

**VOLUME 3: CONTRACT DATA**

## **Part C1: Agreement on Contract Data**

## **C1.2 Contract Data**

**DPW-05: (EC) CONTRACT DATA - (GCC (2010) 2<sup>nd</sup> EDITION: 2010)**

<b>Project title:</b>	<b>Kimberley:Justice:High court including masters office: Installation of airconditioners</b>		
<b>Tender no:</b>	<b>KIM 01/2021</b>	<b>Reference no:</b>	<b>19/2/4/2/2/2327/489</b>

	<b>PART 1: DATA PROVIDED BY THE EMPLOYER</b>
	<b>CONDITIONS OF CONTRACT</b>
	The General Conditions of Contract for Construction Works, Second Edition, 2010, published by the South African Institution of Civil Engineering, Private Bag X200, Halfway House, 1685, is applicable to this Contract and is obtainable from <a href="http://www.saice.org.za">www.saice.org.za</a>

<b>CONTRACT SPECIFIC DATA</b>	
The following contract specific data, referring to the General Conditions of Contract for Construction Works, Second Edition, 2010, are applicable to this Contract:	
<b>CLAUSES</b>	<b>COMPULSORY DATA</b>
1.1.1.8	Amend Clause 1.1.1.8 to include the word "rights" to read as follows: "Contract Data" means the specific data which, together with these General Conditions of Contract, collectively describe the rights, risks, liabilities and obligations of the contracting parties and the procedures for the administration of the Contract.
1.1.1.13	Amend Clause 1.1.1.13 as follows, clarify when the defects liability period starts: "Defects Liability Period" means the period stated in the Contract Data, commencing on the date indicated on the Certificate of Completion or Certificates of Completion in the event of more than one Certificate of Completion is issued for different parts of the Works, during which the Contractor has both the right and the obligation to make good defects in the materials, Plant and workmanship covered by the Contract.  Defects liability period is: <b>12 months.</b>
1.1.1.14 & 5.14.7	The time for achieving Practical Completion of the whole of the works is: <b>12 Months</b> measured from the <u>Commencement</u> Date. The time thus stated includes special non-working days and the year-end break.  <b><i>or, if Practical Completion in portions is required,</i></b> The times for achieving Practical Completion for the portions as set out in the Scope of Works are <i>mutatis mutandi</i> : For portion 1 within <b><i>insert description as may be applicable</i></b> For portion 2 within <b><i>insert description as may be applicable</i></b> For portion 3 within <b><i>insert description as may be applicable</i></b> For portion 4 within <b><i>insert description as may be applicable</i></b> <b><i>(followed by further portions as required)</i></b>  The time for achieving Practical Completion of the whole of the Works is: <b><i>insert total contract period here, measured from the Commencement Date. The time thus stated includes special non-working days</i></b>

	and the year-end break.
1.1.1.15	The name of the Employer is: <b>The Government of the Republic of South Africa in Its Department of Public Works.</b>
1.1.1.16	The name of the Engineer is: <b>BVI CONSULTING ENGINEERS</b>
1.1.1.26	The Pricing Strategy is a: <b>Re-measurement Contract.</b>
1.1.1.31	Not applicable to this Contract.
1.1.1.35	Insert the definition of "Value of Works" as Clause 1.1.1.35: "Value of Works" means the value of the Works certified by the Engineer as having been satisfactorily executed and shall include the value of the works done, the value of the materials and/or plant and Contract Price Adjustments.
1.2.1.2	<b>Employer's address:</b>  Physical Address: <b>21 Markt Square Kimberley 8301</b>  Postal Address: <b>Private Bag x 5002 Kimberley 8300</b>  Facsimile: <i>insert fax no</i>  Telephone: <b>053 -838 5243</b>
	<b>Engineer's address:</b>  Physical Address: <b>55 Bult Street Upington 8800</b>  Postal Address:     Facsimile: <b>054 - 337 6699</b>  Telephone: <b>054- 337 6600</b>
1.3.4	Not applicable to this Contract.
1.3.5	Replace Clause 1.3.5 with the following provisions:  (a) The Employer will become the owner of the information, documents, advice, recommendation and reports collected, furnished and/or compiled by the Contractor during the course of, and for the purposes of executing this Contract, all of which will be handed over to the Employer on request, but

	<p>in any event on the termination and/or cancellation of this Contract for whatever reason. The Contractor relinquishes its retention or any other rights thereon to which it may be entitled.</p> <p>(b) The copyright of all documents, recommendations and reports compiled by the Contractor during the course of and for the purposes of finalizing the Works will vest in the Employer, and may not be reproduced or distributed or made available to any person outside the Employer's service, or to any institution in any way, without the prior written consent of the Employer. The Employer shall have the right to use such material for any other purpose without the approval of information or payment to the Contractor.</p> <p>(c) The copyright of all electronic aids, software programmes etc. prepared or developed in terms of the Contract shall vest in the Employer, who shall have the right to use such material for any other purpose without the approval of, information or payment to the Contractor.</p> <p>(d) In case of the Contractor providing documents, electronic aids, software programs or like material to the Employer, the development of which has not been at the expense of the Employer, copyright shall not vest in the Employer. The Contractor shall be required to indicate to which documents, electronic aids, software programs or like material this provision applies.</p> <p>(e) The Contractor hereby indemnifies the Employer against any action, claim, damages or legal cost that may be instituted against the Employer on the grounds of an alleged infringement of any copyright, patents or any other intellectual property right in connection with the Works outlined in this Contract.</p> <p>(f) All information, documents, recommendations, programs and reports collected or compiled must be regarded as confidential and may not be communicated or made available to any person outside the Employer's service and may not be published either during the currency of this Contract or after termination thereof without the prior written consent of the Employer.</p>
3.1.3	<p>1. The Engineer's authority to act and/or to execute functions or duties or to issue instructions are expressly excluded in respect of the following:</p> <p>(a) Appointment of nominated Sub-contractors – clause 4.4.3;</p> <p>(b) Granting of an extension of time and/or ruling on claims associated with claims for extension of time – clauses 5.12.3, 10.1.5;</p> <p>(c) Acceleration of the rate of progress and determination of the cost for payment of such acceleration – clause 5.12.4;</p> <p>(d) Rulings on claims and disputes – clauses 10.1.5, 10.2.3 and 10.3.3;</p> <p>(e) Suspension of the Works – clause 5.11.1;</p> <p>(f) Final Payment Certificate – clause 6.10.9;</p> <p>(g) Issuing of <i>mora</i> notices to the Contractor – clauses 9.1.1, 9.1.2.1 and 9.2.1;</p> <p>(h) Cancellation of the contract between the Employer and Contractor – clauses 9.1.1, 9.1.2.1 and 9.2.1.</p>
	<p>2. In order to be legally binding and have legal bearing and consequence, any ruling in respect of the above matters (a) to (h) must be on an official document, signed and issued by the Employer to the Contractor.</p> <p>3. The Contractor must submit claims, demands, notices, notifications, updated particulars and reports in writing, as well as any other supporting documentation pertaining thereto, in respect of any of the above listed matters (a) to (h), to the Engineer within the time periods and in the format(s) as determined in the relevant clauses of the Conditions of Contract. Failing to deliver such to the Engineer timeous and in the correct format will invalidate any claim and the consequences of such</p>

	<p>failure will <i>mutatis mutandis</i> be as stated in clause 10.1.4.</p> <p>4. Clauses 6.10.9 and 10.1.5 shall be amended as follows to indicate the limitation on the Engineer's authority in respect thereof:</p> <p><b>Clause 6.10.9 – Amend to read as follows:</b></p> <p>Within 14 days of the date of final approval as stated in the Final Approval Certificate, the Contractor shall deliver to the Engineer a final statement claiming final settlement of all moneys due to him (save in respect of matters in dispute, in terms of Clauses 10.3 to 10.11, and not yet resolved). The Employer shall within 14 days issue to the Contractor a Final Payment Certificate the amount of which shall be paid to the Contractor within 28 days of the date of such certificate, after which no further payments shall be due to the Contractor (save in respect of matters in dispute, in terms of Clauses 10.3 to 10.11 and not yet resolved).</p> <p><b>Clause 10.1.5 – Amend to read as follows:</b></p> <p>Unless otherwise provided in the Contract, the Employer shall, within 28 days after the Contractor has delivered his claim in terms of Clause 10.1.1 as read with Clause 10.1.2, deliver to the Contractor his written and adequately reasoned ruling on the claim (referring specifically to this Clause). The amount thereof, if any, allowed by the Employer shall be included to the credit of the Contractor in the next payment certificate.</p> <p>5. Insert the following under 3.1.3: Provided that, notwithstanding any provisions to the contrary in the Contract, the Employer shall have the right to reverse and, should it deem it necessary, to amend any certificate, instruction, decision or valuation of the Engineer and to issue a new one, and such certificate instruction, decisions or valuations shall for the purposes of the Contract be deemed to be issued by the Engineer, provided that the Contractor shall be remunerated in the normal manner for work executed in good faith in terms of an instruction issued by the Engineer and which has subsequently been rescinded.</p>								
3.2.2.1	<p>Amend Clause 3.2.2.1 to insert the word "Plant" to read as follows:</p> <p>Observe the execution of the Works, examine and test material, Plant and workmanship, and receive from the Contractor such information as he shall reasonably require.</p>								
3.2.3.2	<p>Amend Clause 3.2.3.2 to insert the word "Plant" to reads as follows:</p> <p>Notwithstanding any authority assigned to him in terms of Clauses 3.2.2 and 3.2.4, failure by the Engineer's Representative to disapprove of any work, workmanship, Plant or materials shall not prejudice the power of the Engineer thereafter to disapprove thereof and exercise any of his powers in terms of the Contract in respect of thereof.</p>								
4.8.2.1	<p>Amend Clause 4.8.2.1 to include the word "person", as follows:</p> <p>Makes available to the Employer, or to any such contractor, person or authority, any roads or ways for the maintenance of which the Contractor is responsible, or</p>								
4.8.2.2	<p>Amend Clause 4.8.2.2 to include "Employer" and "contractors", as follows:</p> <p>Provides any other facility or service of whatsoever nature to the Employer or to any of the said contractors, persons or authorities,</p>								
5.3.1	<p>The documentation required before commencement with Works execution are:</p> <table> <tr> <td>Health and Safety Plan</td> <td>(Refer to Clause 4.3)</td> </tr> <tr> <td>Initial programme</td> <td>(Refer to Clause 5.6)</td> </tr> <tr> <td>Security</td> <td>(Refer to Clause 6.2)</td> </tr> <tr> <td>Insurance</td> <td>(Refer to Clause 8.6)</td> </tr> </table>	Health and Safety Plan	(Refer to Clause 4.3)	Initial programme	(Refer to Clause 5.6)	Security	(Refer to Clause 6.2)	Insurance	(Refer to Clause 8.6)
Health and Safety Plan	(Refer to Clause 4.3)								
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	<i>insert other requirements</i> <i>insert other requirements</i> <i>insert other requirements</i>
5.3.2	The time to submit the documentation required before commencement with Works execution is: <b>21 days.</b>
5.4.2	The access to, and possession of, the Site referred to in Clause 5.4.1 shall be <b>"not exclusive"</b> to the Contractor. In the event of access to, and possession of, the Site is not exclusive to the Contractor, the following limitations apply: <b><i>Insert an exposition of limitation.</i></b>
5.8.1	The non-working days are: <b>Saturdays and Sundays</b>  The special non-working days are: <b>(1) Public Holidays;</b> <b>(2) The year-end break commencing on 16 December until the Sunday preceding the first working Monday of January of the succeeding year.</b>
5.9.1	Amend Clause 5.9.1 as follows:  On the Commencement Date, the Engineer shall deliver to the Contractor three (3) copies, at no cost to the Contractor, of the drawings and any instructions required for the commencement of the Works. The cost of any additional copies of such drawings and/or instructions, as may be required by the Contractor, will be for the account of the Contractor.
5.13.1	The penalty for failing to complete the Works is: <b>R12 500.00 ex VAT per day</b>  <b><i>or, if completion in portions is required,</i></b>  The penalty for failing to complete portion 1 of the Works is: <b><i>Rinsert penalty amount per day.</i></b> The penalty for failing to complete portion 2 of the Works is: <b><i>Rinsert penalty amount per day.</i></b> The penalty for failing to complete portion 3 of the Works is: <b><i>Rinsert penalty amount per day.</i></b> The penalty for failing to complete portion 4 of the Works is: <b><i>Rinsert penalty amount per day.</i></b> <b><i>Followed by further portions as required.</i></b>  The penalty for failing to complete the whole of the works is: <b>R 12500.00 ex VAT per day.</b>
5.14.1	Amend the second paragraph of Clause 5.14.1 as follows:  When the Works are about to reach the said stage, the Contractor shall, in writing, request a Certificate of Practical Completion and the Engineer shall, within 14 days after receiving such request, issue to the Contractor a written list setting out the work to be completed to justify Practical Completion. Should the Engineer not issue such a list within the 14 days, the Contractor shall notify the Employer accordingly. Should the Employer not issue such a list within 7 days of receipt of such notice, Practical Completion shall be deemed to have been achieved on the 14 <sup>th</sup> day after the contractor requested the Certificate of Practical Completion.
5.16.1	Amend Clause 5.16.1 to delete the proviso in the third paragraph of this clause.
5.16.2	Amend Clause 5.16.2 as follows:  No certificate other than the Final Approval Certificate referred to in Clause 5.16.1 shall be deemed to



	constitute approval of the Works or shall be taken as an admission of the due performance of the Contract or any part thereof, nor of the accuracy of any claim made by the Contractor, nor shall any other certificate exclude or prejudice any of the powers of the Engineer and/or the Employer.
5.16.3	The latent defect period for all works is: <b>5 years</b> .
6.2.1	The type of security for the due performance of the Contract, as selected by the Contractor in the Contract Data, must be delivered to the Employer.
6.2.3	Amend Clause 6.2.3 as follows: If the Contractor has selected a performance guarantee as security, he shall ensure that it remains valid and enforceable as required in terms of the Contract.
6.5.1.2.3	The percentage allowance to cover overhead charges is: <b>33%, except on material cost where the percentage allowance is 10%.</b>
6.8.2	Contract Price Adjustment (CPA) will be applicable: <b>"No"</b> . If CPA is indicated as 'Yes' above the value of payment certificates is to be adjusted by a Contract Price Adjustment Factor: The value of the certificates issued shall be adjusted in accordance with the Contract Price Adjustment Schedule with the following values: The value of "x" is 0.15. The values of the coefficients are: a = 0.25. (Labour) b = 0.3 (Contractor's equipment) c = 0.3 (Material) d = 0.15 (Fuel) The values of the coefficients for "Repair and Maintenance Project" (RAMP) contracts are: a = 0.35 (Labour) b = 0.20 (Contractor's equipment) c = 0.35 (Material) d = 0.10 (Fuel) The urban area nearest the Site is <b>Kimberley</b> . (Select urban area from Statistical News Release, P0141, Table 7.1.) The applicable industry for the Producer Price Index for materials is <b>Mechanical</b> . (Select the applicable industry from Statistical News Release, P01421, Table 11.) The area for the Producer Price Index for fuel is <b>Kimberly</b> . (Select the area from Statistical News Release, P01421, Table 12.) The base month is <b>March 2021</b> . (The month prior to the closing of the tender.)
6.8.3	Price adjustments for variations in the costs of special materials are not allowed.
6.10.1.5	The percentage advance on materials not yet built into the Permanent Works is: <b>85 %</b> .
6.10.3	The limit of retention money is dependent on the security to be provided by the Contractor in terms of Clause 6.2.1.



6.10.5	<p>Replace Clause 6.10.5 with the following:</p> <p><u>In respect of contracts up to R2 million and in respect of contracts above R2 million where the Contractor elects a security by means of a 10% retention, 50% of the retention shall be released to the Contractor when the Engineer issues the Certificate of Completion in terms of clause 5.14.4. The remaining 50% of the retention shall be released in accordance with the provisions of the conditions of contract and will become due and payable when the Contractor becomes entitled, in terms of Clause 5.16.1, to receive the Final Approval Certificate.</u></p> <p><u>In respect of contracts above R2 million, where the Contractor elects a security by means of a cash deposit or fixed guarantee of 5% of the Contract Sum (excl. VAT) and a 5% retention of the Value of the Works (excl. VAT), the cash deposit or fixed guarantee, whichever is applicable, shall be refunded to the Contractor or return to the guarantor, respectively, when the Engineer issues the Certificate of Completion in terms of Clause 5.14.4. The 5% retention of the Value of the Works (excl. VAT) shall become due and payable when the Contractor becomes entitled, in terms of Clause 5.16.1, to receive the Final Approval Certificate.</u></p> <p><u>In respect of contracts above R2 million, where the Contractor elects a security by means of a cash deposit or a variable guarantee of 10% of the Contract Sum (excl. VAT), the cash deposit or the variable guarantee, whichever is applicable, will be reduced to 5% of the Value of the Works (excl. VAT) when the Engineer issues the Certificate of Completion in terms of Clause 5.14.4. The balance of the cash deposit shall become due and payable or the variable guarantee shall expire when the Contractor becomes entitled in terms of Clause 5.16.1 to receive the Final Approval Certificate.</u></p>
7.9.1	<p>Insert the following at the end of Clause 7.9.1:</p> <p>Provided that, should the Contractor on demand not pay the amount of such costs to the Employer, such amount may be determined and deducted by the Employer from any amount due to or that may become due to the Contractor under this or any other previous or subsequent contract between the Contractor and the Employer.</p>
8.2.2.1	<p>Insert the following as a second paragraph to Clause 8.2.2.1:</p> <p>The Contractor shall at all times proceed immediately to remove or dispose of any debris arising from damage to or destruction of the Works and to rebuild, restore, replace and/or repair the Works, failing which the Employer may cause same to be done and recover the reasonable costs associated therewith from the Contractor.</p>
8.4.3	<p>Insert a new Clause 8.4.3 as follows:</p> <p>The Contractor shall on receiving a written instruction from the Engineer immediately proceed at his own cost to remove or dispose of any debris and to rebuild, restore, replace and/or repair such property and to execute the Works.</p>
8.6.1.1.1	<p>Amend Clause 8.6.1.1.1 to read as follows: Contract Sum plus 10%.</p>
8.6.1.1.2	<p>The value of Plant and materials supplied by the Employer to be included in the insurance sum is: Nil</p>
8.6.1.1.3	<p>The amount to cover professional fees for repairing damage and loss to be included in the insurance sum is: Nil</p>
8.6.1.3	<p>Amend Clause 8.6.1.3 to delete reference to limit of indemnity, to read as follows:</p> <p>Liability insurance that covers the Contractor against liability for the death of, or injury to any person, or loss of, or damage to any property (other than property while it is insured in terms of Clause 8.6.1.1) arising from or in the course of the fulfillment of the Contract, from the Commencement Date to the date of the end of the Defects Liability Period, if there is one, or otherwise to the issue of the Certificate of Completion.</p>

8.6.1.5	<p>1. <b>Public liability insurance</b> to be effect by the Contractor to a minimum value of:</p> <p><input checked="" type="checkbox"/> R5 million</p> <p>or</p> <p><input type="checkbox"/> R <i>insert amount in figures (and in words)</i></p> <p>With a deductible not exceeding 5% of each and every claim.</p> <p>2. <b>Support insurance</b> is to be effected by the Contractor to a minimum value of:</p> <p>R <i>insert amount in figures (and in words)</i></p> <p>With a deductible not exceeding 5% of each and every claim.</p>
8.6.5	<p>Amend Clause 8.6.5 as follows:</p> <p>Save as otherwise provided in the Contract Data, the insurances referred to in Clause 8.6.1 shall be effected with an insurance company registered in the Republic of South Africa. The Contractor shall submit the insurance policy to the Employer for approval, if so requested.</p>
8.6.7	<p>Amend Clause 8.6.7 as follows:</p> <p>If the Contractor fails to effect and keep in force any of the insurances referred to in Clause 8.6.1, the Employer may cancel the Contract in terms of Clause 9.2.</p>
8.6.8	<p>Insert a new Clause 8.6.8 in provide for high risk insurance for projects executed on areas classified as "High Risk Areas".</p> <p><b>HIGH RISK INSURANCE</b></p> <p>In the event of the project being executed in a geological area classified as a "High Risk Area", that is an area which is subject to highly unstable subsurface conditions that might result in catastrophic ground movement evident by sinkhole or doline formation the following will apply:</p> <p>(1) <b>Damage to the Works</b></p> <p>The Contractor shall, from the date of Commencement of the Works until the date of the Certificate of Completion, bear the full risk of and hereby indemnifies and holds harmless the Employer against any damage to and/or destruction of the Works consequent upon a catastrophic ground movement as mentioned above. The Contractor shall take such precautions and security measures and other steps for the protection of the Works as he may deem necessary.</p> <p>When so instructed to do so by the Engineer, the Contractor shall proceed immediately to remove and/or dispose of any debris arising from damage to or destruction of the Works and to rebuild, restore, replace and/or repair the Works, at the Contractor's own costs.</p> <p>(2) <b>Injury to Persons or Loss of or damage to Properties</b></p> <p>The Contractor shall be liable for and hereby indemnifies and holds harmless the Employer against any liability, loss, claim or proceeding arising during the Contract Period whether arising in common law or by Statute, consequent upon personal injuries to or the death of any person whomsoever resulting from, arising out of or caused by a catastrophic ground movement as mentioned above.</p> <p>The Contractor shall be liable for and hereby indemnifies the Employer against any and all liability, loss, claim or proceeding consequent upon loss of or damage to any moveable, or immovable or personal property or property contiguous to the Site, whether belonging to or under the control of the Employer or any other body or person whomsoever arising out of or caused by a catastrophic ground</p>

	<p>movement, as mentioned above, which occurred during the Contract Period.</p> <p>(3) It is the responsibility of the Contractor to ensure that he has adequate insurance to cover his risk and liability as mentioned in Clauses 8.6.8(1) and 8.6.8 (2) above. Without limiting his obligations in terms of the Contract, the Contractor shall, within 21 days of the Commencement Date and before Commencement of the Works, submit to the Employer proof of such insurance policy, if requested to do so.</p> <p>(4) The Employer shall be entitled to recover any and all losses and/or damages of whatever nature suffered or incurred consequent upon the Contractor's default of his obligations as set out in Clauses 8.6.8 (1), 8.6.8 (2) and 8.6.8 (3). Provided that, should the Contractor on demand not pay the amount of such costs to the Employer, such amount may be determined and deducted by the Employer from any amount due to or that may become due to the Contractor under this or any other existing or subsequent contract between the Contractor and the Employer.</p>
9.1.4	<p>Amend Clause 9.1.4 as follows:</p> <p>In the circumstances referred to in Clauses 9.1.1, 9.1.2 or 9.1.3 (provided that the circumstances in 9.1.3 is not due to the fault of the Contractor, his employees, contractors or agents), and whether or not the Contract is terminated under the provisions of this Clause, the Contractor shall be entitled to payment of any increased cost of or incidental to the execution of the Works which is specifically attributable to, or consequent upon the circumstances defined in Clauses 9.1.1, 9.1.2 or 9.1.3;</p>
9.1.5	<p>Amend Clause 9.1.5 as follows:</p> <p>If the Contract is terminated on any account in terms of this Clause (provided that the circumstances in 9.1.3 is not due to the fault of the Contractor, his employees, contractors or agents) , the Contractor shall be paid by the Employer (insofar as such amounts or items have not already been covered by payments on account made to the Contractor) for all measured work executed prior to the date of termination, the amount (without retention), payable in terms of the Contract and, in addition:</p>
9.1.6	<p>This Clause is not applicable to this Contract.</p>
9.2.1.3.8	<p>Insert a new Clause 9.2.1.3.8 as follows:</p> <p>Has failed to effect and keep in force any of the insurances referred to in Clause 8.6.1,</p>
9.2.4	<p>Insert a new Clause 9.2.4 as follows, to provide for unilateral termination by the Employer:</p> <p>The Employer shall be entitled at any time to unilaterally terminate or cancel this Contract or any part thereof. Save for the following, the Contractor shall not be entitled to claim any other amounts whatsoever in respect of such termination or cancellation of this Contract. The Employer shall be obliged to pay the Contractor as damages and/or loss of profit the lesser of:</p> <p>9.2.4.1 An amount not exceeding 10% of the Contract Sum;</p> <p>9.2.4.2 10% of the value of incomplete work; or</p> <p>9.2.4.3 The Contractor's actual damage or loss as determined by the Employer after receipt of evidence substantiating any such damage or loss.</p>
9.3.2.2	<p>Amend Clause 9.3.2.2 as follows to delete the proviso on lien:</p> <p>The ownership of Plant and unused materials brought onto the Site by the Contractor, and for which the Employer has not made any payment, shall revert to the Contractor and he shall, with all reasonable dispatch, remove from the Site such Plant, materials and all Construction Equipment and Temporary Works.</p>
9.3.3	<p>Insert the following at the end of Clause 9.3.3</p>

	After cancellation of the Contract by the Contractor, the Contractor, when requested by the Employer to do so, shall not be entitled to refuse to withdraw from the Works on the grounds of any lien or a right of retention or on the grounds of any other right whatsoever.
10.1.3.1	Amend Clause 10.1.3.1 as follows to insert the word "Plant":  All facts and circumstances relating to the claims shall be investigated as and when they occur or arise. For this purpose, the Contractor shall deliver to the Engineer, records in a form approved by the Engineer, of all the facts and circumstances which the Contractor considers relevant and wishes to rely upon in support of his claims, including details of all Construction Equipment, labour, Plant and materials relevant to each claim. Such records shall be submitted promptly after the occurrence of the event giving rise to the claim.
10.1.6	Insert a new Clause 10.1.6 as follows:  If the Employer fails to give his ruling within the period referred to in Clause 10.1.5 he shall be deemed to have given a ruling dismissing the claim.
10.2.1	Amend Clause 10.2.1 as follows:  In respect of any matter arising out of or in connection with the Contract, which is not required to be dealt with in terms of Clause 10.1 or which does not require the decision or ruling of the Employer, the Contractor or the Employer shall have the right to deliver a written dissatisfaction claim to the Engineer. This written claim shall be supported by particulars and substantiated.
10.2.2	Amend Clause 10.2.2 as follows:  If, in respect of any matter arising out of or in connection with the Contract, which is not required to be dealt with in terms of Clause 10.1 or which does not require the decision or ruling of the Employer, the Contractor or the Employer fails to submit a claim within 28 days after the cause of dissatisfaction, he shall have no further right to raise any dissatisfaction on such matter.
10.3.2	Amend Clause 10.3.2 as follows to replace "adjudication" with "court":  If either party shall have given notice in compliance with Clause 10.3.1, the dispute shall be referred to court proceedings in terms of Clause 10.8, unless amicable settlement is contemplated.
10.3.3	Replace "Engineer" with "Employer".
10.4.2	Amend Clause 10.4.2 as follows to provide for submission to court:  If the other party rejects the invitation to amicable settlement in writing or does not respond in writing to the invitation with 14 days, or amicable settlement is unsuccessful, either party may submit the dispute to court.
10.4.4	Amend Clause 10.4.4 to delete reference to "adjudication" and "arbitration" to read as follows:  Save for reference to any portion of any settlement or decision which has been agreed to be final and binding on the parties, no reference shall be made by or on behalf of either party in any subsequent court proceedings, to any outcome of an amicable settlement, or to the fact that any particular evidence was given, or to any submission, statement or admission made in the course of the amicable settlement.
10.5 10.6 & 10.7	The entire provisions of these Clauses are not applicable to this Contract.
10.10.3	Amend Clause 10.10.3 as follows to reword and remove reference to "arbitrator":  The court shall have full power to open up, review and revise any ruling, decision, order, instruction, certificate or valuation of the Engineer and Employer and neither party shall be limited in such proceedings before such court to the evidence or arguments put before the Engineer or Employer for the purpose of



obtaining his ruling.

<b>PART 2: DATA PROVIDED BY THE CONTRACTOR</b>	
1.1.1.9	The name of the Contractor is: <i>Insert legal name of Contractor</i>
1.2.1.2	<p>The address of the Contractor is:</p> <p>Physical Address: <i>insert physical address</i> <i>insert town</i> <i>insert code</i></p> <p>Postal Address: <i>insert postal address</i> <i>insert town</i> <i>insert postal code</i></p> <p>Facsimile: <i>insert fax no</i></p> <p>Telephone: <i>insert tel no</i></p>
6.2.1	<p>The security to be provided by the Contractor shall be one of the following:</p> <p>(a) Cash deposit of 10 % of the Contact Sum (excl. VAT) <input type="checkbox"/> YES or <input type="checkbox"/> NO</p> <p>(b) Variable performance guarantee of 10 % of the Contract Sum (excl. VAT) <input checked="" type="checkbox"/> YES or <input type="checkbox"/> NO</p> <p>(c) Retention of 10 % of the value of the Works (excl. VAT) <input type="checkbox"/> YES or <input type="checkbox"/> NO</p> <p>(d) Cash deposit of 5 % of the Contract Sum (excl. VAT) plus retention of 5 % of the value of the Works (excl. VAT) <input type="checkbox"/> YES or <input type="checkbox"/> NO</p> <p>(e) Performance guarantee of 5 % of the Contract Sum (excl. VAT) plus retention of 5 % of the value of the Works (excl. VAT) <input type="checkbox"/> YES or <input type="checkbox"/> NO</p> <p><b>NB: Guarantees submitted must be issued by either an insurance company duly registered in terms of the Short-Term Insurance Act, 1998 (Act 53 of 1998) or by a bank duly registered in terms of the Banks Act, 1990 (Act 94 of 1990) on the pro-forma referred to above. No alterations or amendments of the wording of the pro-forma will be accepted.</b></p>

## **C1.3 Form of Guarantee**



## DPW-10.2 (EC): VARIABLE CONSTRUCTION GUARANTEE - (GCC (2004) 1st EDITION: 2004)

Director-General  
Department of Public Works  
Government of the Republic of South Africa

To: **Graham Martin**  
Private Bag x 5002  
**Kimberley**  
**8300**

Sir,

### VARIABLE CONSTRUCTION GUARANTEE FOR THE EXECUTION OF A CONTRACT IN TERMS OF GCC (2004) 1ST EDITION 2004

1. With reference to the contract between \_\_\_\_\_  
\_\_\_\_\_ (hereinafter referred to as the "contractor") and the Government of the Republic of South Africa in its Department of Public Works (hereinafter referred to as the "employer"), Contract/Tender No: **KM 01/2021**, for the **Kimberley:Justice:High court:Installation of airconditioners** . (hereinafter referred to as the "contract") for the sum of R *insert amount*, (*insert amount in words*), (hereinafter referred to as the "contract sum").  
  
