
| 1149872.PRT | ORIFICE SURVEY MOUNT | A.2 | Approved |
| 1149910.ASM | WATER SERVICE | A.17 | Approved |
| 1151977.drw | JB01, JB02 TEMP & FLOW SW.Junction Box | A | Approved |
| 1151979.drw | Slits Motion Control Junction Box GA | A | Approved |
| 1151980.drw | Front End Field Equipment Hook Up | A | Approved |
| SK0147 | HIRSCHMANN ADAPTOR (SAFETY COVER) |  | Approved |
|  |  |  |  |
|  |  |  |  |

# LIST OF APPENDICES

Appendix A. Tables

Appendix B. List of Free-Issue Items

Appendix C. List of Essential Spare Parts

# LIST OF ANNEXES

Annex A MENG-GEN-STD-0001 Drawing and Format Requirements

Annex B MENG-GEN-STD-0002 Standards to which all Electrical and Mechanical

Equipment supplied to DLS must comply

Annex C TDI-EENG-DSGN-0002 Electrical and Control Systems Interfacing

Standard

Annex D TDI-EENG-DSGN-0003 Electrical and Control, Machine Wiring

Standard

Annex E TDI-VAC-QUA-SPC-0001 DLS Requirements for the Manufacture and Supply of Vacuum Components and Systems.

# APPENDIX A.

***Motion Stages***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Axis Name** | **Motor** | **Axis Direction** | **Range (mm)** | **Accuracy (µm)** | **Repeatability (µm)** |
| FE10B-AL-SLIT-01:X | 1 | X | 25 | ±10 | ±3 |
| FE10B-AL-SLIT-02:X | 2 | X | 25 | ±10 |

Table 1: Slits Module Axes Required

Temperature Monitoring

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Tag Name** | **Type** | **No. of Elements** | **Wiring Configuration** | **Sheath Length & Diameter** | **End Seal** | **Termination** | **Resistance Value** | **Standard** | **Fitting** | **Leads** |
| FE10B-AL-APT-01:TMON01 | PT-100 | One | True 4 Wire | To Suit Mechanical Design | Crimp On Stainless Steel | Pot Seal | 100Ω at 0 °C | Class A | Adjustable Compression Fitting | Low Smoke Zero Halogen SS Braid.  Length :To be terminated in FE module 01 Junction Box, along Identified Cable Routes |
| FE10B-AL-APT-01:TMON02 |

Table 2: First Aperture Temperature Measurement Specifications

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Tag Name** | **Type** | **No. of Elements** | **Wiring Configuration** | **Sheath Length & Diameter** | **End Seal** | **Termination** | **Resistance Value** | **Standard** | **Fitting** | **Leads** |
| FE10B-AL-SLIT-01:TMON01 | PT-100 | One | True 4 Wire | To Suit Mechanical Design | Crimp On Stainless Steel | Pot Seal | 100Ω at 0 °C | Class A | Adjustable Compression Fitting | Low Smoke Zero Halogen SS Braid.  Length :To be terminated in FE module 02 Junction Box, along Identified Cable Routes |
| FE10B-AL-SLIT-02:TMON02 |

Table 3: Slits Module Temperature Measurement Specifications

Water Flow Switches

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Tag Name** | **Type** | **Switch types** | **Switch 01**  **Set point** | **Switch 02**  **Set point** | **Terminations** | **Leads** |
| FE10B-RS-ABSB-01:H2OALM01  (SWITCH 01) | All Metal Construction VA Flow Meter with 2 adjustable switches Points. | 2 Independent SP NO volt free contacts.  50 VA | Set @  687 Litre’s / hour | Set @  780 Litre’s / hour | Plug And Socket Mounted on the Flow Switch | Low Smoke Zero Halogen screened twisted pair  Length :To be terminated in FE module 01 Junction Box, along Identified Cable Routes |
| FE10B-RS-ABSB-01:H2OILK01  (SWITCH 02) |