I / We, \_\_\_\_\_  
in my/our capacity as \_\_\_\_\_ and hereby representing \_\_\_\_\_ (hereinafter referred to as the "guarantor") advise that the guarantor holds at the employer's disposal the sum of R *insert amount*, (*insert amount in words*) being 10% of the contract sum (excluding VAT), for the due fulfilment of the contract.
2. I / We advise that the guarantor's liability in terms of this guarantee shall be as follows:
  - (a) From and including the date on which this guarantee is issued and up to and including the day before the date on which the last **certificate of completion** of works is issued, the guarantor will be liable in terms of this guarantee to the maximum amount of 10% of the **contract sum** (excluding VAT);
  - (b) The guarantor's liability shall reduce to 5 % of the **value of the works** (excluding VAT) as determined at the date of the last **certificate of completion** of works, subject to such amount not exceeding 10% of the **contract sum** (excluding VAT);
  - (c) This guarantee shall expire on the date of the last **final approval certificate**.
3. The guarantor hereby renounces the benefits of the exceptions *non numeratae pecunia; non causa debiti; excussionis et divisionis*; and *de duobus vel pluribus reis debendi* which could be pleaded against the enforcement of this guarantee, with the meaning and effect whereof I/we declare myself/ourselves to be conversant, and undertake to pay the employer the amount guaranteed on receipt of a written demand from the employer to do so, stating that (in the employer's opinion and sole discretion):
  - (a) the contractor has failed or neglected to comply with the terms and/or conditions of the **contract**; or
  - (b) the contractor's estate is sequestrated, liquidated or surrendered in terms of the insolvency laws in force within the Republic of South Africa.



4. Subject to the above, but without in any way detracting from the employer's rights to adopt any of the procedures provided for in the contract, the said demand can be made by the employer at any stage prior to the expiry of this guarantee.
5. The amount paid by the guarantor in terms of this guarantee may be retained by the employer on condition that upon issue of the last final approval certificate, the employer shall account to the guarantor showing how this amount has been expended and refund any balance due to the guarantor.
6. The employer shall have the absolute right to arrange his affairs with the contractor in any manner which the employer deems fit and the guarantor shall not have the right to claim his release on account of any conduct alleged to be prejudicial to the guarantor. Without derogating from the foregoing, any compromise, extension of the construction period, indulgence, release or variation of the contractor's obligation shall not affect the validity of this guarantee.
7. The guarantor reserves the right to withdraw from this guarantee at any time by depositing the guaranteed amount with the employer, whereupon the guarantor's liability ceases.
8. This guarantee is neither negotiable nor transferable, and
  - (a) must be surrendered to the guarantor at the time when the employer accounts to the guarantor in terms of clause 5 above, or
  - (b) shall lapse in accordance with clause 2 (c) above.
9. This guarantee shall not be interpreted as extending the guarantor's liability to anything more than payment of the amount guaranteed.

SIGNED AT \_\_\_\_\_ ON THIS \_\_\_\_\_ DAY OF \_\_\_\_\_ 200\_\_

**AS WITNESS**

1. \_\_\_\_\_
2. \_\_\_\_\_

\_\_\_\_\_  
By and on behalf of

\_\_\_\_\_  
(Insert the name and physical address of the guarantor)

NAME: \_\_\_\_\_

CAPACITY: \_\_\_\_\_  
(duly authorised thereto by resolution attached marked Annexure A)

DATE: \_\_\_\_\_

- A. No alterations and/or additions of the wording of this form will be accepted.
- B. The physical address of the guarantor must be clearly indicated and will be regarded as the guarantor's *domicilium citandi et executandi*, for all purposes arising from this guarantee.



C. This GUARANTEE must be returned to: \_\_\_\_\_  
\_\_\_\_\_

## DPW-10.4 (EC): FIXED CONSTRUCTION GUARANTEE - (GCC (2004) 1st EDITION: 2004)

Director-General  
 Department of Public Works  
 Government of the Republic of South Africa

To: **Graham Martin**  
 Private Bag x 5002  
 Kimberley  
 8301

Sir,

### FIXED CONSTRUCTION GUARANTEE FOR THE EXECUTION OF A CONTRACT IN TERMS OF GCC (2004) 1<sup>ST</sup> EDITION 2004

1. With reference to the contract between \_\_\_\_\_ (hereinafter referred to as the "contractor") and the Government of the Republic of South Africa in its Department of Public Works (hereinafter referred to as the "employer"), Contract/Tender No: **KM 01/2021**, for the **Kimberley:Justice:High court including masters office: Installation of airconditioners** (hereinafter referred to as the "contract"), for the sum of R **500**, (*insert amount in words*), (hereinafter referred to as the "contract sum").  
  
 I / We, \_\_\_\_\_  
 in my/our capacity as \_\_\_\_\_ and hereby  
 representing \_\_\_\_\_ (hereinafter referred to as the "guarantor") advise that the guarantor holds at the employer's disposal the sum of R *insert amount*, (*insert amount in words*) being 5% of the contract sum (excluding VAT), for the due fulfillment of the contract.
2. The guarantor hereby renounces the benefits of the exceptions *non numeratae pecunia; non causa debiti; excussionis et divisionis; and de duobus vel pluribus reis debendi* which could be pleaded against the enforcement of this guarantee, with the meaning and effect whereof I/we declare myself/ourselves to be conversant, and undertake to pay the employer the amount guaranteed on receipt of a written demand from the employer to do so, stating that (in the employer's opinion and sole discretion):
  - (a) the contractor has failed or neglected to comply with the terms and/or conditions of the contract; or
  - (b) the contractor's estate is sequestrated; liquidated or surrendered in terms of the insolvency laws in force within the Republic of South Africa.
3. Subject to the above, but without in any way detracting from the employer's rights to adopt any of the procedures provided for in the contract, the said demand can be made by the employer at any stage prior to the expiry of this guarantee.
4. The amount paid by the guarantor in terms of this guarantee may be retained by the employer on condition that upon the issue of the last final approval certificate, the employer shall account to the guarantor showing how this amount has been expended and refund any balance due to the guarantor.
5. The employer shall have the absolute right to arrange his affairs with the contractor in any manner which the employer deems fit and the guarantor shall not have the right to claim his release on account of any conduct alleged to be prejudicial to the guarantor. Without derogating from the foregoing, any compromise, extension of the construction period, indulgence, release or variation of the contractor's obligation shall not affect the validity of this guarantee.

- 6. The guarantor reserves the right to withdraw from this guarantee at any time by depositing the guaranteed amount with the employer, whereupon the guarantor's liability ceases.
- 7. This guarantee is neither negotiable nor transferable, and
  - (a) must be surrendered to the guarantor at the time when the employer accounts to the guarantor in terms of clause 4 above, or
  - (b) shall lapse on the date of the last certificate of completion of works.
- 8. This guarantee shall not be interpreted as extending the guarantor's liability to anything more than the payment of the amount guaranteed.

SIGNED AT \_\_\_\_\_ ON THIS \_\_\_\_\_ DAY OF \_\_\_\_\_ 200\_\_

**AS WITNESS**

- 1. \_\_\_\_\_
- 2. \_\_\_\_\_

\_\_\_\_\_  
By and on behalf of  
\_\_\_\_\_  
\_\_\_\_\_

(insert the name and physical address of the guarantor)

NAME: \_\_\_\_\_

CAPACITY: \_\_\_\_\_  
(duly authorised thereto by resolution attached marked Annexure A)

DATE: \_\_\_\_\_

- A. No alterations and/or additions of the wording of this form will be accepted.
- B. The physical address of the guarantor must be clearly indicated and will be regarded as the guarantor's *domicilium citandi et executandi*, for all purposes arising from this guarantee.
- C. This GUARANTEE must be returned to: \_\_\_\_\_  
\_\_\_\_\_

## **Part C2: Pricing Data**

## **C2.1 Pricing Instructions**





Tender no: **KIM 01/2021**

## **C2.1 Bill of Quantities**

Refer to Volume 2



## **Part C3: Scope of Works**



## PG-01.1 (EC) SCOPE OF WORKS – (GCC (2004) 1<sup>st</sup> EDITION: 2004)

Project title:	<i>Kimberley:Justice:High court including masters office: Installation of airconditioners</i>		
Tender no:	<i>KIM 01/2021</i>	Reference no:	<i>19/2/4/2/2/2327/489</i>

### C3. Scope of Works

#### CONTENTS

#### C3.1 STANDARD SPECIFICATIONS

#### C3.2 PROJECT SPECIFICATIONS

##### A: GENERAL

- PS-1 PROJECT DESCRIPTION
- PS-2 DESCRIPTION OF SITE AND ACCESS
- PS-3 DETAILS OF CONTRACT
- PS-4 CONSTRUCTION AND MANAGEMENT REQUIREMENTS

**NOTE: This is an example only. Compiler / Designer to provide the applicable contents.**

##### B: AMENDMENTS TO THE STANDARD SPECIFICATIONS

#### C3.3 PARTICULAR SPECIFICATIONS

##### PART DESCRIPTION

- 1A General Conditions for the Supply Delivery, Installation and Commissioning of Mechanical Equipment
- 2B Standard Technical Specification
- 3 Project Technical Specification
- 4 Schedule of Equipment Offered By Contractor



Tender no: **KIM 01/2021**

**C3.1 STANDARD SPECIFICATIONS:**

The standard specifications on which this contract is based are the **South African Bureau of Standards Standardized Specifications for Civil Engineering Construction SABS 1200**. *(Note to compiler. "SABS" has been changed to "SANS"; the SABS 1200 specifications are due to be replaced in the foreseeable future by SANS 2100)*

Although not bound in nor issued with this Document, the following Sections of the Standardized Specifications of SABS 1200 shall form part of this Contract:



Tender no: *KIM/01/202*

### C3.2 PROJECT SPECIFICATIONS:

#### Status

The Project Specification, consisting of two parts, forms an integral part of the contract and supplements the Standard Specifications.

Part A contains a general description of the works, the site and the requirements to be met.

Part B contains variations, amendments and additions to the Standardized Specifications.

In the event of any discrepancy between a part or parts of the Standardised of Particular Specifications and the Project Specification, the Project Specification shall take precedence. In the event of a discrepancy between the specifications, (including the Project Specifications) and the drawings and / or the Bill of Quantities, the discrepancy shall be resolved by the Engineer before the execution of the work under the relevant item.

#### A GENERAL

##### PS-1 PROJECT DESCRIPTION:

There is a requirement from Department of Justice to upgrade and repair the air-conditioning installation in the Kimberley High Court including the master offices.

##### PS-2 DESCRIPTION OF SITE

The High Court is located in Kimberley ,Cullinan Crescent, Northern Cape.

##### PS-3 SCOPE OF WORKS

The scope of work covered by this project is the upgrading and repairs of the building air-conditioning installation , The repair works must comply with the latest legislation applicable to the project. The work comprises of the following:

##### Civil Works:

- \* Repair ceilings when removing old redundant equipment;
- \* Repair and paint wall when removing redundant air-conditioner units,;

##### Electrical Works:

- \* Remove and replace all damaged low voltage electrical supply cables to MCC boards;
- \* Supply and install new MCC boards in air-conditioner plants rooms ;
- \* Supply and install new perimeter security lighting on 3m poles ;
- \* Rewire electrical points when required;
- \* Issue Certificate of Compliance (CoC) for all MCC boards.

##### Mechanical Works:

- \*Supply and install new air-conditioning air handling units as per BOQ and engineers drawings
- \* Supply and install VRF air-conditioning systems as per BOQ and engineers drawings.
- \* Remove and replace all single type air-conditioner units with energy efficient type DC inverter units complete including refrigerant piping and brackets.



\* Strip and remove all redundant air-handling units , chillers, cooling towers.

The following drawings indicates the scope of works:

**Mechanical Drawings:**

* 34280.00-740-01	HVAC LAYOUT GROUND FLOOR -	PAPER A0
* 34280.00-740-02	HVAC LAYOUT FIRST FLOOR -	PAPER A0
* 34280.00-740-03	HVAC LAYOUT SECOND FLOOR -	PAPER A0

**Tender no: KIM 01/2021**

**B: AMENDMENTS TO THE STANDARD SPECIFICATIONS:**

**B.1 STANDARD ELECTRICAL SPECIFICATION -**

**Section A Preamble to Standard Specification - PW 354**

**Section B Installation Specification - PW 354**

**Section C General Specification for Materials and Equipment of Electrical Installations**

**B.2 STANDARD MECHANICAL SPECIFICATION -**

**Standard Specification for Air Conditioning and Ventilation Installations - PW 327**



**Standard Conditions in respect of the Supply-, Delivery and Installation of Electrical-, Mechanical-, Pneumatic- and Vacuum Operated Equipment, Control Systems, Plant and Materials - PW 379**

**Note: These documents can be downloaded from  
<http://www.publicworks.gov.za/consultantguidelines.html>.**

**B.3 STANDARD BUILDING WORKS SPECIFICATION -**

**Although not bound in nor issued with this document, the following standards shall form part of the contract document and shall apply:**

<b>SANS 10400</b>	<b>Part J</b>	<b>Floors</b>
<b>SANS 10400</b>	<b>Part K</b>	<b>Walls</b>
<b>SANS 10400</b>	<b>Part L</b>	<b>Roofs</b>
<b>SANS 10400</b>	<b>Part N</b>	<b>Glazing</b>
<b>SANS 10400</b>	<b>Part P</b>	<b>Drainage</b>
<b>SANS 10400</b>	<b>Part R</b>	<b>Stormwater Dispersal</b>
<b>SANS 460</b>		<b>Copper Pipes</b>
<b>SANS 18252</b>	<b>Part 2</b>	<b>Water supply and drainage for buildings</b>



Tender no: *KM 07/2020*

**C3.3 PARTICULAR SPECIFICATIONS:**

**PART DESCRIPTION**

- 1A General Conditions for the Supply Delivery, Installation and Commissioning of Mechanical Equipment**
- 2B Standard Technical Specification**
- 3 Project Technical Specification**
- 4 Schedule of Equipment Offered By Contractor**

Kimberley High Court

PARTICULAR SPECIFICATION FOR THE  
AIR-CONDITIONING AND  
VENTILATION INSTALLATION





**Kimberley High Court****PARTICULAR SPECIFICATION FOR THE  
AIR-CONDITIONING AND VENTILATION INSTALLATION****CONTENTS**

<b>PART</b>	<b>DESCRIPTION</b>	<b>PAGES</b>
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2B	Standard Technical Specification	2B/1 – 2B/57
3	Project Technical Specification	3/1 – 3/18
4	Schedule of Equipment Offered By Contractor	4/1

**PART 1**

**GENERAL CONDITIONS FOR THE SUPPLY, DELIVERY,  
INSTALLATION AND COMMISSIONING OF MECHANICAL EQUIPMENT**

## PART 1A

**GENERAL CONDITIONS FOR THE SUPPLY, DELIVERY,  
INSTALLATION AND COMMISSIONING OF MECHANICAL EQUIPMENT**

**CONTENTS**

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## **GENERAL CONDITIONS FOR THE SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF MECHANICAL EQUIPMENT**

### **1 DEFINITIONS**

**According to the manufacturer's instructions:** The manufacturer's instructions at the time of tender.

**Approval:** Approval by the Engineer in writing and is limited to visual appearance of the work, material or components. Approval does not relieve the Contractor from compliance with the specification.

**BS:** British Standard.

**NBR:** National Building Regulations.

**SABS:** South African Bureau of Standards.

**Hepa:** High efficiency particulate filters

**NPSH:** Net Positive Suction Height

**TEFC:** Totally Enclosed Fan Cooled

**UL:** Underwriters laboratory

**SMACNA:** Sheet Metal and Air-conditioning Contractors National Association.

### **2 COMPLIANCE WITH STANDARDS**

2.1 When so requested by the Engineer, the Contractor shall, provide evidence in the form of delivery slips, certificates, test reports or other written proof that material or components comply with the standards laid down in this specification.

2.2 Products that are specified as mark-bearing must bear the mark of the relevant standards body.

### **3 STANDARDS**

Standards referred to in this specification are the latest edition, including all amendments, published three calendar months or longer before the closing date of tenders.

### **4 SUBMISSIONS**

4.1 Do all submissions indicated hereafter in accordance with the following time table.

4.2 After appointment but prior to commencement of work:

4.2.1 Competency certificates.

4.2.2 Equipment selections.

4.2.3 Builders work drawings.

- 4.2.4 Workshop drawings.
- 4.3 Before commencement of commissioning:
  - 4.3.1 Draft Operating and Maintenance manual.
- 4.4 Prior to practical Completion.
  - 4.4.1 Four sets of approved Operating and Maintenance manuals.
  - 4.4.2 A set of compact disc(s) containing all drawings in electronic format (the format and software shall be subject to the Engineer's approval).
- 4.5 Take note that all equipment selections and drawings approved (or not rejected) by the Engineer shall not free the contractor of his obligation to comply with the specification or relief the contractor from his responsibility for errors or omissions in the drawings.

## 5 COMPETENCY CERTIFICATES

The following certified copies of competency certificates of the tradesmen and/or technicians involved in this project shall be submitted to the Engineer:

- 5.1 Electrician: - Wireman's license and registration at the Electrical Contracting Board of South Africa.
- 5.2 Pipe fitter: - Trade and welders certificates as issued by the Department of Labour.
- 5.3 Refrigeration Mechanic: - Trade certificate as issued by the Department of Labour.

## 6 EQUIPMENT SELECTIONS

- 6.1 Equipment selections of all equipment shall be submitted to the Engineer for approval, to illustrate compliance with the specification requirements.
- 6.2 The submissions are required after appointment but before ordering of equipment takes place and shall be submitted in accordance with the programme requirements.
- 6.3 Submissions shall include inter alias the following information:
  - 6.3.1 Manufacture, name and model.
  - 6.3.2 Equipment capacity.
  - 6.3.3 Power consumption.
  - 6.3.4 Calculations of pressure drops, sound attenuation, etc.
  - 6.3.5 Diagrams, tables and graphs to explain the functioning of equipment where applicable.
  - 6.3.6 Applicable pamphlets or catalogue information.
  - 6.3.7 Name and address of Manufacturer/Distributor
  - 6.3.8 Number of years that equipment were available in the RSA
  - 6.3.9 Other information as may be required by the Engineer.

- 6.4 Duty points of equipment shall be clearly marked on the data sheets.
- 6.5 The contractor shall note that all equipment selections approved (or not rejected) by the Engineer or the Department shall not relieve the contractor to comply with the specification. Any proposed deviations from the specification shall be submitted for approval to the Department in writing.

## **7 MATERIALS AND WORKMANSHIP**

- 7.1 All work is to be executed with materials of the best quality and in the most substantial manner under the inspection and to the entire satisfaction of the Engineer.
- 7.2 The entire installation shall be in accordance with the following:-
- 7.2.1 The latest revision of SABS 0400: The Applications of the National Building Regulations, as amended.
  - 7.2.2 SABS Code of Practice for the Wiring of Premises No. 0142 of 1981, as amended.
  - 7.2.3 The Occupational Health and Safety Act, Act No. 85 of 1993, as amended.
  - 7.2.4 The local Municipal By-laws and Regulations, as well as the regulations of the Supply Authority.
  - 7.2.5 The local fire regulations.
- 7.3 All apparatus, components parts, fittings and materials supplied and/or installed whether especially specified herein or not shall conform in respect of quality, manufacture, tests and performance with the requirements of the appropriate current South African (SABS) or British Standard Specifications (BS) and Addenda thereto, except where otherwise required by this specification or permitted by approval of the Department in writing. All materials and workmanship, which may, in the opinion of the Engineer, be inferior to that specified for the work will be condemned. All condemned material and workmanship shall be replaced or rectified as the case may be, to the satisfaction of the Engineer.
- 7.4 No second-hand equipment of any description may be offered for supply or installation.
- 7.5 If so required the Engineer may call for samples of material and equipment for approval. Such samples shall be submitted within 14 days of the request and if judged necessary by the Engineer may only be returned after completion of the installation in order to ensure that the quality of the installed product is the same as that of the approved sample.
- 7.6 Any fitting or item of equipment not specifically mentioned but obviously necessary for the successful completion of the installation is to be included so as to form a complete working installation.
- 7.7 Only competent artisans shall be employed to erect the units on site as set out in the Standard Technical Specification.

## **8 CO-ORDINATION AND INSTALLATION INFORMATION**

- 8.1 The Mechanical Engineer's drawings and schedules are of a schematic nature unless specific dimensions to mechanical equipment are shown. Should agreement not be reached or if the equipment or fittings cannot be installed in the obvious locations to conform to the design, the Engineer's ruling shall be obtained.

- 8.2 The cost of relocation of equipment or fittings due to the lack of knowledge of site conditions shall be for the Contractor's own account.

## 9 QUALITY OF MATERIALS

- 9.1 All materials, where applicable, shall conform in respect of quality, manufacture, tests and performance, with the requirements of the SABS standards or, where no such standards exist, they shall conform to the appropriate current specification of the British Standard Institution. Materials manufactured in South Africa shall be used wherever possible.
- 9.2 Imported materials shall comply with the requirements of the relevant SABS or British Standard Specifications, although these materials need not necessarily bear the SABS mark.
- 9.3 All materials shall be suitable for the particular site conditions. These conditions shall include weather conditions as well as prevailing conditions during installation and subsequent permanent use.
- 9.4 Should the materials or components not be suitable for use under temporary site conditions where applicable the Contractor shall provide at his own cost, suitable protection until these unfavourable site conditions cease to exist.

## 10 UNIFORMITY

All items of the same make and type of equipment shall where at all possible be used throughout the installation, to ensure interchange ability and ease of maintenance. Deviation from the above will only be allowed after receiving within approved from the Engineer.

## 11 SAMPLES FOR TESTS

The Contractor shall furnish without delay, such samples for tests or other purposes as called for, or may be called for, by the Engineer, who may reject all materials or workmanship not corresponding with the approved sample, e.g. grilles, diffusers, extract fans, dampers, anti-draught louvers, etc.

## 12 INSPECTIONS AND TESTING

The Engineer shall have the power at any time to inspect and examine any part of the contract works or any materials intended for use in or on the contract works, either on site or at any factory, workshop or other place where such parts or materials are being constructed or manufactured or at any place where same are lying or from where they are being obtained, and the Contractor shall give all such facilities as the Engineer may reasonably require to be given for such inspection and examination.

## 13 LUBRICATION

All bearings shall be packed with approved grease or filled with the correct oil, and all gearboxes and sumps shall be filled with the lubricant specified by the manufacturer. The Contractor shall be responsible for the supply of all lubricants required for the initial fill. All lubricants shall be new and supplied in sealed drums or containers.

## 14 SERVICE ACCESS

Where equipment such as fans, dampers, valves etc. are installed above ceiling the Contractor shall ensure that access will be possible for maintenance purposes after installation.



**15 APPLICATION FOR INSTALLATION**

The Contractor shall allow for the submission of the necessary forms, fees and drawings to the Inspector of Machinery or other relevant Authorities to obtain permission to install equipment where this is required. He shall also, in co-operation with the Department make any arrangements that may be required for Government Inspectors or other relevant Inspectors to carry out prescribed tests.

**16 ALTERNATIVE OFFERS**

- 16.1 A tenderer who has duly submitted an offer which in all respects complies with the specification may, at his own initiative, also submit an alternative offer at the same time or any time prior to the closing time of tenders, provided that the Tenderer's offer to specification is acceptable in every respect, his alternative offer may also be considered for purposes of the award of the contract. Any deviation from specification or alternative condition of tender shall be clearly stated and any saving or additional expenditure brought about by each deviation or alternative proposal shall be qualified in the tender documents.
- 16.2 Full descriptive literature, specifications and design calculations shall be submitted with each offer of such alternatives.
- 16.3 It is brought to the specific notice of the tenderer that it is compulsory to price the tender for the specified equipment completely in accordance with the specification. Offered alternatives are therefore in addition to the specified offer.

**17 IMPORTANT NOTE RELATING TO EQUIVALENTS**

Where items from one manufacturer or supplier have been specified, Tenderer's are at liberty to offer equivalents. It is the prerogative of the Engineer to rule whether or not an equivalent item is acceptable in the context of the given design. Where an equivalent is not considered acceptable, the Engineer reserves the right to accept only the items specified. Tenderers shall therefore obtain the Engineer's acceptance, **IN WRITING**, for any proposed equivalent item.

**18 MANUFACTURER'S RATINGS**

- 18.1 All equipment such as fans, compressors, vacuum pumps, cooling towers, pumps, etc, shall be selected to operate well within the manufacturer's ratings. Equipment offered for use beyond these limits will not be considered.
- 18.2 Tenderers shall submit manufacturer's ratings of all equipment offered. Ratings shall be given in the SI system.

**19 NOTICES**

The Contractor shall supply and install all notices and warning signs that are required by the appropriate laws or regulations and by these documents.

**20 DRAWINGS**

- 20.1 The tender drawings issued with the Project Specification are schematic and do not necessarily purport to show the exact position, size or details of construction of equipment.

- 20.2 Tenderer's shall satisfy themselves that the equipment offered by them can be accommodated in the available space and positioned in such a way that access for maintenance, repairs or removal is not obstructed.

## 21 CONTRACTOR'S DRAWINGS

Where indicated in the Project Specification these drawings are to be prepared by the Contractor at his expense in accordance with this document and shall be on a scale of not less than 1:50.

These drawings shall at least consist of:

### 21.1 Builders Work Drawings

These shall indicate all work to be done by others (bases, foundations, holes in concrete and masonry, etc.) as well as the sizes, capacities and positions of service connections (electrical, water, drainage, etc.) to be provided by others, all in accordance with the Project Specification.

### 21.2 General Arrangement Drawings

21.2.1 These shall indicate all equipment, distribution systems, testing and inspection requirements as well as instrumentation positions and access requirements.

21.2.2 During their preparation, the Contractor shall take cognisance of all relevant architectural, structural, electrical and other services drawings in order to properly co-ordinate his layout. These drawings shall be obtained via the Main Contractor. The drawings shall be amended as required during the contract period, and up to date copies kept on site for reference purposes.

21.2.3 Positions and sizes of return air grilles, louvered openings through reinforced concrete beams and slabs, etc. as indicated on the tender drawings shall be adhered to as far as possible. Amendments will only be considered if absolutely unavoidable.

### 21.3 Shop Drawings

These shall be based on the General Arrangement drawings, and shall show in detail the construction of all the parts of the works, method of assembly where applicable, erection and construction, materials and connections, welds, gaskets, sealant, fastenings, reinforcing and all other necessary detail.

### 21.4 Electrical Drawings

Electrical drawings shall comprise complete control and power wiring diagrams, as well as general arrangement layouts of distribution boards indicating front and side elevations, giving major dimensions as well as instrumentation and switch position layouts.

### 21.5 As-Built Drawings And Wiring Diagrams

These are up-to-date approved drawings at the completion of the contract. Tenderer's shall allow in their price for submitting 4 hard copies as well as disk/s (with the drawings in an approved electronic format) of each of the up-to-date general arrangement drawings, shop drawings, as well as electrical drawings together with the O&M manuals specified herein.

## 22 SUBMISSION OF CONTRACTOR'S DRAWINGS

- 22.1 By submitting drawings, the Contractor confirms that he has determined and verified all site measurements, site instruction criteria, materials, catalogue numbers and similar data, or will do so, and that he has checked and co-ordinated each of his drawings with the requirements of the works and the contract documents, taking into account drawings of all other relevant disciplines.
- 22.2 At the time of submission the Contractor shall inform the Engineer in writing of any deviation in the Contractor's drawings from the requirements of the supplementary documents.
- 22.3 After scrutiny the Engineer may at its discretion and depending on the number of discrepancies, require amendment and resubmitted prior to approval. Drawings shall be resubmitted until approved prior to any portion of the works related to the drawings being commenced.
- 22.4 Should the Contractor, during drawing amendment, alter any portion of his drawings not specifically required by the Engineer, he shall point this out in writing when resubmitting the drawing.
- 22.5 Approval of the Contractor's drawings in no way indemnifies him from being responsible for the correctness of the drawings and satisfactory operation of the installation.

## 23 COMMISSIONING AND TESTING

### 23.1 Commissioning Engineers

23.1.1 The Tenderer shall allow in his tender price for the services of approved and expert Commissioning Engineers, as may be appropriate for the individual specialised sections of his contract, as well as a competent Engineer in overall control of the installation. Testing and commissioning shall be carried out by these Engineers.

23.1.2 Should undue problems be encountered at any time, the Contractor may be requested by the Engineer to obtain the services of a representative of the manufacturer of specified items of equipment, at no extra cost.

### 23.2 Notice of Testing and Commissioning

The Engineer shall receive not less than two weeks advance notice of any tests to be witnessed.

### 23.3 Failure of Works, Site or Commissioning Tests

Should the Engineer be notified to attend official tests as laid down, and should the equipment fail the test for any reason whatsoever, such that the Engineer is required to re-witness the test, the time, transport and disbursement by the Engineer in so doing will be for the Contractor's account, which amount may be deducted, at the option of the Engineer, from monies due to the Contractor.

### 23.4 Inspection During Manufacture

The Contractor shall advise the Engineer when the items to be supplied are in the course of manufacture. The Engineer reserves the right to inspect any items during the course of manufacture, and witness any performance tests that may be required thereon. The Contractor shall give the Engineer at least two weeks advance notice of works tests.