Table 4: First Absorber Water Flow Switch Electrical Specification

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Tag Name** | **Type** | **Switch types** | **Switch 01**  **Set point** | **Switch 02**  **Set point** | **Terminations** | **Leads** |
| FE10B-AL-SLIT-01:H2OALM01  (SWITCH 01) | All Metal Construction VA Flow Meter with 2 adjustable switches Points. | 2 Independent SP NO volt free contacts.  50 VA | Set @  457 Litre’s / hour | Set @  518 Litre’s / hour | Plug And Socket Mounted on the Flow Switch | Low Smoke Zero Halogen screened twisted pair  Length :To be terminated in FE module 01 Junction Box, along Identified Cable Routes |
| FE10B-AL-SLIT-01:H2OILK01  (SWITCH 02) |
| FE10B-AL-SLIT-02:H2OILK01  (SWITCH 02) |
| FE10B-AL-SLIT-02:H2OILK01  (SWITCH 02) |

Table 5: Slits Module Water Flow Switch Electrical Specification

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Tag Name** | **Type** | **Range** | **Supply** | **Output** | **Termination** | **Leads** |
| FE10B-HO-FLMTR-01 | George Fischer 2536-T0 | To Suit Required Capacity | 24VDC | PULSE  (open Collector) | Plug And Socket Mounted on the Flow Meter | Low Smoke Zero Halogen screened twisted pair  Length :To be terminated in FE module 01 & 02 Junction Box, along Identified Cable Routes |