## 23.5 Testing

- 23.5.1 The Contractor shall be responsible for carrying out all tests laid down in the specific sections elsewhere in this document, in addition to those listed hereafter and in the Project Specification.
- 23.5.2 Testing and balancing shall not begin until the system has been completed and is in full working order.
- 23.5.3 The plant shall be tested and operated to meet the performance figures and duties specified.
- 23.5.4 All safety features and interlocks will be tested.
- 23.5.5 The Contractor shall be responsible for all costs incurred in the testing, including the supply, calibration and use of all instruments and tools, but not the supply of water or power on site.
- 23.5.6 All instruments and test equipment used shall be provided by the Contractor, and shall be accurately calibrated and maintained in good working order. All test instruments used for tests to be witnessed by the Engineer shall be provided with calibration certificates, which must be submitted to the Engineer.
- 23.5.7 Specific attention is drawn to the fact that calibration certificates will be required for the following:
- Watt meters, amp meters, voltmeters, frequency meters, pressure gauges, flow meters, orifices plates, temperature gauges and dynamometers.
- 23.5.8 All instruments shall be of above standard grade, and test pressure gauges shall not be less than 150 mm in diameter. The maximum scale of the instrument shall not exceed 1,5 times the full test requirement.
- 23.5.9 It is essential that the Contractor inspects and tests all equipment before requesting the Engineer to inspect or witness acceptance tests thereon.
- 23.5.10 All acceptance tests whether in the manufacturer's work or on site, shall be carried out in the presence of the Engineer.
- 23.5.11 Should the Engineer wish to verify the calibration of any instruments, the Contractor shall make the necessary arrangements for the instrument to be re-calibrated by a recognised authority.
- 23.5.12 Two copies of the complete test reports shall be submitted to the Engineer, prior to the first delivery of the project. Reports shall cover all tests carried out on individual sections, including such works tests as may have been conducted. All reports shall be neatly typed.

## 23.6 Test Certificates

The Contractor shall ensure that copies of all relevant test certificates, inspection reports, certificates of compliance for all electrical work done, materials analysis certificates and similar data as may be required under various sections of this specification, or by Government Licensing and Inspection Authorities or Local Authorities, shall be provided before handing over the plant. Acceptance of the plant will be delayed if such certificates are not available. In particular, attention is drawn to pressure vessel and boiler construction and materials test certificates.

### 23.7 Electrical Certificates of Compliance

23.7.1 Mechanical contractors to note that where electrical work of any nature is included in the contract a "Certificate of Compliance" shall be provided to cover this work.

23.7.2 The accredited person providing the certificate shall be a certified installation electrician registered with the Electrical Contracting Board of South Africa.

### 23.8 Commissioning

23.8.1 The Contractor shall carry out all tests and commissioning of the systems installed by him, in a co-ordinated and properly organised manner.

23.8.2 All mechanical installations shall be commissioned in accordance with recognised Codes of Practice.

23.8.3 Should the tests be carried out over an area outside the range of normal speech, it is required that the Contractor make available at least four battery powered, two-way radio sets, to facilitate communications.

23.8.4 The testing procedures shall be sufficiently comprehensive to prove the correct functioning of each and every piece of equipment, and its suitability for the application.

23.8.5 After all systems and equipment have been tested and commissioned to the satisfaction of the Engineer, a detailed demonstration of all functions of the system shall be carried out in the presence of the Engineer's Representatives, so as to allow him to become fully acquainted with the operation of the system.

23.8.6 The Contractor shall allow for the replacement and cost of any materials and fuel used for testing purposes, as part of the contract.

23.8.7 The demonstration to the users shall include a repeat of the operational tests above.

23.8.8 A certificate of completion will not be issued until all tests have been satisfactorily completed, and the plant has operated successfully, to the complete satisfaction of the Engineer.

### 23.9 Performance Tolerance

All performance figures obtained during testing and commissioning shall be within -5% and +5% of the specified performance figures given in the supplementary specification. Should the plant fail to comply with these figures after it has been tested and operated for a period of seven days, then the Contractor shall have a further four weeks to meet the requirements of the specification, after which the Engineer shall have the right to reject the plant and recover all monies paid to the Contractor for the rejected plant.

## 24 MAINTENANCE AND SERVICING

### 24.1 General

24.1.1 Unless otherwise specified in the Project Specification, the Contractor shall be responsible for all maintenance and servicing of the installation for the full 12 month guarantee period. During this period, the Contractor shall make good any defect due to inferior materials or workmanship and maintain all plant and equipment in perfect operating condition.

24.1.2 The Contractor shall be entirely responsible for carrying out regular inspections at intervals not greater than 3 months unless otherwise specified, and for full servicing of all components of the installation in accordance with the manufacturer's instructions. For this purpose, the Contractor shall prepare a detailed inspection and service in the form a checklist and log sheet showing all functions to be carried out at each inspection and service. Copies of these service reports shall be regularly submitted to the Engineer after each service.

24.1.3 The Contractor shall also maintain a plant logbook on site in which he shall record, sign and date all work carried out at each inspection as well as log all temperatures and pressure readings. A representative of the User on site must countersign the logbook.

24.1.4 The Contractor shall allow for all expendable materials necessary for servicing such as lubricating oils, grease, refrigerant and cleaning materials.

#### 24.2 Maintenance Instruction of Owner's Staff

Tenderers shall make proper allowance in their tender price for instruction of the Owner's staff in the maintenance, repair and adjustment of all the equipment. Allowance shall be made for the proper hands-on tuition of the Owner's personnel at the appropriate time to enable them to take over operational duties.

#### 24.3 Spare Parts Agencies

24.3.1 Where Tenderer's offer plant embodying units of manufacture other than those of their principals and for which they are not accredited South African agents, and for which they do not stock spare parts, they shall state in the tender the name of the accredited South African agents from whom spare parts for such units are obtainable.

24.3.2 In all cases, Tenderers shall furnish an undertaking from agents to the effect that they are prepared to carry the necessary stock of spare parts for their particular units.

24.3.3 Tenderers are also required to furnish the same undertakings as regards the spares for units manufactured by their own principals.

24.3.4 During adjudication of tenders, consideration may be given not only to the cost of the plant offered, but also to the cost of the spares.

#### 24.4 Tools

24.4.1 All special tools required, i.e. tools specially designed for the particular equipment offered, shall be supplied and listed in the tender offer and included in the unit price. In the case of a number of identical items of plant being supplied it will only be necessary to supply two sets of tools covering all units, and not one set of each unit.

24.4.2 It is the responsibility of the Contractor to ensure that all tools are handed over to the Owner on completion of the contract, in brand new condition. No damaged tools will be accepted, and the contract will not be considered complete until such tools are satisfactorily received. Tools handed over shall be suitably mounted on a wallboard or supplied in a high quality metal box or other container as may be agreed to by the Owner.

## 25 OPERATING, MAINTENANCE INSTRUCTIONS, WIRING AND CONTROL DIAGRAMS

25.1 The Contractor shall prepare and supply four (4) comprehensive manuals for the successful operation and maintenance of the installation. A draft of the manual shall be submitted to the Engineer before commissioning, for approval. The draft shall then be corrected, if required, and four sets of the manual shall be submitted before first acceptance of the plant will be considered.

25.2 Manuals shall be bound in hard file covers with clear titles and indices and shall contain the following information as a minimum, in the sections indicated:

### SECTION 1: System Description

A comprehensive description of the system, including schematic diagrams.

### SECTION 2: Commissioning Data

The results of all checks and measurements as recorded during the commissioning period shall be compiled in such a manner that every check and measurement is clearly defined.

All fans shall be tested in the factory and checked for vibration to ISO 2372. Bearings shall be checked using a shock impulse meter. All measurements and observations made during these tests shall be included in the O & M Manual.

### SECTION 3: Operating Instructions

- 1 Plant running checklist and frequency of servicing.
- 2 Safety precautions to be taken
- 3 Manual and automatic operation.
- 4 Operator's duties.
- 5 Lubricating oils and service instructions.
- 6 Pre-start checklist for each system.
- 7 Starting and stopping procedures.

### SECTION 4: Mechanical Equipment

- 1 Description of all major items of equipment with the make, model number, names, addresses and telephone numbers of the Supplier, Manufacturer or their Agents.
- 2 Design capacities of all equipment including selection parameters, selection curves, capacity tables, etc.
- 3 Manufacturer's brochures and pamphlets.
- 4 Schedule of spares with part numbers recommended to be held in stock by the Department.

### SECTION 5: Maintenance instructions

- 1 Schedule of maintenance particulars, frequency of service and replacements.
- 2 Troubleshooting guide.
- 3 Part number of all replacements, items and spares.
- 4 Capacity curves of pumps, fans and compressors.
- 5 Serial number of main items of equipment.

**SECTION 6: Electrical Equipment**

- 1 Schedule of equipment indicating manufacturer, type, model number, and capacity, address and telephone number of supplier.
- 2 Maintenance instructions.
- 3 Manufacturer's brochures and pamphlets.
- 4 Complete "as-built" circuit diagrams and diagrammatic representation of inter-connections of electrical equipment

**SECTION 7: Instrumentation and Control**

- 1 Description of each control system.
- 2 Schedule of control equipment indicating make, type, model number, rating, capacity and name, address and telephone number of supplier.
- 3 Maintenance instructions.
- 4 Manufacturer's brochures and pamphlets

**SECTION 8: Drawings**

- 1 Paper prints (reduced if so desired) of all "as-built" mechanical and electrical Contractors' drawings.
- 2 Wiring diagrams, framed behind glass shall be mounted adjacent to each relevant control panel.
- 3 One set of discs with drawings in electronic format. The format to be compatible with the Owners drawing software package.
- 4 Copy of Electrical Certificate of Compliance.

**26 GUARANTEE**

- 26.1 The Contractor shall guarantee to the apparatus and machinery delivered by him for a period of twelve months.
- 26.2 The guarantee shall be valid for a period starting on the date of the Practical Completion. Fair wear and tear is excluded from the guarantee. The guarantee shall provide that all parts, spares and appurtenances that become defective during the guarantee period be replaced free of charge. The costs of labour and transportation required to replace such part of a defective installation shall be borne by the contractor and shall be included in his guarantee. Any remaining portion of an equipment guarantee which the contractor has obtained from his supplier shall be ceded to the Owner with effect from the date of expiry of the above-mentioned guarantee period.

**27 SUMMARY OF SABS AND OTHER SPECIFICATIONS APPLICABLE TO THE STANDARD SPECIFICATION**

SABS 064	:	—
SABS 1200 HC	:	Corrosion protection of structural steelwork
SABS 1091	:	National colour standards for paint
SABS ISO 12944-4	:	Paints and Varnishes –Corrosion protection of steel structures by protective paint system Part 3. Types of surface and surface preparation.
SABS 460	:	Copper and copper alloy tubing



SABS 455	:	Covered electrodes for the manual arc welding of carbon and carbon manganese steels
SABS 044	:	
SABS 0238	:	Welding and thermal cutting processes – Health and safety
SABS 763	:	..... (coated sheet and wire)
SABS ISO 3575	:	Continuous hot-dip zinc-coated carbon steel sheet of commercial, lock forming and drawing qualities
SABS 0214	:	The design, fabrication and inspection of articles for hot-dip galvanising
SABS 1186-1	:	Symbolic Safety Signs Part I : Standard signs and general requirements.
SABS 62	:	Steel Pipes Part 1: Steel pipes of NB not exceeding 200 mm. Steel Pipes Part 2: Pipes and pipe fittings of nominal bore not exceeding 150 mm, made from steel pipe.
SABS 0147	:	Refrigerating System including Plants associated with air-conditioning systems.
SABS 1125	:	Room air conditioners and heat pumps
SABS 719	:	Electric welded low carbon steel pipes for aqueous fluids (ordinary duties)
SABS 23	:	Brazing alloys containing silver
SABS 193	:	Fire Dampers
SABS 0173	:	The installation, testing and balancing of air-conditioning duct work
BS 10	:	Specification for flanges and bolting for piping, valves and fittings.
BS 3601-22	:	Specification for carbon steel pipes and tubes with specified room temperature properties for pressure purposes
BS 4504	:	Circular flanges for pipes, valves and fittings (PN designated)
3.1	:	Specification for steel flanges
3.3	:	Specification for copper alloy and composite flanges.
BS 5000-99	:	Machines for miscellaneous applications.
BS EN 1561	:	Founding. Grey cast irons.
BS EN 1563	:	Founding. Spheroid graphite cast iron
BS EN 1982	:	Copper and copper alloys. Ingots and castings.
BS EN 10213-1	:	Technical delivery conditions for steel castings for pressure purposes. General.

BS EN 10213-2	:	Technical delivery conditions for steel castings for pressure purposes. Steel grades for use at room temperature and at elevated temperature.
BS 1486	:	
BS 848 Part 1 & 3	:	
BS 970	:	
BS 21	:	
BS 1387	:	
BS 1740	:	
ASTM B61	:	Standard Specification for Steam or Valve Bronze Castings.
ASTM B62	:	Standard Specification for Composition Bronze or Ounce Metal Castings.
ASTM A 126	:	Standard Specification for Gray Iron for Valves, Flanges, and Pipe Fittings.
ASTM A 216/A 216M	:	Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
ASTM A 389/A 389M	:	Standard Specification for Steel Castings, Alloy, Specially Heat-Treated for Pressure-Containing Parts, Suitable for High-Temperature Service.
ASTM A 395/A 395M	:	Standard Specification for Ferritic Ductile Iron Pressure – Retaining Castings for use at Elevated Temperatures.
ASTM F 1369	:	Standard Specification for Heaters, Convection, Steam and Hot Water.
ASTM F 1508	:	Standard Specification for Angle Style, Pressure Relief Valves for Steam, Gas and Liquid Services.
API 5L	:	Specification for line pipe.
IP 44	:	
IP 55	:	
ISO 1940	:	
ISO 2372	:	
OHS ACT	:	The Occupational Health and Safety Act, Act 85 of 1993.

**PART 2B**

**STANDARD TECHNICAL SPECIFICATION**

## PART 2B

## STANDARD TECHNICAL SPECIFICATION

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## 1 GENERAL NOTES

- 1.1 This Standard Specification defines the standard of equipment and materials and the quality required for the various elements of the installation.
- 1.2 This General Specification forms a supplement to the drawings and specifications for a particular contract. Where the Project Specification of Part 5 and/or the drawings differ from this Standard Specification, the Project Specification and Drawings shall take precedence.
- 1.3 All workmanship and materials used in the installation shall be of the highest quality and, where not fully covered by this Specification, shall conform to best modern practice, as determined by the Engineer.
- 1.4 The entire installation shall comply fully with all relevant requirements of governmental and local authorities and the equipment provided for the installation shall comply in all respects with the Machinery and Occupational Safety Act of 1984 as amended.
- 1.5 All electrical work associated with the installation shall comply with the requirements of the Municipal Authorities and shall be carried out in accordance with the latest edition of the "Standard Regulations for the Wiring of Premises".
- 1.6 Alternative equipment, materials or apparatus from those that are noted or required on the drawings and/or in the Specifications, may only be offered and supplied on the written approval of such equipment, material or apparatus by the Engineer.
- 1.7 In preparing a project design, the Engineer will contact suppliers of equipment to allow for such normal information requirements with regard to equipment size, access for installation, access for maintenance, mass, electrical supply, safety precautions etc. that suppliers might have, in order to ensure proper installation and future safe and optimum operation of such equipment. As the final selection of equipment is, however, in the hands of the successful tenderer, and the contract for the supply of equipment is between the contractor and supplier, it shall be the contractor's responsibility to ensure that the equipment procured will be suitable for the spaces in which it will be installed and that other influences shall not interfere with the safe and optimum operation of such equipment. Particular attention must be given to the aspects of easy accessibility for maintenance and adjustment, and specific safety requirements of particular suppliers.
- 1.8 Preference will be given to equipment and materials of local manufacture, where such equipment and material meets with the requirements of Part 4 and Part 5 of the specification. The continuous successful operation of the system is dependent on good maintenance and the availability of spares. It is therefore important that Tenderers only include for equipment with good local representation who are able to provide an after-sales service.
- 1.9 The requirements and spacing of equipment and services supports are generally not specified in Part 5 or shown on the drawings. The contractor shall allow for such sufficient supports required by him for the safe and stable support of all equipment and services installed under this contract. Part 4 in some instances do give guidelines as to distances between supports.

## 2 CHILLED WATER GENERATORS

### 2.1 Design Materials and finish

- 2.1.1 Chillers shall be of standard, factory assembled packaged type and the design, material and finish shall be equivalent to a well known make approved by the Engineer.
- 2.1.2 The refrigerant to be used shall be R131A unless otherwise specified in Part 5.

### 2.2 Capacity

- 2.2.1 The cooling capacity as specified in Part 5 shall be delivered in accordance with the relevant ARI specification.
- 2.2.2 The fouling factors used when selecting chillers shall not be less than the following:
- |                 |   |                           |
|-----------------|---|---------------------------|
| Condenser tubes | : | 0,088 m <sup>2</sup> K/kW |
| Chillers tubes  | : | 0,044 m <sup>2</sup> K/kW |
- 2.2.3 The maximum permissible saturated condensing temperature is 40,6°C.
- 2.2.4 The minimum permissible saturated suction temperature is 1°C
- 2.2.5 The minimum permissible sub-cooling of the refrigerant is 6°C at full load.

### 2.3 Components

The chillers shall comprise the following:

- One or more reciprocating or screw compressor
- One or more evaporator
- One or more water cooled condenser
- All necessary refrigeration pipe work
- Accessories as listed
- Control equipment as listed
- Frame
- Compressor motor drive

### 2.4 Compressor(s)

The compressor(s) shall be of the screw type scroll type or of the open or semi-hermetic reciprocating type with built-in cylinder head by-pass controlled by either suction pressure or external signal in a number of steps as specified in Part 5. The compressor shall be fitted with suction and discharge valves and crankcase heater. The compressor shall be direct driven at a speed not exceeding that of a four pole motor. A sight glass for checking oil level shall be fitted in the crankcase.

## 2.5 Water Cooled Condenser

- 2.5.1 The condenser(s) shall be of the multi-pass shell and tube type constructed in accordance with the relevant ASME code. The condenser(s) shall be equipped with a pressure relief device and liquid line isolating valve.
- 2.5.2 The condenser(s) shall be circuited to give the sub-cooling specified and shall be fitted with a device with which the liquid level within the condenser can be readily and reliably checked whilst the machine is on load.
- 2.5.3 The condenser shell shall be fitted with either a marine type water box or shall be connected to external piping in such a way that the water box covers can be easily removed.
- 2.5.4 The maximum permissible velocity of water in the tubes is 3 m/s.

## 2.6 Air Cooled Condenser

- 2.6.1 The Standard Technical Specification for Direct Expansion Coils is applicable.
- 2.6.2 Inlet distribution shall be arranged such that an even distribution of refrigeration gas through all the circuits is achieved.
- 2.6.3 Fans shall be of the propeller type and shall draw the air over the condenser coil.
- 2.6.4 Condensing temperature shall be controlled above 32°C by means of the cycling of the fans.

## 2.7 Evaporator

The evaporator shall be of direct expansion type with refrigerant flowing in the tubes and water in the shell. The shell shall be lagged with a minimum of 25 mm non-combustible insulation, vapour sealed and finished with a durable outer protection. The lagging shall be painted to match the colour of the chillers.

## 2.8 Refrigerant Circuit(s)

Each circuit shall include the following components:

- Refrigeration pipe work in accordance with Part 4
- Expansion Valve
- Liquid line solenoid valve
- Filter driers with replaceable core.
- Sight glass situated above the operating level of the liquid in the condenser.
- Liquid line shut-off valve.
- Hot gas muffler.

## 2.9 Instrumentation

The unit shall be fitted with gauges to indicate suction pressure, discharge pressure and oil pressure for each compressor.

**2.10 Control and Accessories**

The unit shall be wired with all necessary controls in a separate enclosure. The following components shall be included:

- 2.10.1 Crankcase heater control to operate when compressor stops.
- 2.10.2 Non-recycling pump down relay.
- 2.10.3 Timer to prevent compressor cycling in less than five minutes. (Units above 40 kW refrigeration capacity only).
- 2.10.4 Transformer if controls are to operate at less than mains voltage.
- 2.10.5 High and low pressure cut out, the former with manual reset.
- 2.10.6 Oil pressure cut out with manual reset.
- 2.10.7 Unloaders to bypass cylinder heads on start up.
- 2.10.8 Low water temperature safety protection.
- 2.10.9 Chilled water leaving temperature control set to operate with a minimum of four steps in units above 200 kW refrigeration capacities, and in two steps in units above 100 kW refrigeration capacities.

**2.11 Motor**

The compressor(s) shall be driven by a three phase squirrel cage induction motor(s). The motor(s) shall have sufficient power and torque for all operating conditions on the compressor(s).

The motor(s) shall have four or six poles. Where open compressor(s) are used, standard protected drip proof or totally enclosed fan cooled motor(s) shall be fitted.

**2.12 Drive**

Where open compressor(s) are used the motor(s) shall be direct coupled to the compressor(s) by a flexible drive. A protective coupling guard shall be fitted to each drive.

**2.13 Frame**

Components shall be mounted on a rigid frame such that any major component can be readily removed without removing other components. The base holding the motor-compressor shall be sufficiently rigid to prevent any torsion or lateral vibration or misalignment between the motor and compressor shafts.

Anti-vibration mountings shall be in compliance with Part 4, Clause 17.

**3 COOLING TOWERS**

- 3.1 Cooling towers shall be of a well proven manufacture and shall be of sufficient capacity to match the heat rejection requirements of the water cooled packaged air conditioners or chillers. Cooling towers shall be selected in accordance with the air entering wet bulb temperature specified in the Project Specification.
- 3.2 Cooling towers shall be of forced draft or induced draft type, rectangular in shape, of sectional steel construction.



- 3.3 The selection of cooling towers shall take into consideration and shall comply with the noise level limitations at the site boundaries as required by the local authorities. If sound attenuating measures are required then this shall be brought to the attention of the Engineer when the cooling towers are selected but prior to the ordering of the cooling towers.
- 3.4 Cooling tower suppliers shall check that configuration and layout shown on the Engineer's drawings is suitable regarding airflows, for the cooling towers offered. If the configuration is not suitable, then this shall be brought to the attention of the Engineer before cooling tower selection and layout are finalised.
- 3.5 The Cooling Tower sump and main supports shall be constructed of hot-dip galvanised steel with a minimum thickness of 2mm. Reinforcing angles and channels shall be 4 mm thick hot-dip galvanised steel. Standard sump accessories shall include access doors, stainless steel strainers, and brass make-up valve with unsinkable, foam filled, plastic float.
- 3.6 Fans shall be of the forward curved centrifugal type, statically and dynamically balanced. The fans shall be mounted on either a solid steel shaft or a hollow steel shaft with forged bearing journals. Shafts with welded journal construction or centre bearings shall not be permitted. The fan shaft shall be supported at each end by heavy duty, greasable, self-aligning ball bearings in cast iron housings.
- 3.7 Driving motors serving the cooling tower fans shall be of the drip proof, squirrel cage type, and shall run at a rotational speed not exceeding 1500 r.p.m. The motor shall be mounted on an adjustable base external to the unit for ease of service and maintenance. The V-belt drive shall be designed for not less than 150% of the motor nameplate power rating. The motor and drive shall be installed with a protective canopy.
- 3.8 The cooling tower fill shall be of a fill type with a serpentine arrangement, with built in water distributors and air turbulators. It shall be constructed of self-extinguishing, polyvinyl chloride with a minimum thickness of 0,5 mm, and shall be resistant to rot, decay and biological attack.
- 3.9 The spray header and branches shall be constructed of Schedule-40, PVC pipe for corrosion resistance, and shall have a steel connection for attachment of the external piping. The branches shall have removable plugs in the ends for cleaning purposes. The water shall be distributed over the fill by precision moulded spray nozzles with large, 9,5 mm by 25 mm, orifice openings to eliminate clogging.
- 3.10 Eliminators shall be constructed entirely of inert polyvinyl chloride in easily handled sections. The eliminator blades shall be spaced at 25 mm centres, and shall incorporate three changes in air direction to ensure complete removal of all entrained moisture from the discharge air stream. They shall have a hooked leaving edge to direct the discharge air away from the fan's intake to minimise recirculation.
- 3.11 Cooling towers installed at the coast shall be coated with Power Bond II finish (cold tar epoxy coating) or equivalent, for maximum protection against corrosion. All paintwork shall be made good as required once the cooling tower has been installed. Alternatively a casing constructed from fibreglass will be acceptable.
- 3.12 Cooling towers shall be fitted with suitable weld mesh screens across the entire air intake section.
- 3.13 Balancing pipes with isolating valves shall be installed between cooling towers when required by the cooling tower supplier. These balancing pipes shall be adequately sized to prevent starvation.
- 3.14 Overflow and drain connections shall be galvanised and shall be piped to the nearest drain point.

#### 4 CLOSED CIRCUIT COOLERS

- 4.1 Closed circuit coolers shall be of a well proven manufacture and shall be of sufficient capacity to match the heat rejection requirements of the Water Cooled packaged air conditioners or chillers. Closed circuit coolers shall be selected in accordance with the air entering wet bulb temperature specified in the Project Specification.

- 4.2 Closed circuit coolers shall be of the induced or forced draft type, rectangular in shape, of galvanised sectional steel construction.
- 4.3 The selection of closed circuit coolers shall take into consideration and shall comply with the noise level limitations at the site boundaries as required by the local authorities. If sound attenuating measures are required then this shall be brought to the attention of the Engineer when the closed circuit coolers are selected, but prior to the ordering of the closed circuit coolers.
- 4.4 Closed circuit coolers suppliers shall check that configuration and layout shown on the Engineer's drawings is suitable regarding airflows, for the closed circuit coolers offered. If the configuration is not suitable, then this shall be brought to the attention of the Engineer before closed circuit coolers selection and layout are finalised.
- 4.5 The closed circuit cooler sump and main supports shall be constructed of hot-dip galvanised steel with a minimum thickness of 1.8 mm. Reinforcing angles and channels shall be 4 mm thick hot-dip galvanised steel. Standard sump accessories shall include access doors, stainless steel strainers, and brass make-up valve with unsinkable, foam filled, plastic float.
- 4.6 Fans shall be of the forward curved centrifugal type, statically and dynamically balanced. The fans shall be mounted on either side of a solid steel shaft with forged bearing journals. Shafts with welded journal construction or centre bearings shall not be permitted. The fan shaft shall be supported at each end by heavy duty, greasable, self-aligning ball bearings in cast iron housings.
- 4.7 Driving motors serving the closed circuit cooler fans shall be of the drip proof, squirrel cage type, and shall run at a rotational speed not exceeding 1500 r.p.m. The motor shall be mounted on an adjustable base external to the unit for ease of service and maintenance. The V-belt drive shall be designed for not less than 150% of the motor nameplate power rating. The motor and drive shall be installed with a protective canopy.
- 4.8 The cooling coil shall comprise steel tubing circuits supported by a heavy steel frame. The assembled coil shall be tested at 2400 kPa air pressure under water to ensure that it is leak free. The airflow through the coil shall be counter flow to the water flow, and the tubes of the coil shall be staggered in the direction of the flow to obtain a high film co-efficient. The entire tubing and frame assembly shall be hot-dip galvanised.
- 4.9 The spray header and branches shall be constructed of Schedule-40, PVC pipe for corrosion resistance. The branches shall have removable plugs in the ends for cleaning purposes. The water shall be distributed over the coil by precision moulded spray nozzles with large, 9,5 mm by 25 mm, orifice openings to eliminate clogging.
- 4.10 Eliminators shall be constructed entirely of inert polyvinyl chloride in easily handled sections. The eliminator blades shall be spaced at 25 mm centres, and shall incorporate three changes in air direction to ensure complete removal of all entrained moisture from the discharge air stream. They shall have a hooked leaving edge to direct the discharge air away from the fans air intake to minimise recirculation.

- 4.11 Closed circuit coolers installed at the coast shall be coated with Power Bond II finish (cold tar epoxy coating) or equivalent, for maximum protection against corrosion. All paintwork shall be made good as required once the closed circuit cooler has been installed. Alternatively a casing constructed from fibreglass will be acceptable.
- 4.12 Closed circuit coolers and/or evaporative condensers shall be fitted with suitable weld mesh screens across the entire air intake section.
- 4.13 Overflow and drain connections shall be galvanised and shall be piped to the nearest drain point.

## 5 AIR-HANDLING UNITS

### 5.1 General

Finished concrete basis, on which air-handling units shall be mounted, will be provided by the Principal Contractor and shall be constructed to dimensions provided by the contractor in terms of this contract/contract.

### 5.2 Plenum Casings

- 5.2.1 Plenum casings shall have flat sides and top.
- 5.2.2 Where equipment such as coils or filters is smaller than the cross-sectional area of the plenum, the spaces around the equipment shall be sealed off by means of sturdy blank-off plates. Unit casings, for installations consisting of more than one unit, shall be of a standard size as far as possible.
- 5.2.3 Access doors or detachable panels shall be provided to all compartments for inspection and maintenance.
- 5.2.4 Bases shall be constructed of heavy duty hot dipped galvanised mild steel.
- 5.2.5 The casings shall be of double wall, factory made panels with internal insulation and a thickness of 50 mm. Panels shall fasten to each other in an airtight and watertight manner by means of an efficient and suitable locking arrangement and the use of a suitable sealing compound.
- 5.2.6 Construction of panels and the locking method shall be designed so that flexure of the composite panels of the casing will not be more than 1/200 of the span under a stress equivalent to static air pressure of 2 500 Pa. If necessary, structural reinforcement shall be provided to ensure the required rigidity. Junctions between the floor and side panels, and the roof and side panels shall be rigid, strong, watertight and airtight.
- 5.2.7 Casing panels shall be fabricated of galvanised sheet steel with a minimum thickness of 0,6 mm.
- 5.2.8 Plenum casing panels shall be provided with fire retardant polystyrene insulation between the double walls. Panel edges shall be filled with insulation in such a manner that no uninsulated gaps will occur. The insulation shall have a minimum density of 48 kg/m<sup>3</sup> and a conductivity of 0,033 W/m<sup>2</sup>°C at 2,38°C average temperature. The insulation shall not settle, tear loose or produce dust. Polyurethane insulation may be used as an alternative to polystyrene.
- 5.2.9 The positions of access doors are indicated on the Engineer's drawings. Doors shall be of double wall construction with insulation as specified above. Doors shall hinge on sturdy hinges. Doors shall be provided with two door handles which can be operated from inside and from outside the plenum. Doors shall hinge against the system air pressure, and shall be airtight. Access doors shall be 600 mm wide, 1 m high with bottom edge 500 mm above the floor, unless otherwise specified.

### 5.3 Primary and Secondary Air Filters

Upstream space from primary filter and downstream space from secondary filter shall be

750 mm to facilitate filter removal.

#### **5.4 Heating and Cooling Coils**

- 5.4.1 Plenum casings shall be provided with removable sections with a width of 1,5 times coil width and full coil height plus clearance, to provide access to each coil. Such removable sections shall be provided for each coil on both sides of the plenum.
- 5.4.2 Coil connections shall have sufficient length before headers or bends in order that removable sections can be removed to provide an access space of at least 150 mm.
- 5.4.3 Water pipes passing through plenum panels shall be sealed with split collar plates and rubber gaskets to affect a watertight seal.
- 5.4.4 Coils shall be supplied on a robust galvanised steel frame.

#### **5.5 Drip Trays**

- 5.5.1 Drip trays shall be installed at any place where condensation may occur, and shall be large enough to catch up any form of condensate or carry over. The drip tray shall extend under the cooling coil so that all condensation, which forms on the cooling coil and header connections, will drain into the drip tray.
- 5.5.2 Drip trays shall be provided with a galvanised drain pipe of 40 mm installed to the nearest drain point. The pipe shall discharge into a tundish, with an air space left between the end of the pipe and the tundish.
- 5.5.3 Drips trays shall be manufactured from BCR12 stainless steel with a minimum thickness of 1,2 mm.

#### **5.6 Fans**

Fans shall be connected to the plenum casing by means of suitable flexible connections. The material of the flexible connections shall be of plastic impregnated fibre glass or neoprene, and shall be to the approval of the Engineer.

#### **5.7 Air Dampers**

- 5.7.1 Air dampers shall be equivalent to that specified in Part 5.
- 5.7.2 Dampers shall be installed in positions as shown on the Engineer's drawings.

#### **5.8 Electrical Equipment**

- 5.8.1 Electrical equipment shall comply with requirements as specified in the Standard Specification.
- 5.8.2 Each plenum section shall be provided with a plenum light. Conduit shall not be installed between double walls of plenum casing panels.
- 5.8.3 All equipment shall be waterproof.

#### **5.9 Sealing Of Openings**

Where pipes and conduits pass through plenum casings, the spaces between panels and pipes or conduits shall be sealed off by means of rubber packing rings and steel flanges which are bolted to the casing panel on both sides. Packing rings shall fit tightly around pipes or conduits and the flanges shall pull the packing rings tight against plenum casing panels. The space between each pipe or conduit and the inside of the hole in the panel shall be filled with glass fibre insulation or filled with poly-urethane foam insulation.

## **6 ROOM TYPE FAN COIL UNITS**

- 6.1 Fan coil units shall be as indicated on the drawings i.e. concealed or exposed, floor mounted or ceiling mounted.
- 6.2 Each unit shall be complete with cabinet matching the application, chilled water cooling coil, hot water heating coil or electric element heater (as specified), fan, filter, drain pan, drain piping, shut-off valves, balancing valve, three or two way control valve (depending on application) and controls.
- 6.3 Cabinets for exposed units shall be manufactured from 1,2 mm thick sheet steel lined internally with neoprene insulation at least 20 mm thick.
- 6.4 Provide a baked enamel finish to exposed visible surfaces. Provide removable panels to allow full access for servicing of all components.
- 6.5 Motor and fan assembly shall be easily accessible for servicing.
- 6.6 Where called for, collars for the supply and return ducting shall form part of the unit.
- 6.7 Cooling and heating coils, and heating elements, shall comply with the relevant sections of this Standard Specification.
- 6.8 Fans shall be centrifugal type, statically and dynamically balanced and directly connected to the drive motor. Fan wheels and housing shall be galvanised steel.
- 6.9 Fan motors shall be of the shaded pole or permanent split phase capacitor type with built-in thermal overload protection.
- 6.10 Drain pans shall be easily accessible for cleaning purposes and shall be suitably insulated to prevent condensation on the outer surfaces. The drain pan shall project under the entire length and width of the cooling coil including un-insulated portions of chilled water piping and valves, and shall consist of a single piece with no screws or joints.
- 6.11 Fan and unit on/off switch and controls shall be mounted on the unit or remote flush mounted as specified.
- 6.12 Fan control shall be by means of an on/off switch combined with speed selection options. A minimum of three fan speed selections shall be possible. The specified cooling capacities shall be achieved at medium speed.
- 6.13 Cooling/heating control shall be by means of a thermostat and shall be on/off or proportional as specified. The thermostat shall be either wall mounted within the controller or installed into the return air as per the Project Specification.
- 6.14 Filters shall be easily accessible for cleaning and shall be of the washable/cleanable type. Filters shall be of the primary type and conform to the requirements of this Standard Specification.

## **7 FANS**

### **7.1 General**

- 7.1.1 Requirements under this heading apply to fans, which are not integral parts of cooling towers, air-handling units or similar equipment designed as standard units by the manufacturer.
- 7.1.2 Fans shall be quiet in operation and shall be free of objectionable vibrations.
- 7.1.3 No fans shall be operated for any purpose such as temporary ventilation, testing, etc, until the filters, have been put into regular operating condition.

- 7.1.4 The total fan systems' resistance, as indicated in Part 5 of the specification, shall be finally calculated by the Contractor when all information on selected system elements is available. The actual motor duties shall then be transferred onto the electrical control panel drawings. This is to be done before ordering and in accordance with the Principle Contractor's programme.
- 7.1.5 The combination fan and silencer selection shall be such as to satisfy the specified noise levels.
- 7.1.6 Fans handling air with abnormal qualities shall be selected for the particular duties taking corrosion, abrasion and temperature into account.
- 7.1.7 Fans shall be selected as close as possible to the point maximum efficiency.
- 7.1.8 Motors shall be in accordance with the Electrical Standard Specification.
- 7.1.9 If provided, lubrication points for fans bearings shall be extended to the outside of the fan casing.
- 7.1.10 Fans shall be provided in the factory with one primer coat and one coat of protective paint.
- 7.1.11 All fans shall be mounted on anti-vibration mountings or supported from anti-vibration. All anti-vibration mountings shall be to the approval of the Engineer.
- 7.1.12 All fans shall be selected from the standard range of well established fan manufacturers.
- 7.1.13 Bearings shall be of the ball or roller type, shall be quiet in operation. Bearings shall be cleaned and repacked with new grease before commissioning, if so required by the Engineer.
- 7.1.14 V-belts and pulleys shall be matched sets of "Fenner" or equivalent manufacture. V-belt drives shall be selected for a power transmission factor of 1.5. V-belt tensions shall be checked and adjusted three times during the first two hours of operation and daily for the next two weeks of operation.
- 7.1.15 Belt guards shall be arranged to permit lubrication and use of speed counters with the guard in position. Belt guards shall have adequate ventilation for belt cooling.
- 7.1.16 A weatherproof external terminal box forming an integral part of the fan casing shall be provided as standard equipment for motor connections.
- 7.1.17 Installation shall be in accordance with the manufacturer's recommendations.
- 7.2 Centrifugal Fans**
- 7.2.1 Fans shall be supplied complete with matching flanges.
- 7.2.2 Fans with wheel diameters above 1 000 mm shall be provided with access doors fitted to the fan casing.
- 7.2.3 Centrifugal fans specified for variable volume applications shall be provided with variable speed drive motors.
- 7.2.4 Fans and motors shall be rigidly bolted to a common prefabricated steel frame with the motor mounted on slide rails for normal belt drive adjustment or replacement. The complete frame shall be mounted on anti-vibration mountings.
- 7.3 Axial Flow Fans**
- 7.3.1 Lubrication points shall be extended to the outside of the casing and inspection door of ample size shall be provided in the casing.
- 7.3.2 Fans shall be supplied complete with matching flanges.

7.3.3 Flow and rotation direction arrows shall be provided on fan casings easily visible from the plant room floor or from the access to the fan.

#### 7.4 Propeller Fans

7.4.1 Where wall cowls, wire guards, diaphragm plates and louvre shutters are required, these shall be standard products supplied with the fans.

7.4.2 The fans shall be mounted on resilient mountings compatible with the stiffness of the diaphragm plates where required to ensure acceptable vibrations transmission levels to the structure.

#### 7.5 Roof Extract Fans

7.5.1 Roof extract units shall be of the vertical jet type, unless prior approval for an alternative type is given by the Engineer in writing.

7.5.2 Outlet cowls and shutters shall be of the standard product of the fan unit manufacturer.

### 8 SOUND ATTENUATORS

8.1 Sound attenuators shall generally be manufactured, selected and supplied by the fan manufacturer, unless prior approval is given by the Engineer in writing.

8.2 Sound attenuators and splitters shall be standard factory made units of a reputable manufacture.

8.3 Sound absorbers shall be suitable for the internal static system pressure and for an air temperature up to 70°C.

8.4 Sound attenuators shall be of a type as shown on the Engineer's drawings.

8.5 The sound absorbing lining material shall be odourless, non-flammable, rot-proof and shall not delaminate or tear loose as a result of the air stream flowing over it.

8.6 Sound attenuators in the airflow of kitchen extraction systems shall have a sound absorbing lining which shall not absorb any grease or fat.

8.7 In the case of corrosive airflow applications, the sound attenuator materials shall be suitable for the application.

8.8 In the case of normal air-conditioning applications, sound attenuator panels shall be covered with galvanised or epoxy coated wire mesh or expanded metal.

8.9 Sound attenuators shall be provided complete with matched flanges.

8.10 In hospital installations the sound absorbing material shall be completely covered with Melinex plastic.

### 9 AIR DUCTS

#### 9.1 General

9.1.1 Air ducts shall be constructed according to "Low Velocity Duct Construction Standards" and "High Velocity Duct Construction Standards (SMACNA), as applicable.

9.1.2 Ducts shall be airtight, shall not drum or vibrate when the internal static pressure varies and shall be so constructed that airflow is even without excessive static pressure stop.

9.1.3 All ducts dimensions, including dimensions for internally insulated ducts, refer to the clear internal cross-sectional area.

- 9.1.4 The Contractor shall install all equipment such as balancing air dampers, splitter dampers, sound attenuators, etc, as shown on the Engineer's drawings.
- 9.1.5 All ducts passing through concrete or brick walls shall be isolated from the walls by means of a high density glass fibre collar to prevent transmission of vibration to the building structure. All openings where ducts pass through plant room walls shall be sealed by means of polysulphide mastic.
- 9.1.6 Paint work shall be executed in accordance with the Standard Specification.

## 9.2 Low Velocity Ducts

- 9.2.1 This refers to ducts with velocity up to and including 10 m/s and a static pressure up to and including 500 Pa.

Refer to "Low Velocity Duct Construction Standards" (SMACNA) for all constructional requirements. Alternative methods applicable are specified hereafter.

- 9.2.2 Galvanised sheet steel shall be used with thickness as recommended in SMACNA (Table 1, page 11). Either cross-breaking or beading is acceptable. Longitudinal seams shall be of the "Pittsburgh Lock" or Acme Lock" type. Transverse joints shall be as follows (SMACNA – table 1, page 11):

Dimensions of longest side of duct	Transverse joints		Reinforcing angle
	Long side	Short side	
Up to 450 mm	B	A	SMACNA – p11
475 – 750 mm	E	A	SMACNA – p11
775 – 1 500 mm	L	L	SMACNA – p11
1 525 and larger	M	M	SMACNA – p11

Reinforcing angle irons shall be galvanised. Rivets, screws, bolts and other fastening equipment shall be completely corrosion proof.

- 9.2.3 Elbows shall be in accordance with SMACNA page 51. Standard radius elbows shall generally be used. Short radius and elbow pieces shall be installed as shown on the Engineer's drawings.
- 9.2.4 Square elbows shall be provided with galvanised turning vanes, SMACNA Fig A, page 53.
- 9.2.5 Flexible ducts shall be of the flexible metal type, in accordance with SMACNA page 106, and shall not be insulated. In high humidity areas where the wet bulb temperature exceeds 22°C, flexible ducts shall be insulated externally. Flexible ducts shall comply with the requirements of SABS 0177 Part 3 Class 1 and maximum extended lengths shall not exceed 1,5 metres in length.
- 9.2.6 Overhead hangers for horizontal ducts shall of the "Trapeze" type (SMACNA page 45). Vertical ducts shall be supported in accordance with SMACNA page 43, Fig B.

## 9.3 High Velocity, Medium Pressure Ducts

- 9.3.1 Refer to "High Velocity Duct Construction Standards" (SMACNA) for all constructional requirements. Ducts with velocities higher than 10 m/s and a static pressure between 500 Pa and 1 500 Pa apply. Alternative constructional methods applicable are specified hereafter.
- 9.3.2 Galvanised sheet metal shall be used with thickness as recommended in SMACNA Fig 3 – 1, pages 14 and 15. Construction shall be in accordance with (1), (2), (4) and (12) of Fig 3 – 1.



- 9.3.3 Standard radius elbows shall generally be used. Short radius square elbows shall be installed as shown on the Engineer's drawings. Short radius elbows shall be provided with splitters and square elbows shall be proved with double thickness type turning vanes. (SMACNA pages 42, 43 and 44).
- 9.3.4 Flexible ducts shall be of the spiral wire reinforced glass fibre fabric type (SMACNA page 63).
- 9.3.5 Overhead hangers for horizontal ducts shall be of the "Trapeze" type (SMACNA page 56) and vertical ducts shall be supported as indicated in SMACNA page 57.

#### 9.4 High Velocity, High Pressure Ducts

- 9.4.1 This refers to ducts with velocities above 10 m/s and static pressure above 1 500 Pa. Refer to "High Velocity Construction Standards" (SMACNA) for all constructional requirements. Alternative methods applicable are specified hereafter.
- 9.4.2 Galvanised sheet steel shall be used with construction in accordance with Fig 3 – 2 pages 16 and 17, tables (1), (2), (4) and (11).
- 9.4.3 For elbows refer to 7.2.3 and 7.2.4.
- 9.4.4 For flexible ducts refer to Clause 7.2.5.
- 9.4.5 For hangers and supports refer to Clause 7.2.6.

#### 9.5 Duct Access Doors

- 9.5.1 Access doors shall be of the insulated hinged type as shown in SMACNA Fig B, page 17 ("Low Velocity Duct Construction Standards").
- 9.5.2 Access doors shall be sized as shown on the Engineer's drawings.

#### 9.6 Flexible Duct Connections

Refer to "Low Velocity Duct Construction standards" , page 100. Flexible connections shall be provided between fans and ducts or casings where necessary to prevent excessive movement of long ducts and where ducts cross expansion joints in the building structure.

#### 9.7 Manual Air Dampers for Volume Control

- 9.7.1 Each branch duct leading to a single air outlet shall be provided with a damper unless the outlet diffuser is of the variable volume type. Each branch duct leading to a group of air outlets shall also be provided with a damper at the point where the branch leaves the main air duct. Splitters may be used in lieu of dampers where the estimated pressure drop does not exceed 30 Pa. Dampers and splitters shall be installed so that they can be adjusted at any time after the completion of the work. Access panels shall be provided where the adjusting mechanism is concealed by suspended ceilings, furring, etc. Front and back bars or vanes of directional grilles are not to be used for adjustment of air quantities.
- 9.7.2 Butterfly dampers shall be of the balanced type with opposed blades and shall be constructed in accordance with SMACNA, pages 64, 65, 66 and 67. ("Low Velocity Duct Construction Standards"). For splitter dampers refer to page 64.

### 10 FIRE DAMPERS

- 10.1 Fire dampers shall be of an approved manufacture, and shall be in accordance with SABS 193. Fire dampers shall further be installed in accordance with the SMACNA Fire Damper Guide.
- 10.2 Fire dampers shall be installed in fire walls and in floor slabs where specified.

- 10.3 Fire dampers shall be operated by means of fusible links. In addition solenoid releases shall be fitted if specified in Part 5.
- 10.4 Solenoid releases, reset mechanisms and fusible links shall be accessible.
- 10.5 Fire dampers shall have a clear opening size equal to the duct clear opening size in which they are installed.
- 10.6 Spring mechanisms shall be mounted external to the damper casing.
- 10.7 The mechanisms for resetting dampers shall be mounted externally for easy access.
- 10.8 Curtain type fire dampers shall not be acceptable.

## **11 COOLING AND HEATING COILS (WATER)**

### **11.1 General**

- 11.1.1 Coils shall be selected with pipe connections only on the one side.
- 11.1.2 Coils shall be selected in accordance with ARI Code 410 - 64, with economic pressure drops to suit the complete pipe and pumping system.
- 11.1.3 Each coil section shall be securely mounted on a die-formed 1,5 mm thick galvanised sheet steel casing, arranged for bolting to other sections, ductwork, unit casings, etc.
- 11.1.4 Coil sections shall be supported on an angle frame or other strong and rigid construction. Supports for cooling coils shall not damage the drip pans and shall be arranged so that condensate cannot run down them past the drip pans. Cooling coil supports shall be galvanised. Coils shall be accurately levelled during installation.
- 11.1.5 Coils shall be provided with inlet, outlet, vent and drain connections for each section. Pressure gauges and thermometer wells shall be installed as shown on the Engineer's drawings.
- 11.1.6 Each coil shall be complete with isolating valves, calibrated balancing valves with pressure differential gauge connections, control valve and an angle type strainer.
- 11.1.7 Cleanable coils shall be provided with straight tubes and steel or cast-iron headers. Clean-out plugs shall be provided opposite each end of each tube if a cleanable serpentine type coil is specified.
- 11.1.8 Tube wall thickness shall not be less than 0,04 times the outside diameter. Pressure parts of coils shall be constructed and tested for a testing pressure of not less than 1 400 kPa or 1,5 times the normal working pressure, whichever is the largest.
- 11.1.9 Coil headers shall be of steel or cast-iron. Tubes shall be soldered or brazed to headers unless the headers are sturdy enough to withstand, without undue distortion, the stresses due to the rolling or expanding of the tubes.

### **11.2 Cooling Coils**

- 11.2.1 Cooling coils shall be of the extended surface type, constructed of copper tubing with a minimum outside diameter of 13 mm, with plate fins of aluminium, extending at right angles to the tubes. For sprayed coils, fins shall be of copper.
- 11.2.2 Coils shall be of the serpentine type.
- 11.2.3 Fins shall be spaced not closer than 10 per 25 mm, unless approved by the Engineer. Plate fins may be flat or formed, and shall have nominal thicknesses of not less than 0,008 times the outside diameter of tubes. Plate fins shall be soldered to the tubes or shall be provided with integral spacing

collars at least 3 mm wide on full width of space between fins. Tubes shall be tightly and permanently expanded into spacing collars.

### **11.3 Heating Coils**

11.3.1 Heating coils shall be of the extended surface type, constructed of copper tubing with a minimum outside diameter of 13 mm, with helical or plate fins of aluminium. Fins shall extend at right angles to the tubes.

11.3.2 Heating coils shall be of the serpentine type.

11.3.3 Fins shall be spaced not closer than 12 per 25 mm. Fins shall have a minimum thickness of 0,012 times the outside diameter of the tubes.

### **11.4 Face Velocities**

11.4.1 Face velocities for cooling coils shall not exceed 2,5 m/s.

11.4.2 Face velocities for heating coils shall not exceed 3,5 m/s.

## **12 DIRECT EXPANSION COOLING COILS**

12.1 Coils shall be of the serpentine type.

12.2 Coil tubes shall be of copper with a minimum outside diameter of 13 mm and a wall thickness not less than 0,04 times the outside diameter.

12.3 Parts of the coil operating under pressure shall be tested at a pressure 1,5 times the operating pressure.

12.4 Plate fins of copper shall have a minimum spacing of 8 per 25 mm. The fins shall be flat or formed and shall have a nominal thickness of not less than 0,008 times the outside diameter of the tubes.

12.5 Plate or helical fins of aluminium shall have a minimum spacing of 12 per 25 mm. The plate fins shall have a nominal thickness of not less than 0,012 times the outside diameter of the tubes.

12.6 Plate fins shall be soldered to the tubes or shall be provided with integral spacing collars at least 3 mm wide or full width of the fin space, if less than 3 mm, into which the tubes are tightly and permanently expanded.

12.7 Helical fins may be crimped or tapered. If crimped, they shall have a nominal thickness of not less than 0,175 mm and shall be soldered to the tubes. If tapered, they shall have a thickness of not less than 0,25 mm at the base and shall be soldered to the tubes or wound with sufficient tension to ensure permanent bond.

12.8 Helical or plate fins shall extend at right angles to the tubes.

12.9 Each coil section shall be securely mounted in a die-formed 1,5 mm zinc-coated steel casing arranged for bolting to other sections, duct work, unit casings, etc.

12.10 Coils shall be suitably protected during shipment and installation so that fins and casing flanges will not be damaged. Coils having loose or damaged fins at the time of final inspection will be rejected and must be replaced with new coils.

12.11 Coil sections shall be supported in galvanised angle frames. Supports for cooling coils shall not pierce the drip pans and shall be arranged so that condensate cannot run down them past the pans.

12.12 Coil face velocities shall not exceed 2,5 m/s.

- 12.13 Direct expansion cooling coils shall have brass or copper outlet headers arranged to prevent trapping of oil and shall have liquid distributors arranged to ensure even distribution of liquid refrigerant to the several circuits.
- 12.14 Each circuit of each direct expansion coil shall be provided with a thermal expansion valve of the gas-charged type. Valves shall have external equaliser connections, external super-heat adjustments with seal caps and solder joint or flanged pipe connections. Valves shall require not over 2,2°C super-heat change to move from fully open to fully closed. Super-heat setting shall be 6°C at full load. Each valve shall be provided with an external strainer, regardless of any internal strainer that may be incorporated in the construction.

### 13 PIPE INSTALLATIONS

#### 13.1 General

- 13.1.1 Pipe sizes and positions are as shown on the Engineer's drawings. Valves, strainers, etc, shall be suitable for the system.
- 13.1.2 Valves, strainers, pressure gauges and other fittings shall be of a manufacture approved by the Engineer.
- 13.1.3 Construction and materials of valves shall comply with the following specifications:
- Bronze valves : BS 1400 LG 2 - C or ASTM B62 - 63.
  - Cast iron valves : BS 1452 GR 14 or ASTM A126 - 61T Class B.
  - SG cast iron valves : BS 2789 - (1961) or ASTM A445 - 63T.
  - Cast steel valves : BS 1504 - 161A or ASTM A216 Grade WCB.
- 13.1.4 Valves, pipes, strainers and other fittings up to 50 mm may be screwed or flanged. Valves, strainers and other fittings larger than 50 mm shall be flanged. Thread shall be in accordance with BS 21 and flanges to ASA standards or BS 4504 unless otherwise specified.
- Pipes larger than 50 mm diameter connected to equipment or fittings, or where specifically indicated, shall be flanged to ASA Standards or BS 4504. All other piping with a diameter larger than 50 mm shall be welded, except where galvanised pipes are used. Galvanised piping shall be screwed when smaller than 50 mm and flanged above 50 mm.
- 13.1.5 Pressure and temperature ratings of valves and other pipeline equipment shall be suitable for the system into which installed and shall be selected according to ratings given by the manufacturer.
- 13.1.6 Matched flanges shall correspond in construction and dimensions to flanges on equipment. Matched flanges shall be provided with the correct bolts, nuts and packing rings.
- 13.1.7 All piping shall be clean before connecting.
- 13.1.8 On the Engineer's layout drawings pipe fittings are not shown, except for specific reasons such as indication of placing heights, etc.
- 13.1.9 All equipment of one type installed under one contract shall be of the same manufacture, supported by a well established South African organisation. Other makes may only be used on the Engineer's written approval.
- 13.1.10 Pipes shall be supported as shown on the standard drawings.
- 13.1.11 Pipe insulation shall be in accordance with the requirements of this Standard Specification
- 13.2 Valves for Water, Air or Gas up to 120°C and 1 600 kPa Working Pressure

Valves shall be of the following materials and construction:

**13.2.1 Gate Valves up to 50 mm**

Copper alloy valve bodies with screwed bonnets and screwed ends; non-rising copper alloy stems and solid tapered wedge type discs of to SABS 776-1975 Class 6.

**13.2.2 Gate Valves 65 mm and over**

Cast iron valve bodies with flanged ends. Bolted bonnets and yokes; rising brass or bronze stems with outside screw and yoke; solid cast iron wedge discs with bronze seat rings on body and disc; bronze trim, to BS 5150.

Use non-rising stems where space is limited, complete with indicator showing "Open" and "Closed" position.

Gate valves shall be provided with back seating on stems to facilitate repacking under pressure. Valves shall be used as isolating or shut-off valves.

**13.2.3 Globe and Angle up to 50 mm**

Bronze valve bodies with screwed bonnets and screwed ends; rising copper alloy stems with inside screw and back seating. Bronze trim, bronze seat rings and replaceable composition or bronze discs, Teflon for compressed air or liquid oxygen.

**13.2.4 Globe and Angle Valves 65 mm and over**

Cast iron bodies with flanged ends; bolted bonnets and yokes, rising bronze stems with back seating, with outside screw and yoke. Replaceable bronze seats, replaceable discs and bronze trim, to BS 5152.

The type of disc shall be suitable for the application.

Globe valves shall be used for throttling or balancing purposes.

**13.2.5 Butterfly Valves 50 mm and over**

Cast iron bodies with suitable rubber lining inside and flanged ends, or wafer type fitting between flanges. Lever operation acceptable, but gearbox operation shall be provided above 200 mm size with pressure above 1 000 kPa. Both lever and gearbox operation shall have position indication and locking mechanism.

Butterfly valves shall be used for throttling or balancing purposes.

**13.2.6 Diaphragm Valves**

Cast iron bodies, screwed ends up to 50 mm and flanged ends 65 mm and over.

To be used for rough control or as shut-off valves.

**13.2.7 Check Valves (Water or Non-pulsating Air or Gas)**

Bronze bodies; screwed ends up to 50 mm, cast iron bodies and flanged ends 65 mm and over. Mounting between flanges also acceptable. Working parts to be spring-loaded, completely guided or swing-flag operation and fabricated of stainless steel or bronze with elastic seats. Valves to DIN 3202 or API 594 of the "non-slam" type suitable for horizontal or vertical installation. Valves with stainless steel perforated cone and resilient conical diaphragm are also acceptable. If flange-mounted, a short straight removable flanged pipe section or bobbin to be provided for easy removal of valve. Diaphragms to be suitable to system fluid characteristics.

**13.2.8 Float Valves up to 40 mm**

Bronze valve bodies and working parts; screwed connections. Valves shall be suitable to open against the system pressure.

**13.2.9 Float Valves 50 mm and over**

Cast iron bodies with flanged ends and bronze seat rings.

**13.2.10 Plug Cocks up to 50 mm**

Bronze bodies and plugs; screwed ends with gland and square heads.

**13.2.11 Plug Cocks 65 mm and over**

As above, but with cast iron bodies and flanged ends.

**13.3 Valves for Hot Water, Steam, Air or Gas over 120°C and 2 000 kPa**

Valves shall be of the following materials and construction:

**13.3.1 Gate Valves up to 50 mm**

Bronze valve bodies with union bonnets and screwed ends, rising copper alloy stems with inside screw; nickel alloy or solid bronze wedge discs and bronze or stainless steel seats. Stainless steel seats only shall be used with steam. Forged steel class 800 (API standards will be accepted).

**13.3.2 Gate Valves 65 mm and over**

SG cast iron or cast steel valve bodies with flanged ends; bolted bonnets and yokes, rising stainless steel or bronze stems with outside screw and yoke; solid SG cast iron or cast steel wedge discs with replaceable stainless steel or bronze seats on disc and body.

Stainless steel trim to be used for steam application above 1050 kPa.

Gate valves shall be provided with back seating on stems to facilitate repacking under pressure. Valves shall be used as isolating or shut-off valves.

**13.3.3 Globe and Angle Valves up to 50 mm**

Bronze, SG cast iron, forged or cast steel bodies with screwed ends and union bonnets; rising stems of copper alloy; replaceable bronze or stainless steel discs and seats. Stainless steel seats only shall be used with steam above 1050 kPa.

**13.3.4 Globe and Angle Valves 65 mm and over**

SG cast iron or cast steel bodies with flanged ends; rising stems of stainless steel or bronze with outside screw and yoke; bolted bonnet and yoke; stainless steel or bronze trim, replaceable stainless steel or bronze discs and seats. Stainless steel trim to be used for steam application above 1050 kPa.

The type of disc shall be suitable for the application. Back seating shall be provided on valve spindles.

**13.3.5 Check Valves up to 50 mm**

Forged steel or bronze valve bodies; screwed ends.

**13.3.6 Check Valves 65 mm and over**

SG cast iron or cast steel valve bodies with flanged ends, bronze trim, stainless steel trim on steam

above 1050 kPa.

Valves fitting between flanges will be acceptable. Working parts shall be spring-loaded and completely guided and shall be of stainless steel. Elastic seals suitable for the temperature and application shall be provided. Valves shall be installed horizontally or vertically with flow upwards. Valves may also be of the double swing-flap with spring loading on the swing plates. Springs and swing plates shall be of stainless steel. All check valves shall be of the "non-slam" type to DIN 3202 or API 594. The stainless steel cone and diaphragm type are not acceptable.

#### 13.4 Valves for Special Duties

- 13.4.1 Calibrated balancing valves shall be of the plug cock type with bronze or cast iron valve bodies, bronze discs, and internal seals, screwed ends up to 80 mm, flanged ends 100 mm and over. Valves shall be provided with screwed take-off connections to which a pressure differential gauge can be coupled and provided with check valves in the take-offs. A valve position indicator shall be included. Valves shall be suitable for a working pressure and temperature of 1 000 kPa and 90°C (except for higher system pressures, when the temperature rating drops). A removable polyurethane cover shall be provided for each valve.

A portable differential pressure gauge shall be supplied with the above valves, complete with all necessary tubing, shut-off and vent cocks and a carrying case. A graph or chart shall also be supplied on which flow quantities against valve opening and pressure differential across the valve can be read off. The pressure gauge shall be calibrated to SI units system. On completion of the installation, the pressure gauge and charts shall be handed over to the maintenance engineer.

Calibrated balancing valves shall be selected from the standard range of a recognised manufacturer.

OR

- 13.4.2 Calibrated balancing valves shall be of the globe type with bronze or cast iron valve bodies with screwed ends up to 50 mm and flanged ends 65 mm and over. Temperature and pressure ratings shall be as specified as in Clause 13.4.1. Valves shall be provided with position indicators, pressure gauge connections, a pressure differential gauge and graphs as specified in Clause 13.4.1.

Calibrated balancing valves shall be selected from the standard range of a recognised manufacturer.

- 13.4.3 Rotating disc balancing valves are not acceptable.