Table 8: Paddle Wheel Water Flow Meter Electrical Specification

# APPENDIX B

List of Free Issued Items

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Manufacturer** | **Description** | **Part No.** | **Drawing No.** | **Quan-tity** | **Other Information** |
| Gamma | 500 l/s Ion Pump | 500T-Di-8S-SC-220-N |  | 2 |  |
| Gamma | 150 l/s Ion Pump | 150T-Di-6S-SC-220-N |  | 1 |  |
| Gamma | 500 l/s Ion Pump | 500T-DI-8S-SP-UK230-N |  | 1 |  |
| Gamma | Small Ion Pump Controller | SPC-1P-UK240-232-N-N |  | 4 |  |
|  | Ion pump  Heater Cable |  |  | 4 |  |
|  | 1.5m Bulk head HV Cable |  |  | 4 | (Ion pump to Bulk head) |
| DLS | Hirschamnn adaptor | SK0147 |  | 4 |  |
| Hirschamnn | Cable Panel Mounted Connector | STASEI 3N |  | 4 |  |
| Hirschamnn | Power Connector Socket | STAK 3N |  | 4 |  |
| DLS | Bulk Head Connector Bracket | 1032573 | 1032573 | 4 |  |
|  | 10m HV Cable |  |  | 4 | (Bulk head to pump controller) |
| MKS Inst | Pirani | MKS 317 |  | 4 |  |
| MKS Inst | IMG | MKS 422 |  | 4 |  |
| MKS Inst | Gauge Controller | MKS 937b |  | 2 |  |
|  | IMG Bulk head HV Cable |  |  | 4 | Length TBC by supplier  (Gauge to Bulk head) |
|  | IMG Bulk head Current Cable |  |  | 4 | Length TBC by supplier  (Gauge to Bulk head) |
| Kings | Bulk head connector | SHV/SHV 1709-1 |  | 4 |  |
| Kings | Bulk head connector | BNC/BNC KC-99-95-M06 |  | 4 | (Bulk head to gauge controller) |
|  | IMG HV Cable |  |  | 4 | (Bulk head to gauge controller) |
|  | IMG Current Cable |  |  | 4 | (Bulk head to gauge controller) |
|  | 5m Pirani Cable |  |  | 4 | (Gauge to Controller) |
| MKS Spectra | RGA System | 639-221-010/D |  | 2 |  |
| MKS Spectra | 24V Power Supply | 842-120 |  | 1 |  |
| Bestec | 12 Channel Bakeout Controller |  |  | 1 | Requires 63A 3 phase power supply |
| VAT | Fast Closing Shutter DN100CF | 77336-CE44-0006 |  | 1 |  |
| VAT | All Metal Gate Valve DN100CF | 48240-CE44-AEF1 |  | 2 |  |
| VAT | All Metal Right Angle Valve DN40 | 54032-GE02-0002 |  | 4 |  |
| VAT | All Metal Right Angle Valve DN63 | 54136-GE02-0002 |  | 1 |  |
| George Fischer | Flow meter body SK730 | 198 801 899 |  | 3 | 100-1000 l/hr |
| George Fischer | Flow meter body  SK720 | 198 801 898 |  | 1 | 50-500 l/hr |
| George Fischer | Limit switch | GK11 - 198 335 961 |  | 8 |  |
| George Fischer | SS Nut 32DN25 | 724.690.108 |  | 8 |  |
| DLS | Flow Meter Dove Tail Adaptor | 1119984 |  | 4 | For adapting bigger dove tail slot on VA tube |
| DLS | Weld Connector 18 OD Tube To SK100 Union & Cu gaskets |  | 1015857 | 8 |  |
| DLS | Orifice Stem 3.5mm Bore |  | 1078422 | 3 |  |
| DLS | Orifice Stem 3.2 mm Bore |  | 1127138 | 1 |  |
| Swagelok | Union 18 Dia | SS-18MO-6 |  | 4 |  |
| DLS | Test Point Adaptor (G1/4) |  | 1012996 | 5 |  |
| DLS | Copper Seal | FP0135 |  | 5 | To use with Test Point |
| STAUFF | Test Point Fast Coupling | SKK20 G1/4"EB |  | 5 |  |
| George Fischer | Paddle wheel sensor 2536-T0 | 198.840.149 |  | 1 |  |
| George Fischer | Paddle Wheel sensor body | CR4T012 | Stp1747\_4 | 1 |  |
| DLS | Paddle Wheel Sensor Adaptor |  | stp1748 | 1 |  |
| Swagelok | Fitting | SS28mo-1-20RP |  | 2 | To use with Paddle Wheel Sensor |
|  | Copper Seal 1¼ BSP | FP04185 |  | 2 | To use with Paddle Wheel Sensor |
| Swagelok | 28mm Ball Valve | SS-65ES28mm |  | 2 |  |
| DLS | XBPM Bellow |  | 1148831 | 2 |  |
| DLS | XBPM Spool Piece Vessel |  | 1006617 | 1 |  |
| DLS | XBPM Spool Piece Stand |  | 1148833&1119348 | 1 |  |
| DLS | Fasteners for fixing XBPM spool to its stand |  |  |  | Agrred in post tender email on 09/01/20 |
| CINEL | Fluorescent Screen Assembly |  | 1091550 (F9AN6600) | 1 | Will be posted separately after DLS examed the delivery |
| DLS | Survey Monument |  | 1002244 | 21 |  |

# APPENDIX C

List of essential Spare Parts

|  |  |
| --- | --- |
| **Mechanical Spares** | **Quantity** |
| Flexible water cooling hoses. | 1 of each size |
| Compressed Air Regulator | 1 |
| Compressed Air Pressure Switches | 2 |
| Pneumatic actuator and linear guide | 1 |
| Solenoid valves for pneumatic actuators | 2 of each type |
| Absorber Movable Support Assembly | 1 |
|  |  |
| **Vacuum Spares** |  |
| Complete set of cycled bellows assemblies\* | 1 set |
|  |  |
| **Electrical Spares** |  |
| PT100 Temperature Sensors | 4 |
| Limit switches (Absorber Module) | 1 of each type |
| X Motorised stage | 1 of each type |

\* ‘cycled bellows assemblies’ means bellow assemblies that move with motions. Bellow assemblies that are used for installation only and remain static during operation do not count into vacuum spares.