- 13.4.4 Pressure reducing valves up to 32 mm for steam, air or water shall have bronze or cast iron bodies with screwed ends, stainless steel working parts and built-in stainless steel strainers. Valves shall be direct acting and shall be suitable for the system fluid characteristics, pressure and temperature.

Pressure reducing valves 40 mm and over for steam, air or water shall have cast steel or malleable iron valve bodies with flanged ends, stainless steel working parts and built-in strainers. Valves shall be pilot operated.

Pressure reducing valves shall be selected in accordance with the manufacturer's recommendations for inlet pressures and shall be designed to give a constant downstream pressure with varying upstream pressure. The arrangement of pressure reducing stations is shown on the Engineer's drawings.

- 13.4.5 Safety relief valves shall be of the spring-loaded type with side outlet and screwed connections. Valve bodies shall be of bronze or cast iron and working parts and trim of bronze. The outlet shall be piped to a safe position. Valves shall be to BS 1123 specification.

- 13.4.6 Air vents for steam shall be of the automatic balanced pressure type, with bronze or brass bodies with screwed ends, stainless steel liquid filled bellows and stainless steel working parts. Air vents shall be selected to the manufacturer's recommendations regarding working steam pressure temperature, etc. Outlets shall be piped to the nearest drain point.

13.4.7 Automatic air vents with suitable air bottles shall be installed in positive pressure areas in the following circuits:

- ☐ High points of open and closed circuits in plant rooms.
- ☐ Horizontal pipe layouts exceeding 100 m.
- ☐ Vertical risers exceeding 30 m.

Air bottles shall be provided with globe isolating valves installed between the air trap and the automatic vent to facilitate maintenance. The vent line from the automatic vent shall be piped to an open tundish in order to provide a visible check on the operation.

Automatic air vents shall have bodies of cast iron with screwed ends. Float mechanisms and all working parts shall be of stainless steel. Air vents shall be selected to the manufacturer's recommendation regarding working water temperatures and pressures.

13.4.8 Vent pipes of 15 mm diameter shall be installed at all high points and as shown on the Engineer's drawings. Vent pipes shall be provided with globe valves at a position easily accessible. In pipelines suitable air traps shall be provided. Vent pipes shall be taken up to 200 mm above the air trap and then bent and taken down. The globe valve shall be installed at the end of the pipe and provided with a quick coupler.

13.4.9 One suitable hose with quick coupler connection shall be provided per plant room.

13.4.10 Globe type drain valves fitted with quick couplers shall be installed at low points in the system and as shown on the Engineer's drawings to facilitate system drainage for maintenance purposes.

13.4.11 Equipment drain valves shall be globe type and shall be permanently piped to an open drain. Piping shall be galvanised piping.

### 13.5 Strainers for Cold Water up to 120°C and 1 600 kPa Working Pressure

13.5.1 Strainers shall be of the angle or Y-type. Strainers up to 50 mm shall have bronze bodies with screwed ends and stainless steel screens.

Strainers 65 mm and over shall have cast iron or fabricated steel bodies with flanged ends and screens of stainless steel.

13.5.2 Screens shall be perforated as follows:

Strainer size	Perforation size
Up to 50 mm included	0,8 mm
65-150 mm	2,0 mm
200 mm and over	3,5 mm

13.5.3 Strainers fitted in pipes larger than 150 mm diameter shall be provided with a 15 mm blowdown drain valve fitted with a quick coupler.

### 13.6 Strainers for Steam or Hot Water at over 120°C and up to 2 000 kPa

Strainers shall be as specified above but with SG cast iron or cast steel bodies and stainless steel screens.

### 13.7 General Equipment

13.7.1 Pressure gauges for water or air shall be of the "Bourdon" type with dials not less than 100 mm diameter. For steam services the turbine movement type shall be used, also with dials at least 100 mm diameter. A gauge cock and syphon tube shall be provided with each gauge. Gauges shall be calibrated to the SI units to a minimum reading of 50% higher, but not more than 75% higher than the



system working pressure. A red line shall be provided on the dial at the maximum system pressure. Selection of gauges shall be as follows:

- General application on pipe systems: Ferris type PBR or equivalent.
- Pump suction and delivery: Ferris type PBG or equivalent.
- Industrial applications: Ferris type PBB or equivalent.

13.7.2 Vacuum gauges shall be as specified for pressure gauges for air.

13.7.3 Flow metering shall be by means of stainless steel calibrated orifice plates for fitting between flanges. The bodies shall be provided with screwed take-off connections with built-in check valves to which a differential pressure gauge can be connected. Flow meters shall be suitable for the system working pressure and temperature. Orifice plates and bodies shall be selected from the standard range of recognised manufacturers. The position of orifice plates shall be according to supplier's requirements.

A differential pressure gauge, complete with tubes, shut-off cocks, air vents and a carrying case shall be supplied for the flow meters, as well as graphs or charts on which the flow quantities are plotted against pressure differential across the flow meter. The range of the instrument shall be suitable for the pressure drops of the installed orifice plates.

13.7.4 Thermometers shall be of the replaceable glass type, of straight or angle pattern, and calibrated in °C. Scale length shall be at least 170 mm and calibration shall be suitable for the system temperature range. Loose thermometer wells shall be provided. Thermometer wells shall be of brass with wall thickness not less than 1,5 mm around the thermometer bulb. For hot water and steam applications, thermometer wells shall be stainless steel. Thermometer wells shall be approximately 150 mm long and shall project 50 mm into the pipe. Pipes smaller than 65 mm in size shall be enlarged at the points where the wells are installed. Wells shall be oil-filled and be installed vertical or at an angle so as to retain oil.

13.7.5 Thermometers, pressure gauges and other instruments shall be placed in such positions as to be easily readable for a standing person with normal lighting.

### 13.8 Pipe Expansion and Contraction

Where the pipe configuration cannot accommodate expansion and contraction, expansion compensators shall be installed. Special attention must be given to riser take-offs, branch take-offs and equipment connections.

### 13.9 Steel Pipes for Water up to 120°C

13.9.1 Pipes shall comply with SABS 62-1971 and SABS 719 specifications and shall be of medium black steel. Wall thickness for pipes above 150 mm diameter shall be suitable for the pressure and temperature of the water. Fittings shall be of steel or malleable iron to BSS 1740 or SABS 509 specifications. Flanges shall be of cast iron or steel to BS 4504 or ASA standards. Flange packing shall be of the reinforced rubber type or CAF.

13.9.2 Piping shall be supported or hung and shall be isolated from the building structure.

13.9.3 The maximum horizontal support spacing of pipes shall be as follows:

Nominal pipe size	Span
15 mm - 32 mm	2,50 m
40 mm - 65 mm	3,00 m
80 mm - 90 mm	3,60 m
100 mm - 150 mm	4,25 m
200 mm - 300 mm	4,75 m
350 mm - 600 mm	6,00 m

**13.10 Condenser Water Piping, Drain Pipes and Soft Water Pipes**

- 13.10.1 Pipes shall be of medium or heavy black steel piping as specified in Part V, to SABS 62-1971 or SABS 719 specifications but shall be hot-dipped galvanised with a minimum coating of 300 g/m<sup>2</sup>. Fittings shall be of heavy galvanised steel or malleable iron with galvanising as above, and shall be manufactured to BS 1740 or SABS 509 specifications. Flanges shall be of steel to BS 4504 or ASA Standards and shall be galvanised as above. Flange packing shall be of a material approved by the Engineer.
- 13.10.2 Drain pipes shall have a fall with a gradient of 1:50.
- 13.10.3 All drain pipes are to be provided with cleaning eyes at each change in pipe direction.

**13.11 Sleeves and Plates**

Where piping runs through walls, flooring or ceilings, sleeves shall be provided. Sleeves shall be of 1,2 mm thick galvanised steel sheet, large enough to leave not less than 6 mm clear around the pipe and insulation, if any. Sleeves through flooring shall be of the proper length to pass through the entire floor construction with finish. Wall, ceiling and floor sleeves shall be provided with plates on both sides of the wall, ceiling or floor. Plates shall be designed so as to leave the pipe free for expansion and contraction. The Contractor shall supply all required sleeves to the principal contractor at a time well in advance of building construction. The Contractor shall position sleeves to be built in by the principal contractor.

**13.12 Pipe Hangers**

- 13.12.1 Spring hanger mountings for vibration damping shall be used in plant rooms of which the above and/or underneath and/or the adjoining spaces are completely or partly occupied, unless otherwise shown on the drawings, or otherwise specified in Part V of the specification.
- 13.12.2 The Contractor shall select spring hanger mountings in accordance with the supplier's recommendations. Springs shall not be compressed fully due to pipe mass, but there shall be a minimum deflection in accordance with the supplier's recommendations.
- 13.12.3 Spring hanger mountings shall be provided with acoustical neoprene washers.
- 13.12.4 Hangers shall be spaced so that the pipe mass is distributed evenly over all the hangers.
- 13.12.5 Refer to the Engineer's drawings for the detail requirements of hanger systems.
- 13.12.6 If hanger or support distances, as shown on the Engineer's drawings, exceed the specification for certain pipes when multiple pipes are supported by the same hangers, then the Contractor shall provide hangers or supports in between for these pipes.

**14 REFRIGERATION PIPING AND ACCESSORIES****14.1 General**

- 14.1.1 Refrigerant piping shall be as shown on the Engineer's drawings.
- 14.1.2 Horizontal lines shall be pitched in the direction of refrigerant flow at least 5 mm per meter of run.
- 14.1.3 Refrigerant lines shall be installed in a straight and direct manner without low points in the system.
- 14.1.4 Where vertical risers in the hot gas and suction lines exceed 2,5 m, the piping shall be provided with suitable oil traps and double riser arrangements.
- 14.1.5 Minimum velocities in hot gas and suction lines shall be 2,5 m/s for horizontal lines and 5,0 m/s for vertical lines.

- 14.1.6 Maximum velocity in hot gas and suction lines shall be 15 m/s but shall in any case be sized to provide a total friction pressure drop in the hot gas line of not more than 40 kPa.
  - 14.1.7 For refrigerant R22 the liquid line shall be sized to provide a friction pressure drop not exceeding 20 kPa.
  - 14.1.8 The liquid refrigerant shall be sub-cooled sufficiently to prevent flashing in vertical risers.
  - 14.1.9 For refrigerant R22 the suction line shall be so sized to provide a friction pressure drop not exceeding 20 kPa and shall be free of oil traps to provide direct and free draining into the compressor.
  - 14.1.10 Pipe sizing shall be such that under all load conditions gas velocities will be such to ensure entrainment of oil.
- 14.2 Piping**
- 14.2.1 Refrigerant piping shall be hard drawn seamless copper tubes equal to Maksal "RL" with recessed solder joint fittings.
  - 14.2.2 Solder shall be silver solder or "Coppertectic".
  - 14.2.3 Fittings shall be wrought soldered copper capillary type.
  - 14.2.4 Piping shall be absolutely free of dirt and scale.
  - 14.2.5 A refrigerant liquid line charging valve shall be provided for between the condenser and refrigerant drier. Before the system is charged, a vacuum test shall be carried out at a pressure of 3,2 kPa absolute for a period of 24 hours.
  - 14.2.6 Pipe support shall be such to prevent sagging. All refrigerant pipe fixing saddles shall be of copper. Wherever copper piping is in contact with metal surfaces other than copper, rubber or plastic inserts shall be installed between such dissimilar metal surfaces.
  - 14.2.7 Refrigeration suction lines shall be insulated with continuous lengths of "Armaflex", properly vapour-proofed.
- 14.3 Valves**
- 14.3.1 Pressure and temperature ratings of valves and other pipeline equipment shall be suitable for the system into which they are installed and shall be selected according to the ratings given by the manufacturer.
  - 14.3.2 On the Engineer's layout drawings, pipe fittings are not shown except for specific reasons such as indication of placing heights, etc.
  - 14.3.3 All equipment of one type installed under one contract shall be of the same manufacture obtained from an established South African supplier.
  - 14.3.4 Fittings connected to copper tubing shall have capillary solder type ends or flanged ends and soldered flanged adaptors.
  - 14.3.5 Isolating valves on the suction and discharge of compressors shall be of the back-seating, key-operated, seal cap type and shall be as manufactured by the compressor manufacturer.
  - 14.3.6 Isolating valves fitted elsewhere shall be of the pack less diaphragm type fitted with hand wheels and shall be of "Audco" or equivalent manufacture.
  - 14.3.7 Solenoid operated valves shall be suitable for the voltage of the control system and shall be energised to open unless otherwise stated in Part 5 of the specification.

- 14.3.8 A pressure relief valve of the spring loaded type shall be installed on the receiver or condenser and shall be set at 2 100 kPa for R22.
- 14.4 Other Refrigerant Fittings**
- 14.4.1 Sight glasses of the double lens type shall be installed in the following positions:
- In the liquid line near the evaporator, directly ahead of the expansion valve.
  - Near the liquid line shut-off valve at the receiver or condenser.
  - At the top of vertical risers exceeding 3,0 m in height.
  - In the liquid line on the evaporator side of heat exchanger.
- 14.4.2 A suitable filter drier shall be installed to remove moisture from the system. Driers shall be of the replaceable cartridge type and shall not be used in the place of the strainer. Isolating valves shall be provided on each side of the drier to facilitate filter replacement. Dryers shall be installed in liquid lines close to the receiver outlet. A liquid sight glass and moisture indicator shall be installed in the liquid line close to each drier.
- 14.4.3 Strainers shall be installed ahead of expansion valves and solenoid stop valves. Strainers shall be of the angle type, cleanable without disturbing pipe connections. Bonnets shall be flanged and bolted. Screen shall be 0,5 mm for gas lines and 0,25 mm for liquid lines. The free area of each screen shall be not less than 5 times the area of the strainer inlet pipe.
- 14.4.4 Oil separators shall be installed in the hot gas line close to the compressor discharge in the event of suction or liquid lines more than 15,0 m or with a hot gas riser more than 6,0 m. Oil separators shall have an effective impingement type separating element on oil sump and a float operated return trap to return oil to the compressor automatically.
- 14.4.5 If condenser volume is insufficient to store the system refrigerant charge, then a liquid receiver shall be installed. Condensers and receivers shall not be filled to more than 80% of their total volume. Receivers shall be piped into the system with valve inlet, outlet, purge and drain connections and safety valve. Receivers shall be equipped with liquid level gauge glass. Piping from the condenser to evaporator shall be provided with a valve bypass over the receiver. Receiver manufacture shall comply with the requirements of the Occupational Health and Safety Act, as amended, covering pressure vessels.
- 14.4.6 Heat exchangers manufacture shall comply with the requirements of the Occupational Health and Safety Act, as amended, covering pressure vessels. Heat exchangers shall not be used with hermetic compressors.
- 14.4.7 Flexible connectors shall be installed in the hot gas line as close as possible to the compressor and parallel to the compressor. Flexible connectors shall have a diameter larger than the piping to eliminate whistling and noise.
- 14.4.8 Hot gas mufflers shall be installed in the hot gas line after the flexible connector to absorb the compressor pulsation energy. Hot gas muffler shall be complete with aspirator tube and shall be installed in such a way to prevent trapping of oil in the muffler.
- 15 THERMAL INSULATION**
- 15.1 General**
- 15.1.1 All thermal insulation work shall be executed by specialists in the specific field. Recommendations of manufacturers regarding application of insulation materials, insulation cladding, adhesives, etc, shall be strictly observed by the Contractor. The work shall be executed in a workmanlike manner and the final surface shall have a neat, smooth and symmetrical finish.

- 15.1.2 Thermal insulation of equipment shall comply with BS CP 3005, provisions of BS 1334, BS 1558 and BS 476 or the latest amendments as applicable.
- 15.1.3 Before the application of thermal insulation, steel surfaces shall be degreased and primed with zinc chromate primer.
- 15.1.4 No equipment shall be insulated until tested and approved.
- 15.1.5 Adhesives, sealants and coatings shall be compatible with the insulation material.
- 15.1.6 Certified tests reports from an instance approved by the Engineer shall be submitted by the Contractor in which the following information is given:
- The thermal conductivity of insulating materials at operating temperature.
  - The surface spread of flame of insulating materials, adhesives and other finishes.
  - The permanent of vapour barrier systems (chilled water systems).
  - The sound absorption co-efficient of insulation materials (internal insulated ducts).
- 15.1.7 Surface spread of flame of insulation cladding shall be in accordance with BS 476 Class I Specification.
- 15.1.8 Vapour barrier permeability on chilled water pipes shall not be more than 1.
- 15.1.9 Insulation, adhesives and finishes shall be resistant to rotting, mould, fungus growth, decay or attack by vermin.
- 15.2 Chilled Water Pipe Work Insulation**
- 15.2.1 Chilled water piping shall be insulated, using rigid preformed polyisocyanurate (PIC) sections having a density of 32 kg/m<sup>3</sup> and a bore to suit the pipe.
- 15.2.2 The insulation shall be externally covered. The covering to the insulation shall form a complete vapour barrier as specified below.
- 15.2.3 Insulation that is not visible, i.e. above ceilings, shall be finished with two coats of polymeric emulsion (Foster 30/36 or approved equivalent), reinforced with calico. A high gloss enamel topcoat shall be applied over the Foster 30/36 to the colour codes as specified.
- 15.2.4 Insulation in plant rooms and enclosures, insulation which is visible, and insulation exposed to the weather, shall be finished with two coats of polyester resin reinforced with 300g fibreglass Chopstrand. This shall be sanded smooth and coated with a resin rich topcoat pigmented to the colour codes as specified.
- 15.2.5 Factory made, fibreglass coated (as above), preformed saddle sections of pipe shall be placed at all hanging points. The pipe supports shall be placed over these saddle sections, allowing for a continuous vapour seal across the pipe insulation.
- 15.2.6 Rigid preformed piping insulation shall be applied, wherever possible, for the insulation of bends, tees, elbows, flanges and valves. Where pre-formed pipe insulation is not possible to use, blocks or bats shall be securely wired or banded in position and all joints and voids shall be filled with mineral wool.
- 15.2.7 Piping shall be supported outside the insulation on cradles. Where the load on the insulation exceeds the strength thereof, a suitable part of the insulation shall be replaced by material having higher crushing strength.
- 15.2.8 Where insulation is specified for piping, the same shall apply to all fittings and pipe connections within the system.

15.2.9 The Contractor shall base his main offer on the following specification: -

INSULATION		POLYISOCYNURATE (PIC) 32 kg/m
PRIMER	Make	Bitumen Emulsion, First Coat Pipe\section seal PEKAY BE2 BITUMEN EMULSION
JOINT SEAL	Make	PEKAY MASTIC 220
BINDING TAPE	Make	Vinyl Buff Tape 24 mm wide 3M
VAPOUR SEAL (Concealed Piping)	Make	TWO COATS POLYMERIC EMULSION FOSTER 30/36
VAPOUR SEAL (All other Piping)		TWO COATS POLYESTER RESIN
MEMBRANE (Concealed Piping)		CALICO CLOTH
MEMBRANE (All other Piping)		300g FIBREGLASS CHOPSTRAND
FINISH VAPOUR SEAL (Concealed Piping)		HIGH GLOSS ENAMEL
FINISH VAPOUR SEAL (All other Piping)		PIGMENTED RESIN RICH TOPCOAT
<b>INSULATION THICKNESS</b>		
15 mm diameter to 50 mm diameter	-	25 mm thick
65 mm diameter to 150 mm diameter	-	40 mm thick
Above 150 mm diameter	-	50 mm thick

### 15.3 Insulated Valves and Fittings

15.3.1 Valves and fittings shall be insulated with a 25 mm thick non-asbestos plastic compound covered by a 15 mm thick layer of non-asbestos hard setting compound, trowelled to a neat, smooth and symmetrical finish or accommodated in a neat sheetmetal cladding to suit the rest of the insulation.

15.3.2 Steam valves, flanges and fittings shall be insulated with a 40 mm thick non-asbestos plastic compound. Condensate fittings other than bends smaller than 40 mm diameter shall not be insulated.

### 15.4 Hot Water and Condensate Pipes in Plantrooms

15.4.1 All supply and return pipes shall be insulated with plain resin bonded glass fibre insulation with a density of 96 kg/m<sup>3</sup>.

Insulation shall be of the following thickness:

Pipes up to 125 mm diameter	-	25 mm
Pipes bigger than 125 mm diameter	-	40 mm

15.4.2 Insulation in plant areas, all exposed insulation and all insulation installed externally is exposed to the weather, shall be treated as specified in Clause 15.2.4.

#### 15.5 Hot Water and Condensate Pipes Outside Plantrooms

15.5.1 All supply and return pipes outside plantrooms in concealed spaces is in shafts and ceiling voids shall be insulated as described in Clause 15.4.1 but glass fibre insulation shall be provided with a factory applied canvas covering.

15.5.2 Circumferential and longitudinal laps to the canvas shall be adhered with "Foster Lagfas 81-42W" or equivalent.

15.5.3 A protective cladding equivalent to "Foster Sealfas Coating 30-36" or "Decadex Firecheck" shall be brush applied over the canvas. Application shall be as follows:

"Foster 30-36"	-	One coat at 2 m <sup>2</sup> /litre
"Decadex Firecheck"	-	One coat at 1,8 m <sup>2</sup> /litre

#### 15.6 Sheetmetal Cladding

Where sheetmetal cladding is specified, it shall be installed with seams in non-visible positions. Where cladding is exposed to the elements, seams shall be installed to the underside of horizontal pipe runs.

#### 15.7 Thermal Storage Vessels and Heat Exchangers

Insulation shall consist of a 100 mm thick layer of glass fibre with a density of 96 kg/m<sup>3</sup>. The insulation shall be covered with a 0,5 mm thick sheetmetal covering. Dished ends shall be clad with triangular segments. Internal supports shall be fitted to prevent compression of the glass fibre material. All manholes and inspection welded seams shall be provided with easily removable sections. Where pipes are connected to the equipment, neat fitting sheetmetal trims shall be fitted around such pipes and bolted or screwed to the sheetmetal cladding.

#### 15.8 Air Ducts in Plantrooms or Visible Positions

15.8.1 Ducts shall be externally insulated with resin bonded glass fibre of 25 mm thickness and density of 24 kg/m<sup>3</sup> and covered with a factory applied aluminium foil facing. Insulation shall be adhered to the duct surface by means of "Foster Safetee Ductfas Adhesive 81-99" or equivalent. All protrusions and cuts through the insulation shall be sealed for the full insulation thickness by one brush application of "Foster 30-45" or equivalent, to obviate moisture migration at these points. Duct hangers shall not be covered with insulation. Hangers shall be removed one by one when applying external insulation.

15.8.2 Inverted and side insulation shall be additionally supported by the use of hanger pins. Where insulation is cut to provide for duct hangers or supports for instance, or at projections through the insulation, the insulation shall be sealed.

#### 15.9 Ducts Outside Plantrooms or In Concealed Areas

15.9.1 Ducts shall be externally insulated with resin bonded glass fibre of 25 mm thickness and density of 24 kg/m<sup>3</sup> and covered with a factory applied aluminium foil facing. Insulation shall be adhered to the duct surface by means of "Foster Safetee Ductfas Adhesive 81-99" or equivalent. All protrusions and cuts through the insulation shall be sealed for the full insulation thickness by one brush application of "Foster 30-45" or equivalent, to obviate moisture migration at these points. Duct hangers shall not be covered with insulation. Hangers shall be removed one by one when applying external insulation.

#### 15.10 External Ducts

All external duct work is duct work exposed to the elements, shall be externally insulated with 40 mm rigid preformed poly-isocynurate (PIC) sections with a density of 32 kg/m<sup>3</sup> and shall be finished with two coats of polyester resin reinforced with 300g fibreglass Chopstrand. This shall be sanded

smooth and coated with a resin rich topcoat pigmented to the final colour (to be advised at a later date).

#### **15.11 Ducts – Internally Insulated**

If specified in the Project Specification, ducts shall be internally insulated with resin bonded glass fibre of 25 mm thickness and a density of 24kg/m<sup>3</sup> and covered with Sonic Liner. The insulation shall be glued to the inside surface with a fire retardant adhesive. In addition the insulation shall be mechanically secured with Grip Nails or Spotter Pins at 450 mm centres, and not more than 75 mm from the edges of each panel. The insulation ends shall be covered with 0,8 mm thick galvanized metal strips riveted to the duct panels to prevent erosion of particles of the insulation into the air stream.

#### **15.12 Ducts - General**

- 15.12.1 Hanger pins for the fastening of external insulation shall comply with requirements as specified in "Duct Liner Application Standard" (SMACNA) where applicable, with respect to construction, distance between hanger pins and positioning of hanger pins. Hanger pins shall preferably be of the electric stud weld type.
- 15.12.2 Welding time shall be sufficient to ensure a firm adhesion. If the "gripnail" type is used and the hanger pins show evidence of poor fastening during inspection, the Contractor may be required to replace all fastener pins with the electric stud weld type.
- 15.12.3 Return air, fresh air and exhaust air ducts shall not be insulated unless specifically so specified in Part 5.

### **16 AIR FILTERS**

#### **16.1 General**

- 16.1.1 Filter units or components shall be selected from the standard range of established suppliers, well represented in South Africa. Filter units shall be fitted and components assembled according to the recommendations of the supplier.
- 16.1.2 Frames and filters shall be constructed in such a manner so as to prevent the passage of unfiltered air. Filter frames shall be constructed of standard components supplied by the filter manufacturer/supplier and shall be strengthened if necessary to absorb the full dirty pressure drop across the frame with no deflection. Air seals between the filter unit and supporting frame shall be of resilient material of grooved or labyrinth type.
- 16.1.3 Metal filter parts, except those that are in contact with oil, shall be sufficiently protected against corrosion.
- 16.1.4 Filters shall be adequately protected against dirt during construction. Filters must be put in regular operating condition before the fans to which they connect are operated for any purpose, such as temporary ventilation or adjusting.
- 16.1.5 The Contractor shall ensure, when selecting a filter, that the filter dimensions suit the configuration of the air-handling unit.
- 16.1.6 Filters shall be selected at approach air velocities not exceeding 2,5 m/s unless otherwise approved by the Engineer.

#### **16.2 Disposable Media Panel Filters**

- 16.2.1 Each filter shall consist of a factory made robust sectional steel supporting frame which shall accommodate the filter cells.



16.2.2 Media shall be kept in position by means of matching inner and outer retaining frames forming a filter cell.

16.2.3 Filter cells shall be easily removable from the upstream or downstream side of the filter when of the clip-on type, or from the side of the filter assembly when of the slide-in type.

16.2.4 Media shall be 50 mm thick unless otherwise specified.

### **16.3 Bag Filters**

16.3.1 Bag filters shall be of the extended pocket type with suitable spacers restraining expansion of pockets.

16.3.2 Filter cell holding clips shall ensure quick removal of units and shall be designed to ensure even pressure on the air seal.

16.3.3 Filter units shall be removable from the upstream or dirty air side.

### **16.4 High Efficiency Filters**

16.4.1 High efficiency filters, where specified, shall be of the HEPA type. Where these are specified in Part 5 of this document, allowance shall be made for test openings upstream and downstream of the filter, in accordance with the requirements of the supplier and specialists.

16.4.2 The contractor shall carry out tests to confirm the efficiency of the filters. The tests shall be carried out by an approved specialist, before handover and after each replacement during the maintenance period.

16.4.3 The filter housing shall be designed to contain HEPA type filters with a neoprene seal to ensure effective sealing. A seal test groove shall be provided with a monitoring point accessible from the air exit side, to test and monitor the effectiveness of the seal.

16.4.4 HEPA filter boxes shall be of a reputable manufacture and shall be installed to the requirements of the manufacturer.

### **16.5 Washable Media Filters**

16.5.1 Filter cells shall be of the pleated type and mounted in a robust holding frame with corrosion resistant finish.

### **16.6 Filter Efficiencies**

16.6.1 Unless otherwise specified in Part 5, the following filter efficiencies shall apply:

- Primary filters : Filter Class G3: 80 - 90% Arrestance according to DIN EN 779
- Secondary filters : Filter Class F8: 90 - 95% Efficiency according to DIN EN 779
- Hepa filters : Filter Class H13: 99,5 – 99,95% Efficiently according to DIN EN 1822 (HEPA)

## **17 ELECTRICAL HEATER BATTERIES**

### **17.1 Construction and Installation**

17.1.1 Each heater battery shall consist of the required heating elements built into a flanged metal frame. The frame sizes shall be suitable for the built-up sheet metal boxes as indicated on the drawings. Connections to the frame shall be airtight. All frame members, control box, control box cover and associated sheet metal parts are to be of adequate thickness galvanised plate.

- 17.1.2 Each heater battery shall be complete with a side-fitted terminal box with an easily removable cover over the power supply terminal block. The side panels of the terminal box shall be perforated for ventilation. Sufficient knock-outs shall be conveniently located for power and control wiring.
- 17.1.3 In the event of the elements being smaller than the duct size, the area around the elements shall be filled in with perforated or expanded metal with 50% open area, to maintain a uniform air velocity across the duct face.
- 17.1.4 In the event of the heater battery flange being larger than the duct size, the sheet metal transition on the upstream side of the heater shall not be more than 30° from the flow direction and on the downstream side not more than 40° from the flow direction.
- 17.1.5 Heater batteries shall not be installed closer than 600 mm from the air-handling unit or any bends in the ductwork. The air-handling unit flexible connection shall be suitable for an air temperature of 90°C.
- 17.1.6 The heater elements shall be suitable for a power supply of 220 volt, 50 hertz, 1 phase AC, and shall be able to function in still air without damage.
- 17.1.7 The full load shall be evenly balanced over the three phases, and connections to the heaters shall be with heat resistant wire.
- 17.1.8 The casings shall be properly earthed and insulated from the ducting. The elements shall be firmly supported and the terminals shall be located in a terminal box outside the air stream.
- 17.1.9 The heater casing and ductwork 600 mm upstream and downstream of the casing shall be internally insulated with 6 mm thick Nutec sheeting fixed with mechanical fasteners as specified in SMACNA for internal insulation.
- 17.2 Heater control**
- 17.2.1 Each heater battery shall be electrically interlocked with its corresponding supply air fan.
- 17.2.2 Where interlocking with the supply air fan is not possible, an airflow switch shall be provided in the supply air duct, interlocked with the heater circuit for that duct. In the event of supply air failure the heaters shall be de-energised.
- 17.2.3 Each heater battery shall be complete with an automatic reset thermal cut-out to de-energise the heating elements in the event of the air temperature rising above 77°C.
- 17.2.4 Each heater battery shall be complete with a manual reset overheat thermostat mounted in an accessible position inside the duct.
- 18 PUMPS**
- 18.1 General**
- 18.1.1 Water pumps shall be centrifugal pumps with volute casings and shall have non-overloading characteristics. Pump casings may be horizontally or vertically split and the design, materials and finish shall be equivalent to a well-known make, approved by the Engineer. The pump installation shall be complete with flanged inlet and outlet connections, matching flanges, removable drive coupling guard and fabricated steel base for pump and motor. This specification covers pumps which do not form an integral part of cooling towers, air-handling units or similar equipment where the pump forms an integral part of a complete unit.
- 18.1.2 Pumps shall be silent and vibration free when running.
- 18.1.3 No pump shall be started before the installation of strainers.

- 18.1.4 Pumps shall be provided with adequate protection over inlet and outlet flanges before being delivered to site. Protection covers shall be able to withstand normal handling during construction work.
- 18.1.5 The design total system resistance as indicated in Part 5 of the specification shall be finally calculated by the Contractor when all the information regarding selected system elements are available. The actual motor duties shall then be transferred onto the electrical distribution board drawings. This is to be done before ordering and in accordance with the Principle Contractor Programme.
- 18.1.6 Pumps shall be suitable for the fluids and fluid temperatures, which they handle and shall be selected accordingly.
- 18.1.7 Electric motors shall be in accordance with the Electrical Standard Specification.
- 18.1.8 Pumps shall be complete with flexible drive couplings to allow for angular and axial misalignment.
- 18.1.9 Pumps shall be aligned by a representative of the pump supplier.
- 18.1.10 Pumps shall be provided with extended lubrication points in applications where lubrication points on the pump are not easily accessible.
- 18.1.11 Pump drives shall be suitably protected by a securely mounted sheet metal guard.
- 18.1.12 Manual vent valves shall be provided at high points on the pump casings. For applications with temperature above boiling point the vent must be piped to a safe drain point.
- 18.1.13 Drain plugs shall be provided at low points on the pump casings.
- 18.1.14 Pump casing parts with a mass more than 25 kg shall be provided with lifting eyes or lugs of ample strength.
- 18.1.15 All pumps shall be provided with drip trays forming an integral part with the pump casing. A 25 mm galvanised drain pipe shall be installed between each drip tray and the nearest floor drain or tundish. The necessary air gap shall be left between the end of the pipe and tundish.
- 18.1.16 All pumps with discharge connections larger than 80 mm diameter and operating at more than 200 kPa total dynamic pressure shall be provided with casing wearing rings. Rings shall be of bronze, chrome iron, nickel iron or other composition suitable for the specific application.
- 18.1.17 Impellers shall be of bronze and shall be dynamically balanced. Impellers of pumps having a 40 mm and larger discharge connection shall be fully enclosed and hydraulically balanced.
- 18.1.18 Mechanical seals of the balanced type shall be provided. Mechanical seals shall match the rating, fluid and temperature requirements.
- 18.1.19 Each pump shall be provided with a cast iron or fabricated steel bedplate of ample size to hold both pump and motor in correct alignment. Pump and motor shall be accurately aligned when running at normal temperature. The impeller shall be removable without dismantling the motor or pipe work. Dowel pins shall be fitted to base plates after alignment
- 18.1.20 No more than one pump and motor may be mounted on one common bedplate. The bedplate of each pump unit must be separately mounted on anti-vibration machine base mountings.
- 18.1.21 Bearings shall be cleaned and packed with new grease before commissioning.
- 18.2 Pump Selection**
- 18.2.1 The efficiency of each pump selected shall not be less than 70% and not more than 3% below the peak of the efficiency curve for the impeller furnished.
- 18.2.2 The pump casing shall be suitable for a pressure 1,5 times the pressure at the delivery side of the pump.

- 18.2.3 The supplier shall ensure that the NPSH of the pump selected is suitable for each pump application.
- 18.2.4 The supplier shall ensure that the motor supplied is adequate for the full pump characteristic and not only for the duty specified.

## **19 MACHINE BASE MOUNTINGS**

- 19.1 Machine base mountings shall be of a make approved by the Engineer and shall be of a type as specified in Part 5 and/or as shown on the Engineer's drawings. Anti-vibration mountings shall be selected by a specialist supplier.
- 19.2 The design and selection of anti-vibration mountings shall be such that all unbalanced forces and vibrations will be completely damped and absorbed by the mounting, at any machine speed up to maximum working speed. Mountings shall be suitable for the weight of the machine in combination with unbalanced forces, if any. Mountings shall be provided with levelling bolts and neoprene stabilisers for vertical and lateral motion control.
- 19.3 Neoprene cork pad mountings shall consist of a cork layer with a ribbed neoprene layer bonded to both sides, suitable for a working pressure of 350 kPa.

## **20 WATER TREATMENT INSTALLATIONS**

### **20.1 Chemical Treatment – General**

- 20.1.1 The chemical treatment programme shall perform the following functions:

Inhibit corrosion  
Inhibit scale forming  
Protect system against algae growth  
Protect system against sludge formation

- 20.1.2 Chemicals shall comply with the local health authority regulations and shall be compatible with all materials forming part of the piping system.
- 20.1.3 Chemicals shall be readily available from a recognised supplier.
- 20.1.4 Chemicals shall be selected so as not to interact with or neutralised each other.
- 20.1.5 Concentration of chemicals in pipe system shall be in accordance with suppliers' recommendations.
- 20.1.6 Twelve service visits at monthly intervals shall be provided. Recognised corrosion tests and water analysis shall be carried out during each visit. Reports on the above shall be sent to the engineer.
- 20.1.7 The Contractor shall provide twelve months' supply of chemicals of an approved manufacture and suitable for this water treatment equipment.

### **20.2 Chemical Treatment for Open Cooling Tower and Evaporative Cooling Systems**

- 20.2.1 The Contractor shall install a chemical injection system and bleed-off control, complete with all necessary controls and equipment.
- 20.2.2 The system shall consist of a chemical feed pump and bleed-off valve controlled by a controller measuring the water conductivity with a probe. The conductivity probe shall measure the electrical conductivity of the cooling water, and shall be installed in an interconnecting pipe between the supply and return pump manifolds. The conductivity controller shall be equipped with a "Test", "Off" and "Auto" position switch to determine whether the solenoid valve and chemical feed pump are in an operational condition.

- 20.2.3 The system shall consist of two separate systems – a bleed-off system controlled by the TDS and a chemical feed system controlled by the amount of make-up water.

The bleed-off system shall function similarly to the system specified in Clause 18.2.2, but in this case the chemical feed pump shall not be activated by the TDS controller. The TDS controller will only activate the bleed-off solenoid valve as specified.

The chemical feed system shall function as follows:

A make-up water meter with an electric impulse contactor shall be installed in the make-up water line and shall send an impulse to a timer control centre each time a specific quantity of water passes through the meter.

The valve by-pass shall be installed to allow the removal of the meter without system shut down.

The meters shall automatically begin to function whenever water flows through it. In addition to sending electric impulses to the counter, the meter shall contain a totalising register which shall make it possible to determine the volume of make-up water used over a period of time.

The timer shall be an electrical control, designed to accept the impulses from the water flow meter, accumulate these impulses and initiate one reset type timer. The timer, through a relay and three-position selector switch, shall be adjustable and the operating time for the chemical feed pump shall be set so that the correct quantity of chemical solution is fed.

An auto-off-manual switch shall provide a check feature to determine if the chemical feed pump is in operation by switching it to manual.

The feed pump shall be of sufficient size to be able to feed correct amounts of chemicals to the system. Connection of the pump discharge to the water system shall be as specified in Clause 12.2.2.

## 20.3 Chemical Treatment for Chilled Water and Closed Systems

- 20.3.1 Systems shall be filled and the water circulated sufficiently to flush the entire system before draining and filling with clean water, after which corrosion inhibitors shall be added.
- 20.3.2 The Contractor shall provide a dosing pot to facilitate addition of the inhibitor.

## 21 GALVANISING

### 21.1 General

- 21.1.1 Galvanising shall mean either hot-dipped galvanising or electro-deposited zinc coating.
- 21.1.2 All hot dip galvanising shall be carried out in accordance with SABS 763-1988 and SABS 934-1969 where applicable.
- 21.1.3 For electro-deposited zinc coating SABS 1502081 shall apply.
- 21.1.4 Items to be galvanised shall be entirely prefabricated and then dismantled for galvanising. No cutting of threads or welding will be accepted after galvanising.
- 21.1.5 The materials to be coated shall be free from slag, laminations, paint, oil, grease and similar impurities.
- 21.1.6 All welds and exposed surfaces shall be sand blasted prior to galvanising.

**21.2 Coatings**

- 21.2.1 Except where otherwise specified for individual items, the thickness of the coating shall not be less than 300 g/m<sup>2</sup> of surface covered.
- 21.2.2 Galvanising coating shall be smooth, adherent continuous and free from block spots or flex stains.
- 21.2.3 Repairs to damaged galvanised coatings will not be accepted. Damaged items shall be re-galvanised.
- 21.2.4 Wherever zinc coating after fabrication is specified herein, the Contractor may use mill-coated materials, provided all edges that are cut (sheared, punched, drilled, etc) or deformed sufficiently to cause peeling of the zinc coating, are re-coated with a zinc dust pigmented paint or a suitable polymerized resin paint.

**22 ELECTRICAL****22.1 Scope of Work**

The following are included:

- motor control panel/s
- wire-ways
- cabling and wiring

**22.2 Electricity Supply**

The electricity supply will be 400/231 V (nominal), 50 Hz, 4-wire with an earth conductor.

**22.3 Standards**

Comply with SABS 0142 and any applicable SABS Specifications and Codes of Practice, or BSI or IEC documents where no SABS document exists.

Provide a Certificate of Compliance at the completion of the work.

**22.4 Drawings**

Submit cross-referenced layout, schematic and wiring diagram drawings as shop drawings and as part of manual.

**22.5 Testing**

Test in accordance with SABS 0142 and submit Certificate of Compliance for Electrical Installation Annexure F37.

**22.6 Earthing**

Bond the installation and provide bonding straps across flexible bellows and expansion joints.

## 22.7 Motor control panels

### 22.7.1 Comply with the following:

Description		Requirements
1	Motor control panels	SABS 1180
2	Motor control panels with fault rating requirement over 5 kA.	SABS 1180
3	Circuit breakers (1 000 A & over).	Withdrawable air circuit breakers to IEC-157
4	Circuit breakers (under 1 000 A).	Moulded case circuit breakers to SABS 156
5	Switches	SABS 152
6	Fuse links and holders	SABS 172 and 173
7	Contactors and relays	SABS 1092
8	Protection relays	BS 587
9	Push buttons	BS 4794
10	Indicator lights	BS 1050
11	Ammeters and voltmeters	SABS 1229 Class 1, 5
12	Current transformers	BS 3939 Class 5
13	Terminal strips	DIN rail mounting, 15 A, labelled with pressure shoes, fire-resistant plastic moulding
14	Motor starters	Rate for 3 x 106 operations AC3 duty 15 starts/hour
15	Star-delta motor starters	Electrically and mechanically interlocked
16	Instrumentation incomer	3 ammeters and 1 voltmeter with 7 position selector switch (meters 96 mm square format)
17	Instrumentation circuits for motors of 15 kW and above	1 ammeter (72 mm square format)
18	Paint	Epoxy-polyester powder coating to SABS 1274
19	Busbars	SABS 1195 and 784

22.7.2 Connect instrument and control wiring to the busbars through 20 A HRC fuses mounted on the busbars and 5 A HRC fuses mounted on the front panel.

**22.8 Wire-ways****22.8.1 Comply with the following:**

Description	Requirements
Steel conduit	SABS 162 or 1007
PVC conduit	SABS 950
Galvanised conduit	SABS 763
Flexible conduit	BS 4607 (with PVC sheath, except in ceiling plenums)
Conduit boxes	SABS 162, 1084 or 1085
Running threads or damage to steel conduit	2 coats of paint (red lead primer for black enamelled and zinc rich primer for galvanised conduit)
Trunking	SABS 1197, 1,6 mm steel galvanised to SABS 934
Wire-ways (general)	SABS 1197 & min. protection to IP3X of IEC-162
Spacing for steel wire-ways	160 mm minimum from gas, steam or hot water pipes etc
Spacing for PVC wire-ways	300 mm from gas, steam or hot water pipes, etc

**22.8.2** Do not use black-enamelled conduit where: exposed to weather, damp or corrosive environments; within 50 km of the coast; U traps formed; and in kitchens, boiler rooms and plenums containing humidified air.

**22.8.3** Use the PVC conduit only where: permitted by the Engineer; not exposed to mechanical damage or to temperatures over 50°C; and not used to support any loads.

**22.9 Cable And Wiring**

Cables and wiring shall be selected according to the Wiring Code and the minimum size shall be 1,5 mm<sup>2</sup> with 2,5 mm<sup>2</sup> earth conductor.

Wire and cable shall comply with SABS 150. Cable glands shall comply with SABS 1213.

**22.10 Motor Connections**

Run fixed cabling or conduit to a point near the motor. Run flexible cable or flexible conduit from this point to the motor. Ensure that the point is close to the motor so that the flexible cable or conduit is not longer than 600 mm. Provide an isolator (switch disconnecter) adjacent to the motor.

**23 PAINTING**

**23.1** No untreated metal surfaces shall be permitted on the project. All items which are not galvanised or similarly protected against corrosion shall be painted. No equipment, hangers, brackets, etc, shall be permitted to be delivered to site in unprotected form. The equipment shall be factory-coated with an approved zinc-rich primer coat before despatch from the place of manufacture.



- 23.2 Painting shall comprise the following consecutive processes. First thoroughly clean, descale and degrease all surfaces, follow by a good coating of approved zinc-rich primer, and finish with two coats of quality high-gloss enamel of an acceptable make. Final finish shall be to the approval of the Engineer.
- 23.3 Particular care shall be taken that appropriate primers be used as a basis for painting, and that paint be of high quality manufacture, to provide a completely satisfactory finish to the approval of the Engineer. Galvanised surfaces shall be treated to ensure proper bonding of paint.
- 23.4 Whereas it would not be necessary to paint any ductwork or conduits installed in roof voids, shafts, masonry ducts, etc., or where not normally visible, it is a requirement that such equipment be properly cleaned, treated with two coats of rustproofing paint.
- 23.5 With the exception of ducting and piping, items with a galvanised finish, such as cable trays, need not be painted, but shall be properly cleaned with a suitable proprietary galvanised iron cleaning fluid.
- 23.6 All equipment shall be colour-coded in accordance with recognised standards and, where possible, to comply with SABS 1091-1975.
- 23.7 Equipment shall be painted in accordance with colour code as specified below. Where factory painted items such as the Air Handling Units, Cooling Towers and Pumps are not painted a specified colour, they shall be repainted by the Contractor. Factory painted equipment which is required to be repainted shall be rubbed down prior to being given two coats of gloss enamel paint. Alternatively the equipment shall be in accordance with the paint manufacturer's recommendations.

EQUIPMENT	BASIC COLOUR	COLOUR CODE INDICATOR	
		ONE BAND	TWO BAND
Chilled water pumps	Oriental Blue F22	-	-
Chilled water pipes	Brilliant Green H10	Oriental Blue F22	-
Condenser water pumps	Oriental Blue F22	-	-
Condenser water pipes	Brilliant Green H10	Golden Yellow B49	Flag Orange B20
Air handling units	Ice Blue F76	-	-
Supply air fans	Strong Blue F11	-	-
Exhaust air fans	Mid Grey G25	-	-
Drains and overflows	Black	-	-
Copper	Cleaned	-	-
Distribution Boards	Electric Orange	-	-
Belt Guards	Red	-	-
Equipment basis	Black	-	-
Exposed air duct flanges and hangers	Same as duct	-	-
Pipe hangers and brackets	Mid Grey G25	-	-

## 24 PROTECTION, ADJUSTMENTS, COMMISSIONING, TESTS AND MAINTENANCE MANUALS

### 24.1 Protection and Cleaning

- 24.1.1 The Contractor shall take all reasonable precautions to protect equipment and materials installed under this contract against damage by other trades from delivery to site to handover.
- 24.1.2 Equipment delivered to site shall be suitably crated, which protection shall only be removed once equipment can be moved into a protected storage area.

- 24.1.3 If equipment cannot be stored in an enclosed storage area, then PVC covering of sufficient strength shall be wrapped around the equipment to eliminate the ingress of moisture and dust. This covering shall be kept in an acceptable condition until the equipment can be moved into a secure and protected area.
- 24.1.4 Internally insulated ducting shall not be stored in the open and shall be stacked in such a way that internal insulation cannot be damaged. Any damaged insulation shall be rectified to the satisfaction of the Engineer prior to the installation of such ducting.
- 24.1.5 Ducting and piping, installed in positions where it is possible that rubble, water, etc, can enter the ducting and piping prior to completion of the duct or pipe system, shall be properly capped with heavy gauge sheet metal fixed to the duct or pipe, and only be removed for the purposes of completing the system.
- 24.1.6 Installation of equipment and materials shall be programmed in such a manner, whilst taking due consideration of the installation of other services and the completion of construction work so as to protect the equipment and materials against possible damage.
- 24.1.7 Damaged equipment and materials shall be rectified to the satisfaction of the Engineer so as to be equivalent to that of the new undamaged product. All damaged surfaces must be repainted to the satisfaction of the Engineer.
- 24.1.8 Equipment and materials shall be properly cleaned and treated to accept paintwork specified under Part IV.56 of this specification.
- 24.1.9 The Contractor shall continuously remove rubble resulting from his sub-contract so as to keep the working space in a tidy and neat condition until handover.
- 24.1.10 Ducts and apparatus casings shall be thoroughly cleaned before fans and filters are put into operation.
- 24.1.11 Water piping systems shall be thoroughly flushed and drained to remove dirt and loose scale prior to chemical treatment and testing of the equipment. Water strainers shall be regularly removed and cleaned during commissioning until the water system is in a satisfactory clean condition.
- 24.1.12 Surface conduits and pipe work on floors of service areas must be suitably protected during the construction time to prevent damage to protective surfaces as a result of people and equipment moving in and out of such areas.
- 24.1.13 Storage areas must be kept clean and tidy and excess combustible and other packing materials must continuously be removed from such rooms.
- 24.2 Adjustments and Commissioning**
- 24.2.1 Commissioning of equipment and systems shall not be undertaken if damage to the equipment, systems or the building could result due to incomplete and incorrect installation work.
- 24.2.2 Commissioning procedures as stipulated by the suppliers of equipment shall be strictly adhered to.
- 24.2.3 The entire control systems shall be adjusted and placed into operation by the control system specialist contractors. Re-adjustments necessary to accomplish the specified results shall be carried out at no additional cost during commissioning and up to formal handover to the Employer.
- 24.2.4 The commissioning of specialised equipment such as refrigeration machines, boilers, vacuum pumps, air compressors, etc, shall be undertaken by an approved specialist and/or specialist contractors.
- 24.2.5 Water circulating systems shall be adjusted and balanced so that water quantities circulated through condensers, coolers, coils, towers, etc. will be as specified. Tolerances of -5% and +10% shall normally be acceptable but shall be clarified with the Engineer in writing prior to commissioning.

- 24.2.6 Air duct systems shall be adjusted and balanced so that air quantities at outlets are as specified and so that distribution from supply outlets is free from drafts and uniform over the face of each outlet.
- The entire air distribution system shall be adjusted and balanced in accordance with the "Manual for the Balancing and Adjustment of Air Distribution Systems" as compiled by SMACNA Bulletin AIA File No 30-D-4.
- Air quantities specified for fans include for duct leakage of 2,5%. The sum of air quantities of all outlets shall normally be acceptable at a tolerance of -5% and +10% of that specified for the fans.
- The air quantities at individual outlets in a single space shall be accepted at a tolerance of -10% and +15%, as long as the total air supplied to that space is within a tolerance of -5% and +10%.
- 24.2.7 Water and airflow quantities shall not be reduced by artificially increasing the system's resistance by more than 5% of the total system resistance.
- 24.2.8 Chilled water systems shall be fully commissioned and adjusted to the design flow requirements, shall be free of air and excessive dirt and shall have the specified water treatment in working order before refrigeration equipment is commissioned.
- 24.2.9 Chilled water, hot water and condenser water systems shall not remain in operation for a period of more than 7 days without the specified water treatment systems being in a proper functioning condition.
- If the Contractor fails to comply with the above requirement, then the Contractor shall at no extra cost to the contract open up all heat exchanging equipment and clean out to the satisfaction of the Engineer.
- 24.2.10 All safety protection systems shall be fully commissioned and set points properly checked and adjusted before equipment shall be allowed to run for commissioning purposes. The responsible commissioning engineer shall be present to supervise the operation and adjustment of the equipment during the entire commissioning stage.
- 24.2.11 Water flow quantities shall be determined by a combination of the following:
- Pressure differential over-heat exchanging equipment
  - Orifice plates
  - Calibrated balancing valves
  - Pressure differential over pump
  - Pump power consumption
- 24.2.12 Airflow quantities shall be determined by a combination of the following:
- Airflow reading over filter or damper
  - Airflow reading over coil
  - Pressure differential over fan
  - Main supply air duct pitot tube reading
  - Diffuser or supply air grille quantities measured with an adapter base fitted over the outlets
  - Fan power consumption
- 24.2.13 All instrumentation required to measure flows, shall be provided by the Contractor.
- 24.2.14 All commissioning data shall be fully tabulated in conjunction with the design data and submitted to the Engineer prior to any performance inspections being carried out by the Engineer.
- 24.2.15 Measured and design air quantities shall be shown on schematic duct drawings prepared on a size A4 paper. In the case of variable volume systems, the measured flow rates for maximum conditions shall be indicated. The minimum condition shall be indicated for the overall system to verify fan performance.

### **24.3 Tests**

- 24.3.1 Where the Engineer is to witness tests, the Contractor shall ensure that the Engineer receives one week's prior notice in writing before such tests commence. Tests to demonstrate the capacity specified and general operating characteristics of all apparatus, etc. shall be made under the direction of the Engineer at time of final inspection under conditions imposed by him.
- 24.3.2 All field assembled refrigeration piping and apparatus shall be pressure tested in accordance with the stipulations of the American Standard Safety Code for mechanical refrigeration.
- 24.3.3 Field assembled refrigerating equipment shall be tested under vacuum and shall show no evidence of leakage with an absolute pressure of 5 mm mercury, sustained for a period of one hour without pumping.
- 24.3.4 Leaks in pipe joints shall be corrected by remaking the joints. Caulking will not be permitted.
- 24.3.5 The vacuum test shall follow the pressure test. Charging of the equipment with refrigerant shall follow the vacuum test as closely as is practicable to minimise the possibility of air or moisture being returned to the system. After charging and prior to capacity tests, joints in refrigerant piping and apparatus shall be checked with a halide torch or other equally sensitive leak detector. If leaks are found, the system shall be pumped down and the leaks corrected as specified above.
- 24.3.6 Water piping shall be tested with water pressure of not less than 700 kPa or 1,5 times the maximum working pressure, whichever is greater, at the lowest point in the system. Care shall be taken to avoid putting excessive pressures on mechanical seals, safety devices, etc. The system shall be filled and all air vented at least 24 hours before the actual test pressure is applied. Test pressure shall be applied when water and average ambient temperatures are approximately equal and constant. The pressure shall be maintained for not less than 30 minutes without appreciable drop after the force pump has been disconnected. Leaks in screwed fittings shall be corrected by remaking the joints. Leaks in welded joints shall be cut out and re-welded. Caulking of leaks will not be permitted.
- 24.3.7 Compressed air piping (except low pressure control piping) shall be tested at not less than 1000 kPa. This pressure shall be maintained for one hour without pumping. A correction of the final pressure of not more than 12,5 kPa for each 3°C change in average ambient temperature during the test will be permitted. Leaks shall be corrected as specified for water piping.
- 24.3.8 Capacities of refrigerating machines, cooling towers, pumps, heating and cooling coils, fans and other equipment shall be determined by operating tests of not less than 4 hours duration, after stable conditions have been established. Test procedures shall be in accordance with applicable portions of ASME and other generally recognised test codes as far as field conditions permit.

### **24.4 Testing of Ducts**

- 24.4.1 All medium and high pressure air ducts shall be tested in accordance with SMACNA ("High Velocity Duct Construction Standards").
- 24.4.2 The Contractor shall include for blank-off plates to isolate the main supply duct system from the branch ducts for test purposes. The complete main supply duct system shall be tested.
- 24.4.3 The Contractor shall provide the required test fan and approved instrumentation and the tests shall be witnessed by the Engineer.
- 24.4.4 The first completed branch duct from the main supply duct to the supply air diffusers shall be pressure tested while witnessed by the Engineer. The Contractor shall allow for the closing off of spigots.
- 24.4.5 All other branch ducts shall be visually inspected by the Engineer, and if found to be of the same standard of workmanship as the first branch duct tested and approved by the Engineer, no further testing will be done. If not, then the Contractor shall test such other supply ducts to the same standard.

24.4.6 Ducts classified as "low pressure ducts" shall only be visually inspected by the Engineer.

24.4.7 All test instruments shall be provided by the Contractor.

Test instruments shall be tested for accuracy by an approved laboratory or by the manufacturer and certificates showing degree of accuracy shall be furnished to the Engineer.

Instruments and appliances required for tests shall be furnished by the Contractor. If gauges, thermometers, etc. which are to be left permanently installed are used for tests, they shall not be installed until just prior to the tests to avoid possible changes in calibration.

24.5 After completion, either in a part or as a whole, the complete installation shall be subject to acceptance tests by the Engineer. The Contractor shall assist the Engineer during any test carried out and shall supply tools and instruments for testing purposes.

- 24.6 The stipulations of the Occupational Health and Safety Act, Act 85 of 1993, as amended, shall be fully complied with. The following clauses are specifically brought to the attention of the Contractor:
- 24.6.1 Vessels under Pressure Regulations. The following are some items covered by these regulations:
- Boilers
  - Evaporators
  - Condensers
  - Heat exchangers
  - Thermal storage vessels
  - Compressed air receiver
- 24.6.2 Driven Machinery Regulations. The following are some items covered by these regulations
- Fans
  - Pumps
  - Air compressors
- 24.7 Recording charts of all tests by Contractor shall be submitted to the Engineer before applying for acceptance inspections.
- 24.8 Maintenance and Operating Manuals**
- 24.8.1 The Contractor shall prepare and submit to the Engineer four complete copies of the comprehensive maintenance and operating manuals for the services installations specified in this document.
- 24.8.2 One draft copy of the manuals shall be submitted to the Engineer at least two months prior to the programmed commissioning starting date for his comments and approval.
- 24.8.3 Four copies of the final approved manuals shall be available prior to any handover inspections taking place.
- 24.8.4 The operating manual shall consist of the following sections:**
- 23.8.4.1 Operations section covering all starting-up and stopping procedures.
- 23.8.4.2 Comprehensive data log sheets to be kept by the Owner.
- 24.8.5 The maintenance manual shall consist of the following sections:**
- 24.8.5.1 General system description.
- 24.8.5.2 General controls description.
- 24.8.5.3 Schedule of plant and equipment listing all model numbers and optional extras and/or modifications included for. This schedule shall include all electrical loads for the equipment.
- 24.8.5.4 All orifice plates, balancing valves, pumps, fans, coils, etc. data.
- 24.8.5.5 Schematic wiring diagrams and equipment ratings.
- 24.8.5.6 Detailed monthly, three-monthly, six-monthly and yearly preventative maintenance instructions.
- 24.8.5.7 Manufacturer's literature indicating lubrication points, lubricants to be used and other data.
- 24.8.5.8 Commissioning data of all equipment and systems indicating in tabulated form the design requirements and the actual measured performance. This section to include size A4 paper,

schematic drawings of air and water systems, listing design and actual flow quantities. Operating points for pumps and fans to be indicated on performance curves.

24.8.5.9 List of equipment suppliers with addresses and telephone numbers.

24.8.5.10 Spare parts list for all equipment.

24.8.5.11 Fault finding procedures.

24.8.5.12 Shop drawing schedule.

24.8.5.13 Coded equipment guarantees.

24.8.6 The maintenance and operating manuals shall be complete with an index and be bound in a suitably identified hard cover binder.

24.8.7 Two complete sets of folded paper prints of all shop drawings shall be submitted in box files together with the manuals. All drawings and files shall be suitably indexed and identified. In addition, one complete set of electronic copies of all shop drawings shall be submitted on computer disk in a format to be specified by the Engineer.

24.8.8 The main distribution board electrical diagram, the chilled, hot and condenser water flow diagrams and the controls schematic shall be suitably framed with Perspex protection and be mounted in the main plant room in a position approved by the Engineer.

**PART 3**

**PROJECT TECHNICAL SPECIFICATION**



## PART 3

## PROJECT TECHNICAL SPECIFICATION

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## PART 3

## PROJECT TECHNICAL SPECIFICATION

## 1 SCOPE OF WORK

- 1.1 The scope of work includes the removal of redundant faulty HVAC equipment, engineering design, manufacture, supply, delivery, installation, commissioning, handing over, guarantee, servicing and maintenance of the new Air-conditioning and Ventilation Equipment for the Kimberley High Court.
- 1.2 The installation comprises the following:
- Air handling units
  - Room type fan coil units
  - VRV heat recovery units
  - Air duct work
  - Electrical work
  - Strip and removal of redundant air-conditioning equipment.

## 2 APPLICABLE DOCUMENTS

- 2.1 The following drawings are applicable to this contract:

DRAWING NO	REV	DESCRIPTION
34280-740-01	0	HVAC LAYOUT GROUND FLOOR
34280-740.02	0	HVAC LAYOUT FIRST FLOOR
34280-740.03	0	HVAC LAYOUT GROUND FLOOR
34280-740-01	Z	AS-BUILD HVAC LAYOUT GROUND FLOOR
34280-740-01	Z	AS-BUILD HVAC LAYOUT FIRST FLOOR
34280-740-03	Z	AS-BUILD HVAC LAYOUT SECOND FLOOR

VRV SYS NO	REV	DESCRIPTION
ODU1	0	LATS LAYOUT - VRV SYSTEM 1
ODU2	0	LATS LAYOUT - VRV SYSTEM 2
ODU3	0	LATS LAYOUT - VRV SYSTEM 3

- 2.2 Tenderers attention is specifically drawn to the specified requirements of the following:
- Part 1A: General Conditions for the Supply Delivery, Installation and Commissioning of Mechanical Equipment
  - Part 2B: Standard Technical Specification

**3 BUILDER'S WORK DRAWINGS**

3.1 Not applicable

**4 WORKSHOP DRAWINGS**

4.1 Two copies of all workshop drawings shall be submitted for approval.

4.2 The workshop drawings shall be submitted timeously to comply with the Contractor's programme. A period of 2 weeks shall be allowed for approval of the drawings by the Engineer.

4.3 The contractor shall take note that all workshop drawings approved shall not relieve the contractor of his obligations to comply with the specification.

**5 GENERAL REQUIREMENTS**

**5.1 Site Supervision by contractor**

The contractor is responsible for supervision on this contract. A complete CV of the person responsible for the site supervision shall be submitted to the Engineer. The Engineer may require an interview with the proposed supervisor. The final choice of the supervisor shall not in any way alter the final tender amount on this contract.

The contractor shall replace the supervisor at his own cost if the aforementioned supervisor is unable to perform his duties satisfactorily.

The submission of the supervisor's CV is required only after the contractor has been appointed.

## 5.2 Submissions by Contractor

5.2.1 The Contractor shall take note that all equipment selections approved (or not rejected) by the Engineer shall not relieve the Contractor of his obligations to comply with the specification.

5.2.2 The following information with regards to equipment selections shall be submitted to the Engineer:

- Manufacture, name and model
- Motor capacity
- Power consumption
- Diagrams, tables, and graphs to explain the functioning of equipment, where applicable
- Applicable pamphlets or catalogue information
- Name and address of manufacturer and/or distributor
- Number of years that equipment are available in RSA
- Any other relevant information required by the Engineer.

5.2.3 The above submissions are required after appointment of the Contractor and in accordance with the requirements of the contract programme.

## 5.3 Supports

No supports for the ducting, piping, etc, are shown on the drawings. The Contractor shall allow for sufficient supports or as indicated by the Engineer.

## 5.4 Performance of Systems and Equipment

The systems and equipment layout designed by the Engineer shall conform to his requirements with regards to installation and system performance. This suggests that the performance of the equipment in the system supplied and installed by the Contractor, shall be in accordance with the design and performance figures as published by the manufacturers and/or suppliers.

The efficiency of the design of the specified system is not the responsibility of the Contractor. It is however, the responsibility of the Contractor to ensure that the quality of the workmanship and the installation of the equipment shall conform to the requirements of the Engineer and to the satisfaction of the supplier or manufacturer.

It is furthermore accepted that the Contractor has assured himself that all equipment supplied and installed under this contract shall perform within the given limits, as stated by the supplier/manufacturer, to conform the specification.

## 5.5 Samples

The following samples shall be supplied:

- 5.5.1 One return air grille.
- 5.5.2 One weather louver.
- 5.5.3 Flexible air duct (1m length).
- 5.5.4 Duct hangers and supports.
- 5.5.5 Pipe hangers and supports.
- 5.5.6 All other samples as directed by the Engineer.

The samples will be retained for reference during the contract period.

## 6 DESIGN CONDITIONS AND PARAMETERS

### 6.1 Outside Ambient Conditions

6.1.1	Altitude .....	836m AMSL
6.1.2	Summer Ambient .....	42,0°Cdb/18°Cwb
6.1.3	Winter Ambient .....	0,0°Cdb

### 6.2 Inside Conditions

6.2.1	Summer .....	24°C±1,5°C
6.2.2	Winter .....	20°C±1,5°C

### 6.3 The following noise levels shall not be exceeded:

6.3.1	Offices .....	NR 40
6.3.2	Court Rooms .....	NR 35

6.4 Noise levels generated by mechanical equipment outside the buildings shall not exceed the noise levels as laid down by the local authority. Measures shall be implemented to attenuate the noise to comply with the requirements of the local authority and shall be deemed to form part of the Tender Price.

6.5 The outside noise levels of equipment shall be taken into account when determining inside noise levels.

6.6 Acoustical calculations shall be performed by a specialist. The selection of sound attenuators shall be submitted to the Engineer for examination before the ordering of equipment.

6.7 The specified noise levels shall not be exceeded with all equipment running.

## 7 AIR HANDLING UNITS (AHU)

7.1 The air handling units shall be "**Kit Assembled**" Type units of the horizontal & vertical type, suitable for indoor installations in existing plant rooms, and shall comprise the following main components:

- **Manufacture shall be "HC Heat Exchangers"**
- Casing
- VSD controlled Supply air fan and motor
- Refrigerant R410A cooling / heat coil
- Primary air filters
- Electrical distribution board (DB) mounted on the air handling units
- Ancillary equipment such as refrigerant piping, electrical work, wiring and controls

- 7.2 All air-handling units shall be constant volume units.
- 7.3 Cooling coils shall have aluminium fins and copper tubes and shall be selected for a face velocity of not higher than 2,5m/s.
- 7.4 Coil sections shall be provided with stainless steel drip pans sized to prevent water carry over and piped to the nearest floor drain point. Drip trays shall be extended to catch any condensate droplets from chilled water connecting pipe work.
- 7.5 Drip trays shall be 304 stainless steel thermally insulated on the outside with at least 15 mm thick closed cell insulation.
- 7.6 The air handling units shall each conform to performance requirements as specified in the schedules on the drawings.
- 7.7 Air filters shall conform to the requirements as specified in the schedules on the drawings.
- 7.8 DX coil selection shall conform to the following:

**AHU 1-2 off**

**RDX - 3B - 32 x 2400 x 4R x 10F x 32C - CU R41A**

Tubing	10 1x0.4 mm	Coil Height	812.8 mm	SA	125 m <sup>2</sup>
Fins	0.14 mm	Coil Height	32 "	Vol	21.27 f

**BAROMETER**

Altitude	1196 m
Pressure	87.78 kPa

**AIR**

On-Coil	26.8/16.5 °C
Off-Coil	10.91/9.9 °C
RH On	36.753 %
RH Off	69.06 %
Mass Flow	4.87 kg/s
Volume Flow	4.8 m <sup>3</sup> /s
Face Velocity	2.46 m/s
Pressure Drop	40.29 Pa
Enthalpy On	50.72 KJ/kg
Enthalpy Off	32.05 KJ/kg
Inlet Dew Point	10.79 °C
Inlet HR	0.01 gW/kg
Dehumidification Rate	17.04 kg/hr

**FAN** Duchone

**FLUID** R410A

Evap Temp	6 °C
Superheat	9 K
Charge	3.41 kg
Inlet Quality	20 %
Mass Flow	0.512 kg/s
Volume Flow	13.62 l/s
Tube Velocity	6.27 m/s
Pressure Drop	14.81 kPa

**DUTY**

Capacity	50.83 kW	Server Version	1.0.4.0
Sensible	79.04 kW	Client Version	debug
Latent	11.79 kW		
SHR	0.87		
Coil Condition	DRY/WET		

**AHU 2-2 off**

**RDY - 3B - 34 x 2400 x 4R x 10F x 34C - CU RRAI**

Tubing	10 f x 0.4 mm	Coil Height	883.6 mm	SA	132.51 m <sup>2</sup>
Fin	0.14 mm	Coil Height	34 "	Vol	22.54 l

**BAROMETER**

Altitude	1196 m
Pressure	87.78 kPa

**AIR**

On-Coil	26.8165 °C
Off-Coil	18.88988 °C
RH On	95.753 %
RH Off	80.08 %
Mass Flow	5.12 kg/s
Volume Flow	5.08 m <sup>3</sup> /s
Face Velocity	2.44 m/s
Pressure Drop	39.68 Pa
Enthalpy On	50.73 kJ/kg
Enthalpy Off	32 kJ/kg
Inlet Dew Point	10.79 °C
Inlet HR	0.01 gwt/kg
Dehumidification Rate	18.21 g/s

**FAN** Omron

**FLUID** R410A

Evap Temp	0 °C
Superheat	5 K
Charge	3.65 kg
Inlet Quality	20 %
Mass Flow	0.54 kg/s
Volume Flow	14.37 dm <sup>3</sup> /s
Tube Velocity	6.22 m/s
Pressure Drop	14.84 kPa

**DUTY**

Capacity	95.82 kW		
Sensible	83.31 kW		
Latent	12.51 kW	Server Version	1.0.4.0
SHR	0.67	Client Version	debug
Coil Condition	DRYWET		

**AHU 3- 2 off**

**RDX - 3B - 32 x 2400 x 4R x 10F x 32C - CU R/AI**

Tubing	10.1x0.4 mm	Coil Height	812.8 mm	SA	125 m <sup>2</sup>
Fin	0.14 mm	Coil Height	32 "	Vol	21.22 l

**BAROMETER**

Altitude	1196 m
Pressure	87.78 kPa

**AIR**

On-Coil	26.8/16.5 °C
Off-Coil	10.91/9.9 °C
RH On	36.753 %
RH Off	69.06 %
Mass Flow	4.87 kg/s
Volume Flow	4.8 m <sup>3</sup> /s
Face Velocity	2.46 m/s
Pressure Drop	40.28 Pa
Enthalpy On	50.72 KJ/kg
Enthalpy Off	32.05 KJ/kg
Inlet Dew Point	10.79 °C
Inlet HR	0.01 gwt/kg
Dehumidification Rate	17.04 kg/hr

**FAN**

0:none

**FLUID**

R410A

Evap Temp	6 °C
Superheat	5 K
Charge	3.41 kg
Inlet Quality	20 %
Mass Flow	0.512 kg/s
Volume Flow	13.62 l/s
Tube Velocity	6.27 m/s
Pressure Drop	14.81 kPa

**DUTY**

Capacity	90.83 kW		
Sensible	79.04 kW		
Latent	11.79 kW	Server Version	1.0.4.0
SHR	0.87	Client Version	debug
Coil Condition	DRYWET		



**AHU 4-2 off**

**RDX - 3B - 38 x 2400 x 4R x 10F x 38C - CU RI/AI**

Tubing	10.1x0.4 mm	Coil Height	965.2 mm	SA	148.44 m <sup>2</sup>
Fin	0.14 mm	Coil Height	38	Vol	25.19 t

**BAROMETER**

Altitude	1196 m
Pressure	87.78 kPa

**AIR**

On-Coil	26.8/16.5 °C
Off-Coil	10.94/9.93 °C
RH On	36.753 %
RH Off	89.06 %
Mass Flow	5.88 kg/s
Volume Flow	5.8 m <sup>3</sup> /s
Face Velocity	2.5 m/s
Pressure Drop	41.4 Pa
Enthalpy On	50.72 kJ/kg
Enthalpy Off	32.1 kJ/kg
Inlet Dew Point	10.79 °C
Inlet HR	0.01 gw/kg
Dehumidification Rate	20.28 kg/hr

**FAN** Oxnone

**FLUID** R410A

Evap Temp	6 °C
Superheat	5 K
Charge	3.98 kg
Inlet Quality	20 %
Mass Flow	0.617 kg/s
Volume Flow	16.42 l/s
Tube Velocity	6.38 m/s
Pressure Drop	15.18 kPa

**DUTY**

Capacity	109.45 kW	Server Version	1.0.4.0
Sensible	95.96 kW	Client Version	debug
Latent	14.09 kW		
SHR	0.87		
Coil Condition	DRY/WET		

AHU 5-7-2 offRDX - 3B - 27 x 1800 x 4R x 10F x 27C - CU R/AI

Tubing	10.1x0.4 mm	Coil Height	665.8 mm	SA	79.1 m <sup>2</sup>
Fin	0.14 mm	Coil Height	27 "	Vol	13.6 l

**BAROMETER**

Altitude	1198 m
Pressure	87.78 kPa

**AIR**

On-Coil	26.8/16.6 °C
Off-Coil	11.12/10.09 °C
RH On	38.753 %
RH Off	89.06 %
Mass Flow	3.06 kg/s
Volume Flow	3.05 m <sup>3</sup> /s
Face Velocity	2.47 m/s
Pressure Drop	40.54 Pa
Enthalpy On	50.72 KJ/kg
Enthalpy Off	32.51 KJ/kg
Inlet Dew Point	10.78 °C
Inlet HR	0.01 gw/kga
Dehumidification Rate	9.54 kg/hr

**FAN** Oxone**FLUID** R410A

Evap Temp	6 °C
Superheat	5 K
Charge	2.26 kg
Inlet Quality	20 %
Mass Flow	0.318 kg/s
Volume Flow	8.46 l/s
Tube Velocity	4.81 m/s
Pressure Drop	6.71 kPa

**DUTY**

Capacity	56.3 kW	Server Version	1.0 4.0
Sensible	49.57 kW	Client Version	debug
Latent	6.73 kW		
SHR	0.88		
Coil Condition	DRYWET		

**8 AIR DUCTWORK**

- 8.1 All ducts shall comply with the requirements of SMACNA.
- 8.2 All ducts are designated "Low Velocity Ducts" and the duct sizes indicated on the drawing shall refer to clear internal dimensions.
- 8.3 Elbows shall be in accordance with SMACNA, page 51. Standard radius elbows shall be used.
- 8.4 Cross joints on all exposed ductwork shall be of the Mez type. All duct joints shall be sealed with an approved duct sealer.
- 8.5 Ductwork supports shall be of the rod and angle type. Sheet metal straps are not permitted.
- 8.6 All duct connections to vibrating equipment shall be via flexible canvas connections. Ducting at flexible connections shall be supported so that ductwork is held square with the adjoining ducting without any stress being imposed on the flexible joint.

- 8.7 All supply and return air ducts and plenums shall be externally insulated. Tenderers attention is specifically drawn to the insulation requirements specified in the Standard Technical Specification applicable to external duct work.
- 8.8 Supply air diffusers shall be of Brian Rickard manufacture, or approved equivalent. Supply air grilles shall be aluminium of the double deflecting type, fitted with an opposed blade damper, similar and equivalent to Europair type DD, or approved equivalent. The diffusers and grilles shall have a white epoxy powder finish.
- 8.9 Return air grilles shall be of aluminium with filter material type, similar to Europair type RAFF, or approved equivalent. The grilles shall have a white epoxy powder finish.
- 8.10 All weather louvers shall be similar to Europair manufacture, or approved equivalent, and shall be aluminium with an epoxy powder finish for the outside conditions, complete with vermin proofing unless otherwise specified on the drawings. The colour of the weather louvers will be confirmed at a later date.
- 8.11 All screws and fastening devices of grilles, louvers, etc, shall be corrosion resistant. Electro-galvanised and chromium plated fastening devices shall not be acceptable.
- 8.12 All flexible ducting shall be Europair Isodec Type 25A insulated flexible ducting, or approved equivalent.
- 8.13 Fire dampers shall be of the bladed type (not motorised) fitted with fusible links. Curtain type fire dampers are not acceptable.

- 8.14 Air filters shall be supplied and installed for fresh air supply systems, in the positions as indicated on the relevant drawings. Air filters shall conform to the requirements as specified in the schedules on the drawings.
- 8.15 Stainless steel 304 ductwork shall be supplied and installed for all air handling systems provided with HEPA filters, as indicated on the drawings.

## 9 FANS

- 9.1 The positions and types of ventilation fans are indicated on the drawings. The fans shall be of AMS, Donkin, Ziehl or Luft manufacture, or approved equivalent.
- 9.2 Fans shall conform to the performance specifications as indicated on the relevant drawings.
- 9.3 Estimated static pressure drops specified are for tender purposes only. The final static pressures shall be determined by the contractor, after all the system components and equipment have been selected.
- 9.4 Fans shall be selected to conform to the specified indoor noise levels. Sound attenuators shall be installed to comply with the specified noise levels. Acoustical calculations shall be performed by a specialist. The selection of sound attenuators shall be submitted to the Engineer for examination before the ordering of equipment.
- 9.5 Fans shall be isolated from the building structure by means of anti-vibration mountings.
- 9.6 Canvas connections shall be installed to prevent vibration carry-over from fans to ductwork or to the building structure.

## 10 ELECTRICAL

- 10.1 The electrical installation shall comply with the requirements of the Standard Technical Specification and the requirements of the local authorities in all respects. On completion of the work, a Certificate of Compliance shall be provided.
- 10.2 The electrical installation shall be designed and supplied by an approved specialist, as part of the Air-conditioning and Ventilation contract. The contractor shall be responsible for the complete electrical installation, is the selection of all equipment of appropriate rating, all as covered under this contract.
- 10.3 The electrical contractor will provide power to the distribution boards (DB's) in the form of a cable. The supply and installation of the DB's complete with all switchgear and protection, as well as all the interconnecting supply and control cables to all the equipment specified under this contract, shall form part of this contract. The connecting of the supply cables to the DB's forms part of this contract.
- 10.4 The electrical contractor will provide power to the distribution boards (DB's) supplied with all the air handling units (including heat recovery air handling units) in the form of a cable. The supply and installation of the distribution board complete with all switchgear and protection for the air handling units, as well as all the interconnecting supply and control cables to all the equipment forming part of that specific air handling system, shall form part of this contract. The connecting of the supply cables to the DB's forms part of this contract.
- 10.5 In the case of fan coil units, remote ventilation fans and other remote mechanical equipment the electrical contractor will provide power up to and including a local isolator adjacent to each unit. The connecting of the equipment to the isolators and the provision of starters and control panels forms part of this contract. Where these fans and mechanical equipment must be

controlled by the BMS (ie start, stop, etc) then all the necessary contactors, relays and switch gear shall be supplied with the control panel and forms part of this contract.

- 10.6 All cabling and wiring in Plant Rooms and in Plant Areas on the roof shall be supported on cable trays, cable ladders and cable ducts. Smaller cabling ie control wires shall be installed in conduits. Conduits installed inside buildings shall be black mild steel and conduits installed externally shall be galvanised mild steel. Cable trays, cable ladders, conduits and wire ways related to this contract shall be supplied and installed as part of this contract.
- 10.7 Conduits required for control wiring shall be recessed in the walls and shall be installed as part of this contract.
- 10.8 The control ie starting and stopping of the fans shall be as indicated in the schedule on the drawing.
- 10.9 Star-delta starters shall be provided for all motors between 7,5 kW and 15 kW. Approved soft starter shall be provided for all motors larger than 15 kW.
- 10.10 The switchgear shall be selected and rated for the following fault levels:
- All other DB's : 10 kA
- 10.11 All the chillers, pumps, compressors, heat pumps shall be provided with power factor correcting capacitors in the DB as part of this contract. These shall be disconnected from the electrical power supply when the associated motor is stopped. The power factor correction system shall be improved to 0,99 with the motor running at full load. All capacitors shall have internal fuses and built-in discharge resistors.
- 10.12 All control cabling, interconnecting electrical supply cables etc, necessary for the proper operation of the equipment specified under this contract, shall form part of this contract. All wiring from the air handling units and fan coil units to remote equipment eg sensors, reheaters, etc, shall form part of this contract.
- 10.13 Electrical panel heaters of the fibre cement type, shall be supplied and installed as part of this contract, as indicated on the drawings. The heaters shall be of a manufacture approved by the Engineer and shall be mounted against brick walls in the positions as indicated on the drawings. The power supplies and control cabling from the respective air handling unit DB's to the heaters, protection, isolators, conduits, chasing of conduits in the brick walls, shall form part of this contract.

- 10.14 Phase failure sequence protection relays shall be arranged to shunt trip the incoming breakers so that on failure, or phase reversing, the plants will stop
- 10.15 Timers shall be of the adjustable electronic type.
- 10.16 Sequence controllers to start plant with a minimum of 20 seconds time delay between each start-up of motors of 3 kW and over shall be provided to avoid heavy current inrush on plant start-up. Sequence controllers shall be of the electronic type, and shall automatically recycle to zero position after power interruption, and on normal plant shutdown.
- 10.17 Pilot lights shall be provided for all pumps, compressors (ice storage air bubbler and heat pumps), air handling unit fans (including heat recovery units), and electrical heaters and shall be of the neon or incandescent type, with round Plexiglass lenses. The colours of the lenses shall be as noted below:
- Indication: Amber
  - Operation: Green
  - Failure or Alarm: Red
- 10.18 Pilot lights shall be grouped in the sequence of operation of the plant components, with amber coloured lamps generally above green lamps, and the red 'failure or alarm' lamps below the respective green 'operation' lamps.
- 10.19 Reset pushbuttons shall be similar in appearance and size to the pilot lights and shall be mounted adjacent to the red failure or alarm pilot lamps on the switch-panels.
- 10.20 The main incoming switch of the DB in the Main Plantroom shall be fitted with a kWh-meter, three Ammeters and one Voltmeter with selector switch.
- 10.21 Kilowatt-hour meters shall have 6 digits and manual reset knob. Above 100 Amp the kWh-meter shall be fitted with current transformers.
- 10.22 Ammeters shall be fitted in the power circuits of all motors of 5 kW and over. Ammeters over 50 Amps shall be operated by current transformers of the ring type. Ammeters shall have an accuracy of 2% of the scale range or better. For non-inductive loads, the scale of ammeters shall not exceed the maximum current drawn by more than 40%. Motor ammeters shall be suitable for the starting current of the motor, and shall have an extended scale in the region of the operating current.
- 10.23 Volt meters shall be provided for all the DB's forming part of this contract and shall be of the moving iron or moving coil type with selector switches.
- 10.24 All indicating instruments shall be of the flush mounted square face pattern with 96 mm dials.
- 10.25 Terminal boards, or blocks, shall be mounted in each DB for all external connections, and shall be so located that they are readily accessible from the front of the DB, and not in the wiring gutter, leaving it completely free for power and control wiring. If terminal blocks are of the split disconnect type, the female part shall be secured to the removable unit cubicle, and the male part shall be free and of a close-pin type. The disconnect type terminal blocks shall be held together with screws or clamps. Terminal strips shall be properly labelled, and panel field wiring shall be marked accordingly by the means of numbered ferrules. Not more than one incoming and one outgoing wire shall be fixed to any one terminal.
- 10.26 Labels showing the unit designations shall be provided adjacent to each of the terminals.

- 10.27 The DB's shall be fully labelled with engraved white ivory labels, having 6 mm high black lettering. The labels shall be fixed securely to the DB cover or chassis plates by means of small, self-tapping screws, to identify all switchgear, relays, instruments and controls, etc., on the face of, or inside the switchpanels.
- 10.28 Equipment operating above 250 Volts shall be fitted also with a red danger label.
- 10.29 Embossed tape or labels fixed with adhesive will not be accepted.
- 10.30 The contractor shall be responsible for marking all switchgear and other equipment on the Wiring Diagrams with the wording of the labels to be used.
- 10.31 All cable terminals shall be clearly identified by permanent labels.
- 10.32 All wires inside, and outside, the switchboard shall be fitted with ferrules, and shall be labelled with identical numbers at both ends.
- 10.33 All terminal numbers and wire identification numbers shall correspond with identical numbers which must be shown on the wiring and control diagrams.
- 10.34 Work tests may be witnessed at the discretion of the Engineer. One week's notice in writing, prior to the date on which they will be ready for inspections, shall be given by the contractor. Three copies of Wiring Diagrams and ladder type schematic diagrams, complete with terminal numbers, shall be sent to the Engineers at least fourteen days before testing can commence. Testing shall be carried out on all completed equipment, including:
- High voltage insulation and insulation resistance tests to earth and between phases.
  - Satisfactory operation of relays shall be proved.
  - Closing and opening operation of all starters and contactors shall be satisfactorily demonstrated.
  - All mechanical interlocks shall be satisfactorily demonstrated.
  - Satisfactory operation of current and voltage instruments.
  - Operation of all control circuits shall be proved by simulating operation of switching devices in the external circuit.
- In addition, all component parts shall comply with the type specified in the SABS or BS Standards.
- The pre-delivery tests are not final acceptance test, and shall not absolve the contractor from his responsibility for the DB's.
- 10.35 All protection devices throughout shall be correctly set by the contractor to the approval of the Engineer. Before any circuit is energised, the data for correct setting shall be established by the contractor.

## 11 CONTROLS PHILOSOPHY

- 11.1 All air handling plants shall be constant volume plants.
- 11.2 The air handling plants shall generally be zone controlled to maintain the room temperatures at  $22^{\circ}\text{C} \pm 1,5^{\circ}\text{C}$  in summer, and  $20^{\circ}\text{C} \pm 1,5^{\circ}\text{C}$  in winter, via 4 averaging room temperature sensors per air handling unit (mounted 1,5m AFFL), which controls the refrigerant modulating control valves.
- 11.3 The room temperatures of the air handling plants as listed below shall be zone controlled via 2 averaging room temperature sensors per air handling unit (mounted 1,5m AFFL), but the indoor temperatures shall be occupant adjustable (one controller per air handling unit):

- Court Rooms : 24°C±1,5°C to 25°C±1°C
  - Offices : 24°C±1,5°C to 25°C±1°C
- 11.4 Air handling units, as indicated in the schedules on the drawings, shall be equipped with variable speed drives (VSD'S) to ensure constant volume air supply under varying pressure (filter clean vs filter dirty) conditions.
- 11.5 All air handling and ventilation systems shall be capable of being started and stopped from the future Building Management System (BMS).
- 11.6 A fire signal will be provided to each HVAC DB . In the event of a fire:
- All air handling systems shall switch off.
  - All supply air ventilation systems shall switch off.
  - All exhaust air fans shall switch off.
  - All heat pumps and associated HVAC plant shall switch off.



## 12 VRF HEAT RECOVERY SYSTEMS

- 12.1 The VRV systems shall conform to the LATS designs that forms part of this contract – see VRV System ODU1, 2 & 3 designs.
- 12.2 The system shall make use of R410A refrigerant, and shall be a 3 pipe system.
- 12.3 Furthermore the VRF system shall conform to the following:

### Efficiency –

#### **Advanced Smart Load Control**

Automatically adjusts system target pressures based on outdoor temperature and humidity for increased cooling performance.

#### **Active Refrigerant Control**

Depending on the operating mode and conditions, the system refrigerant level is automatically adjusted for increased part load and heating efficiency.

#### **Variable Path Heat Exchanger**

Depending on the operating mode and conditions, both the refrigerant flow path and velocity are adjusted for improved efficiency.

#### **Advanced PCB Cooling**

Improved cooling performance of the inverter PCB by using liquid refrigerant instead of heat sink cooling methods.

#### **Inverter Scroll**

Innovative high side-shell design creates a more compact unit providing the same capacity output, with greater reliability in cold climates.

#### **HiPOR™ (High-Pressure Oil Return)**

Oil is returned to the compressor through a separate inlet pipe, ensuring that compressor energy is used to compress refrigerant only.

#### **Smart Oil Control**

Eliminates timed oil-return cycles and takes hours off of the time required to return oil compared to systems that use a timed oil-recovery cycle

#### **Intelligent Heating**

By monitoring the outdoor humidity, system target pressures can be reduced to extend heating operation, delay defrost operation and reduce power consumption.

**13 PAINTING**

- 13.1 No untreated metal surfaces shall be permitted on the project. Items which are not galvanized or suitably protected against corrosion, shall be painted.
- 13.2 All surfaces shall be thoroughly cleaned, descaled and degreased after which an approved zinc rich primer shall be applied.
- 13.3 All visible steel surfaces shall be finished with two coats of quality high-gloss enamel of approved manufacture. The colour will be advised at a later date.

**14 OPERATING AND MAINTENANCE MANUALS**

Four sets of Operating and Maintenance Manuals, incorporating commissioning data and as-built drawings shall be provided. Refer to Parts 1A and 2B.

**15 MAINTENANCE**

- 15.1 The Contractor shall provide free maintenance for a period of 1 year following handover.
- 15.2 The maintenance shall include for all management, labour, materials, lubricating and cleaning materials and transport.
- 15.3 Refer to the Standard Specifications for maintenance requirements regarding water treatment, chillers, etc.
- 15.4 Monthly service reports, signed by the Client's representative, shall be submitted to the Engineer.

**16 SPARES**

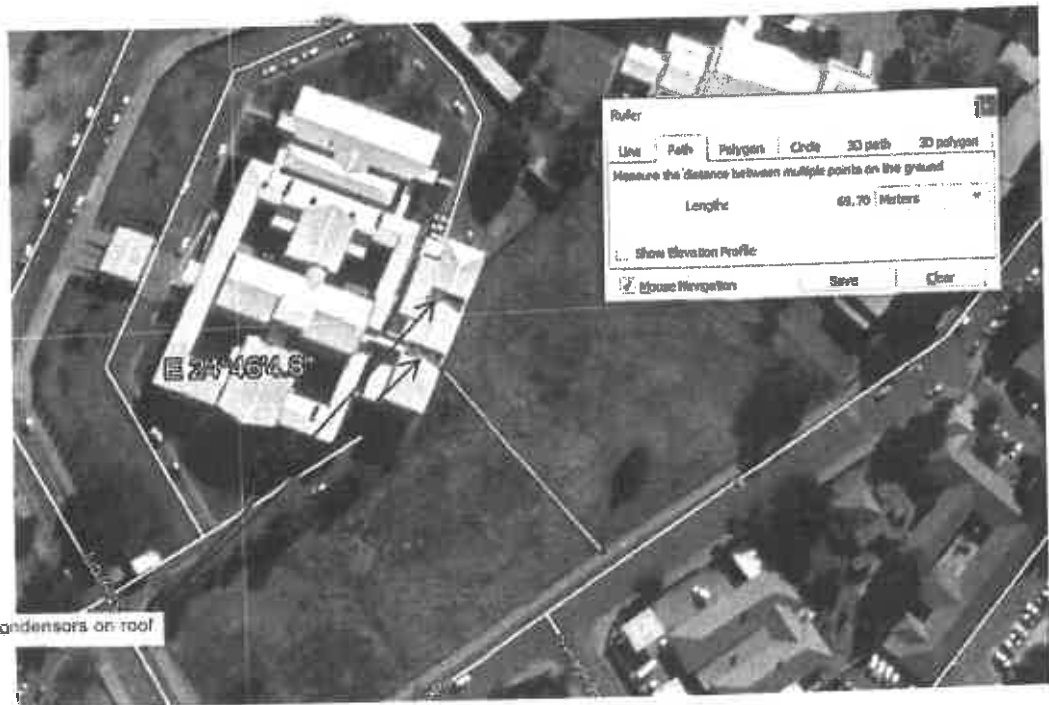
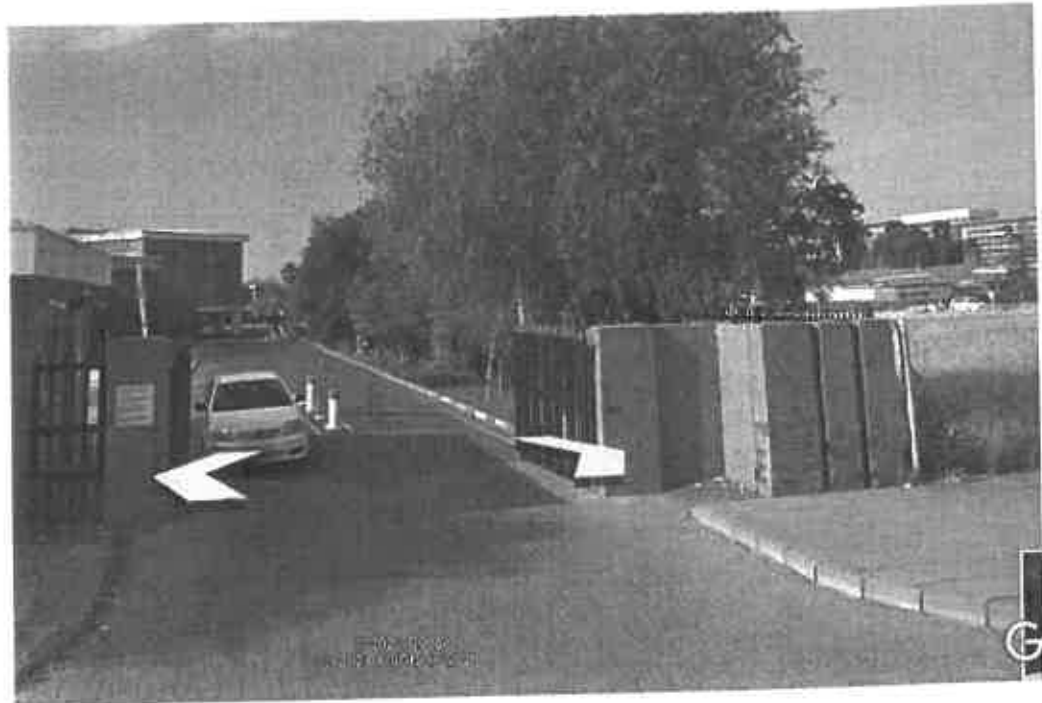
The following spare parts shall be supplied in addition to the requirements specified in Parts 1A and 2B:

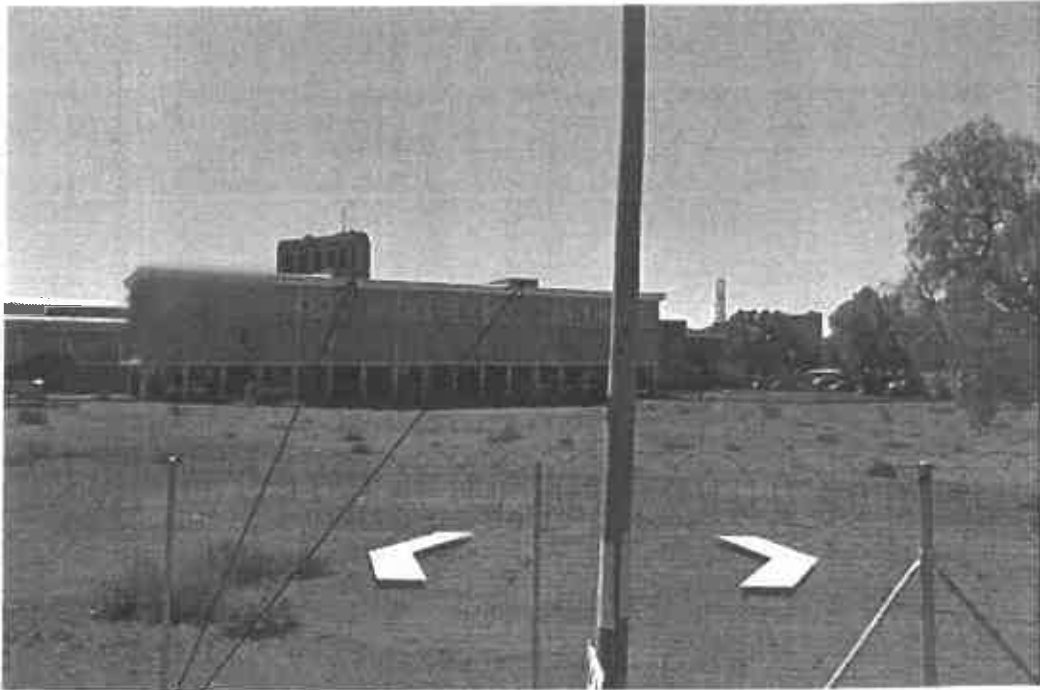
- One complete set of air filters for each air handling (including heat recovery) unit
- One air filter for each fan coil unit

**17 TUITION**

The Contractor shall provide capable instructors to train the client's personnel. These instructors shall be available for a total period of five (5) working days (eight hours per day) after the system has been commissioned and handed over to the Client. The Operating and Maintenance Manuals shall be in possession of the Client before the training commences.

18 Site Photos





Position of plant rooms on roof  
for condensers

# **VRV SYSTEM1 : ODU1**

Date: 2020/12/11



Prepared by: BVi Consulting Engineers

**Customer/Contractor Information**

***Customer***

Name : DPW / DOJ

Address : Chapel Street

City : Kimberley

State/Province : Northern cape

**Contents**

1. Abbreviations
2. Building Load Summary
3. Model Selection - Summary
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5. System Model Section - IDU
6. System Tree Diagram
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8. System Cost Estimate
9. System Type Cost Estimate
10. Project Cost Estimate
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**Abbreviations**

Abbreviations	Description
TC	Total Cooling Capacity
SC	Sensible Cooling Capacity
HC	Heating Capacity
Capacity Ratio(%)	Corrected Capacity / Room Load
PI	Power Input
IDU	Indoor Unit
ODU	Outdoor Unit
DBT	Dry Bulb Temperature
WBT	Wet Bulb Temperature
IAT	Indoor Air Temperature
OAT	Outdoor Air Temperature
EWT	Entering Water Temperature
LWT	Leaving Water Temperature
RH	Relative Humidity
OA	Outdoor Air
RA	Return Air
SA	Supply Air
EA	Exhaust Air
MCA	Minimum Circuit Ampere
MFA	Maximum Fuse Ampere
MOP	Maximum rating of Overcurrent Protective device
FLA	Full Load Ampere
RLA	Rated Load Ampere
EER	Energy Efficiency Ratio
COP	Coefficient of Performance
ESP	External Static Pressure
AFR	Air Flow Rate
EDT	Estimated Discharge Temperature
Qty	Quantity
Liq	Liquid
WxHxD	Width x Height x Depth
H / M / L	High / Middle / Low
CR	Combination Ratio
Freq.	Frequency
Volt	Voltage
CF(%)	Correction Factor (Total Cooling Capacity / Total Rated Cooling Capacity)



## Building Load Summary

1. Project name: Kimberley High Court ODU 1 Project\_20201211
2. Date: 2020/12/11
3. Location : Nation (BLOEMFONTEIN, South Africa), Altitude (1348m)
4. Design conditions

		Cooling	Heating
OAT	DBT(°C)	34.0	-2.2
	WBT(°C)	15.4	-3.0
	RH(%)	13.6	86.0
IAT	DBT(°C)	27.0	20.0
	WBT(°C)	19.0	13.4
	RH(%)	49.2	50.0

### 5. Cooling and Heating Loads

Floor Name	Room Name	Cooling Load(kW)		Heating Load(kW)
		Total	Sensible	
	AC1.10	As shown	Refer to sytem tree	As shown
	AC1.11	As shown	Refer to sytem tree	As shown
	AC1.6	As shown	Refer to sytem tree	As shown
	AC1.7	As shown	Refer to sytem tree	As shown
	AC1.8	As shown	Refer to sytem tree	As shown
	AC1.9	As shown	Refer to sytem tree	As shown
	AC1.5	As shown	Refer to sytem tree	As shown
	AC1.4	As shown	Refer to sytem tree	As shown
	AC1.3	As shown	Refer to sytem tree	As shown
	AC1.2	As shown	Refer to sytem tree	As shown
	AC1.1	As shown	Refer to sytem tree	As shown

**Model Selection - Summary****Date: 2020/12/11****1. Outdoor Units**

No.	Model Name	Quantity	Description
1	ARUM300LTE5		
1.1	ARUM180LTE5	1	50,60Hz/R410A/Heat Recovery/MULTI V 5/Southern Africa
1.2	ARUM120LTE5	1	50,60Hz/R410A/Heat Recovery/MULTI V 5/Southern Africa
<b>Total</b>		<b>2</b>	

**2. Indoor Units**

No.	Model Name	Quantity	Description
1	ARNU15GSJN4	4	Wall Mounted(Standard)
2	ARNU18GSKN4	4	Wall Mounted(Standard)
3	ARNU24GSKN4	3	Wall Mounted(Standard)
<b>Total</b>		<b>11</b>	

**3. Branch/Header**

No.	Model Name	Quantity
1	ARBLB03321	1
2	ARBLB07121	1
3	ARCNB21	1
4	PRHR043	1
5	PRHR063	2

**4. Pipes**

No.	Diameter(Liq:Gas,mm)	Length(m)
1	6.35 : 12.7	55.0
2	9.52 : 15.88	10.0
3	9.52 : 12.7 : 15.88	8.0
4	9.52 : 15.88 : 19.05	3.0
5	9.52 : 19.05 : 22.2	3.0
6	12.7 : 22.2 : 28.58	6.0
7	19.05 : 28.58 : 34.9	15.0

## Model Selection - Summary

Date: 2020/12/11

### 5. Accessories

Index	Model Name	Quantity	Description
IDU	PREMTB001	11	Standard II Wired Remote Controller (White)

## System Model Selection - ODU

System Name: Multi V1

Date: 2020/12/11

System No : 1/1

### 1. Design conditions

	Cooling			Heating		
	DBT(°C)	WBT(°C)	RH(%)	DBT(°C)	WBT(°C)	RH(%)
OAT	34.0	15.4	13.8	-2.2	-3.0	66.0
IAT	27.0	19.0	49.2	20.0	13.4	50.0

### 2. Outdoor Units

Model Name	Maximum Indoor Units	Maximum CR (kW(%))	Current CR(%)	Precharged Refrigerant (kg)	Additional Refrigerant (kg)
ARUM300LTE5	60	134.4(160%)	73.5 %	25.50	12.79

Model Name	Combination
ARUM300LTE5	ARUM180LTE5 + ARUM120LTE5

Rated / Corrected Capa. (kW)		Rated / Corrected Power Input (kW)	
Cooling	Heating	Cooling	Heating
84.0/59.1	94.5/59.6	16.7/8.9	20.2/18.5

Efficiency(W/W)		Weight(kg)	Dimension (WxHxD) (mm)	Electrical Characteristics				
Cooling	Heating			Volt (V)	Phase	Freq. (Hz)	MCA (A)	Breaker (A)
6.6	3.2	(300)*(215)	(1240x1890x700)215*(1820x1890x700)215	380-415	3	50/60	68.2	80

### 3. Pipes

Diameter(Liq;Gas,mm)	Length(m)
6.35 : 12.7	55.0
9.52 : 15.88	10.0
9.52 : 12.7 : 15.88	8.0
9.52 : 15.88 : 19.05	3.0
9.52 : 19.05 : 22.2	3.0

### 4. Branch/Header

Model Name	Quantity
ARBLB03321	1
ARBLB07121	1
ARCNB21	1
PRHR043	1
PRHR063	2

#Notes: Correction factor is corrected by such as, but not limited to, indoor unit combination, temperature, and pipe length. The result can be slightly different from Product Data Book due to simulation.

### System Model Selection - ODU

System Name: Multi V1

Date: 2020/12/11

System No : 1/1

#### 3. Pipes

Diameter(Liq:Gas,mm)	Length(m)
12.7 : 22.2 : 28.58	6.0
19.05 : 28.58 : 34.9	15.0

#### 4. Branch/Header

Model Name	Quantity
-	-
-	-

#Notes: Correction factor is corrected by such as, but not limited to, indoor unit combination, temperature, and pipe length.  
The result can be slightly different from Product Data Book due to simulation.

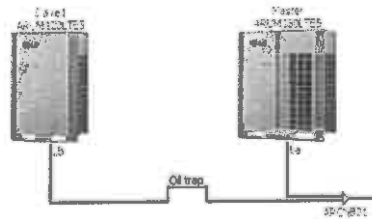
## System Model Selection - ODU

System Name: Multi V1

Date: 2020/12/11

System No : 1/1

### 5. Branch-Branch



Branch-Branch		
Pipe	Diameter(mm)	Length(m)
LA	-	-
LB	-	-

Outdoor Unit-Branch		
Pipe	Diameter(mm)	Length(m)
La	15.88 : 22.2 : 28.58	-
Lb	12.7 : 19.05 : 28.58	-
Lc	-	-
Ld	-	-

Height Difference	
Pipe	Length(m)
Hb (Master-Slave1)	-
Hc (Master-Slave2)	-
Hd (Master-Slave3)	-

#Notes: Height difference is calculated based on master ODU.

## System Model Section - IDU

System Name: Multi V1

Date: 2020/12/11

System No : 1/1

### 6. Indoor Units(1)

Room	Room Load(kW)			IAT(°C)				Model Name	Rated / Corrected Capa.(kW)			Capacity Ratio(%)		
	TC	SC	HC	Cooling		Heating			TC	SC	HC	TC	SC	HC
				DBT	WBT	DBT	WBT							
AC1.1	-	-	-	27.0	19.0	20.0	13.4	ARNU18GSKN4	5.6/5.4	4.0/3.8	6.3/5.4	-	-	-
AC1.10	-	-	-	27.0	19.0	20.0	13.4	ARNU24GSKN4	7.1/6.8	5.0/4.8	7.5/6.9	-	-	-
AC1.11	-	-	-	27.0	19.0	20.0	13.4	ARNU24GSKN4	7.1/6.8	5.0/4.8	7.5/6.9	-	-	-
AC1.2	-	-	-	27.0	19.0	20.0	13.4	ARNU18GSKN4	5.6/5.4	4.0/3.8	6.3/5.4	-	-	-
AC1.3	-	-	-	27.0	19.0	20.0	13.4	ARNU18GSKN4	5.6/5.4	4.0/3.8	6.3/5.4	-	-	-
AC1.4	-	-	-	27.0	19.0	20.0	13.4	ARNU24GSKN4	7.1/6.8	5.0/4.8	7.5/6.9	-	-	-
AC1.5	-	-	-	27.0	19.0	20.0	13.4	ARNU18GSKN4	5.6/5.4	4.0/3.8	6.3/5.4	-	-	-
AC1.6	-	-	-	27.0	19.0	20.0	13.4	ARNU15GSJN4	4.5/4.3	3.2/3.1	5.0/4.3	-	-	-
AC1.7	-	-	-	27.0	19.0	20.0	13.4	ARNU15GSJN4	4.5/4.3	3.2/3.1	5.0/4.3	-	-	-
AC1.8	-	-	-	27.0	19.0	20.0	13.4	ARNU15GSJN4	4.5/4.3	3.2/3.1	5.0/4.3	-	-	-
AC1.9	-	-	-	27.0	19.0	20.0	13.4	ARNU15GSJN4	4.5/4.3	3.2/3.1	5.0/4.3	-	-	-

#Notes: Correction factor is corrected by such as, but not limited to, indoor unit combination, temperature, and pipe length.

The result can be slightly different from Product Data Book due to simulation.

EWT=Entering Water Temperature / LWT=Leaving Water Temperature.

**System Model Section - IDU**

System Name: Multi V1

Date: 2020/12/11

System No : 1/1

**7. Indoor Units(2)**

Tag	Model Name	Type	EDT (°C)		AFR (CMM)	Remark
			Cooling	Heating		
15	ARNU18GSKN4	WALL MOUNTED	13.4	39.2	14.0	NA
1	ARNU24GSKN4	WALL MOUNTED	11.4	42.4	15.2	NA
2	ARNU24GSKN4	WALL MOUNTED	11.4	42.4	15.2	NA
14	ARNU18GSKN4	WALL MOUNTED	13.4	39.2	14.0	NA
13	ARNU18GSKN4	WALL MOUNTED	13.4	39.2	14.0	NA
12	ARNU24GSKN4	WALL MOUNTED	11.4	42.4	15.2	NA
11	ARNU18GSKN4	WALL MOUNTED	13.4	39.2	14.0	NA
5	ARNU15GSJN4	WALL MOUNTED	12.5	40.5	10.5	NA
6	ARNU15GSJN4	WALL MOUNTED	12.5	40.5	10.5	NA
7	ARNU15GSJN4	WALL MOUNTED	12.5	40.5	10.5	NA
8	ARNU15GSJN4	WALL MOUNTED	12.5	40.5	10.5	NA

#Notes: Correction factor is corrected by such as, but not limited to, indoor unit combination, temperature, and pipe length.

The result can be slightly different from Product Data Book due to simulation.

EWT=Entering Water Temperature / LWT=Leaving Water Temperature.



## System Model Section - IDU

System Name: Multi V1

Date: 2020/12/11

System No : 1/1

### 8. Indoor Units(3)

Tag	Model Name	Weight	Dimension (WxHxD)	Electrical Characteristics				
				Volt (V)	Phase	Freq. (Hz)	MCA (A)	FLA (A)
15	ARNU18GSKN4	12.2 kg	975x354x209 mm	220~240	1	50/60	0.65	0.52
1	ARNU24GSKN4	12.2 kg	975x354x209 mm	220~240	1	50/60	0.65	0.52
2	ARNU24GSKN4	12.2 kg	975x354x209 mm	220~240	1	50/60	0.65	0.52
14	ARNU18GSKN4	12.2 kg	975x354x209 mm	220~240	1	50/60	0.65	0.52
13	ARNU18GSKN4	12.2 kg	975x354x209 mm	220~240	1	50/60	0.65	0.52
12	ARNU24GSKN4	12.2 kg	975x354x209 mm	220~240	1	50/60	0.65	0.52
11	ARNU18GSKN4	12.2 kg	975x354x209 mm	220~240	1	50/60	0.65	0.52
5	ARNU15GSJN4	8.4 kg	818x316x189 mm	220~240	1	50/60	0.31	0.25
6	ARNU15GSJN4	8.4 kg	818x316x189 mm	220~240	1	50/60	0.31	0.25
7	ARNU15GSJN4	8.4 kg	818x316x189 mm	220~240	1	50/60	0.31	0.25
8	ARNU15GSJN4	8.4 kg	818x316x189 mm	220~240	1	50/60	0.31	0.25

#Notes: Correction factor is corrected by such as, but not limited to, indoor unit combination, temperature, and pipe length.

The result can be slightly different from Product Data Book due to simulation.

EWT=Entering Water Temperature / LWT=Leaving Water Temperature.

## System Validation Check

System Name: Multi V1

Date: 2020/12/11

System No : 1/1

### 9. System Validation Check - General Condition

Contents	Limit	Current(Max value : connected unit)
Total pipe length	1000.0 m	100.0 m
Longest equivalent pipe length	175.0 m	41.5 m : ARNU18GSKN4[15]
Longest pipe length after 1st branch	40.0 m	23.0 m : ARNU18GSKN4[15]
Height difference [Above: IDU, Below: ODU]	110.0 m	0.0 m
Height difference [Above: ODU, Below: IDU]	110.0 m	3.0 m : ARNU18GSKN4[15]
Height difference [IDU to IDU]	40.0 m	0.0 m : ARNU24GSKN4[1]-ARNU24GSKN4[1]
Longest actual pipe length	150.0 m	38.0 m : ARNU18GSKN4[15]
Height difference [HRU to HRU]	30.0 m	0.0 m
Height difference [HRU to HRU connected in series (same branch)]	5.0 m	0.0 m
Height difference [HRU to IDU]	15.0 m	0.0 m

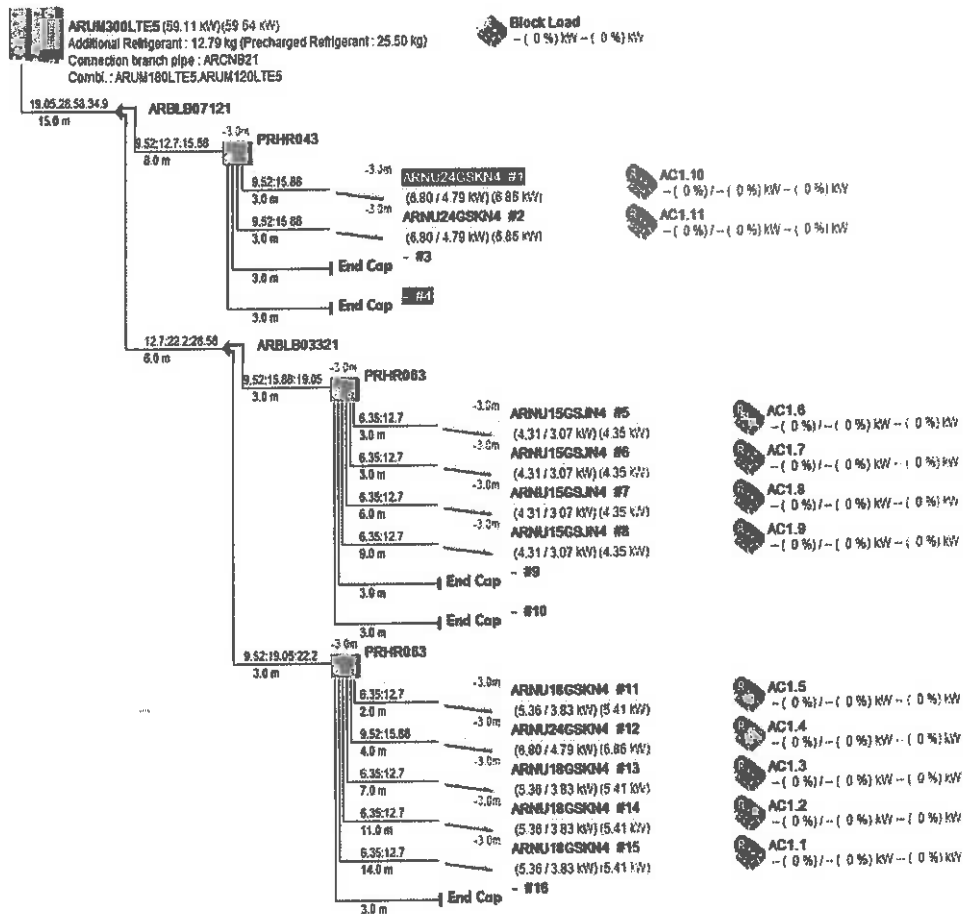
Note : Except "Longest equivalent pipe length", the other pipe length limitations are actual length.

# System Tree Diagram 1

System Name: Multi V1

Date: 2020/12/11

System No : 1/1



\*\*\* : Conditional Application  
 Three pipe : Liquid : High Gas : Low Gas  
 Two pipe : Liquid : Gas

① Remote Controller,    ④ Group Control,    ⑤ Dry Contact  
 ② Leakage Detector,    ③ Temperature Sensor,    ⑥ Air purification kit

Indoor Units : 11 of 66  
 Combination Ratio : 61.7 of 84.6 ( 73%)  
 Total Pipe : 100.0 of 1000.0 m

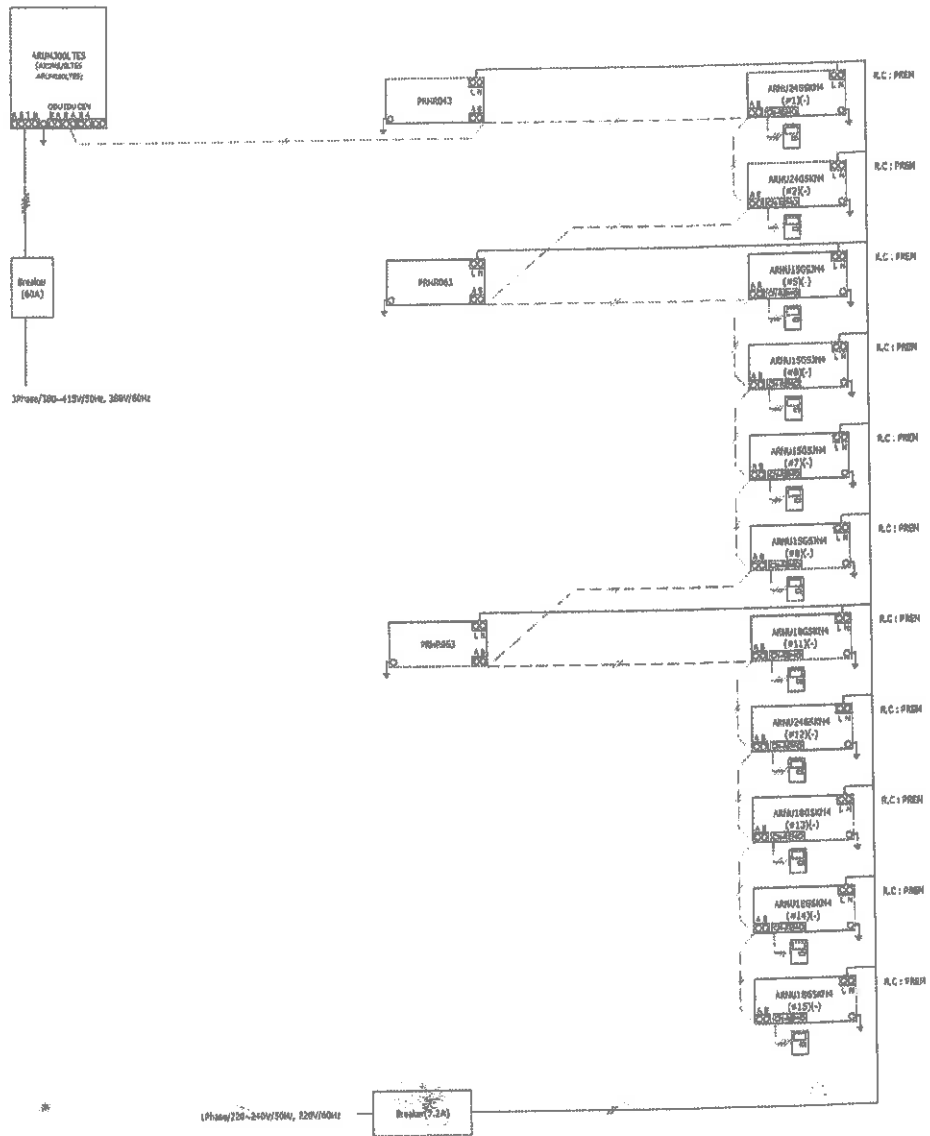
# System Schematic Diagram 1

System Name: Multi V1

Date: 2020/12/11

System No : 1/1

- Power line(Outdoor unit)
- Power line(Indoor unit / HR unit)
- Communication line (ODU-ODU) : VCTF-SB 2C x 1.0 - 1.0 mm<sup>2</sup>
- Communication line (ODU-CDU) : VCTF-SB 2C x 0.75 - 1.5 mm<sup>2</sup>  
\* VCTF-SB 4C x 0.75 - 1.5 mm<sup>2</sup> VQ E2: Simple central controller
- Communication line(Remote controller) : AVT 24 x 3C



# Note  
We recommend one size bigger circuit breaker than the calculated size

## System Cost Estimate

System Name: Multi V1

Date: 2020/12/11

System No : 1/1

Total Cost	0
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### 1. Outdoor Units

Model Name	Quantity	Unit Cost	Total Cost
ARUM120LTE5	1		0
ARUM180LTE5	1		0
<b>Sub Total</b>	<b>2</b>		<b>0</b>

### 2. Indoor Units

Model Name	Quantity	Unit Cost	Total Cost
ARNU15GSJN4	4		0
ARNU18GSKN4	4		0
ARNU24GSKN4	3		0
<b>Sub Total</b>	<b>11</b>		<b>0</b>

### 3. Accessories

Model Name	Quantity	Unit Cost	Total Cost
PREMTB001	11		0
<b>Sub Total</b>	<b>11</b>		<b>0</b>

### 4. Branch/Header

Model Name	Quantity	Unit Cost	Total Cost
ARLB03321	1		0
ARLB07121	1		0
ARCNB21	1		0
PRHR043	1		0
PRHR063	2		0
<b>Sub Total</b>	<b>6</b>		<b>0</b>

### 5. Pipes

Diameter(mm)	Length(m)	Unit Cost	Total Cost
6.35	55.0		0
9.52	24.0		0

## System Cost Estimate

System Name: Multi V1

Date: 2020/12/11

System No : 1/1

### 5. Pipes

Diameter(mm)	Length(m)	Unit Cost	Total Cost
12.7	69.0		0
15.88	21.0		0
19.05	21.0		0
22.2	9.0		0
28.58	21.0		0
34.9	15.0		0
Sub Total			0

### 6. Refrigerant

Refrigerant	Additional Refrigerant(kg)	Unit Cost	Total Cost
R410A	12.79		0
Sub Total			0

**Cost Estimate - MULTI V****Date: 2020/12/11**

Total Cost	
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**1. Outdoor Units**

Model Name	Quantity	Unit Cost	Total Cost
ARUM120LTE5	1		0
ARUM180LTE5	1		0
<b>SubTotal</b>	<b>2</b>		<b>0</b>

**2. Indoor Units**

Model Name	Quantity	Unit Cost	Total Cost
ARNU15GSJN4	4		0
ARNU16GSKN4	4		0
ARNU24GSKN4	3		0
<b>SubTotal</b>	<b>11</b>		<b>0</b>

**3. Accessories**

Model Name	Quantity	Unit Cost	Total Cost
PREMTB001	11		0
<b>SubTotal</b>	<b>11</b>		<b>0</b>

**4. Branch/Header**

Model Name	Quantity	Unit Cost	Total Cost
ARBLB03321	1		0
ARBLB07121	1		0
ARCNB21	1		0
PRHR043	1		0
PRHR063	2		0
<b>SubTotal</b>	<b>6</b>		<b>0</b>

**5. Pipes**

Diameter(mm)	Length(m)	Unit Cost	Total Cost
6.35	55.0		0
9.52	24.0		0
12.7	69.0		0
15.88	21.0		0