



SUBHOLDING
REFINING & PETROCHEMICAL

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GENERAL SPECIFICATION

HVAC SYSTEM FOR BUILDING

ENGINEERING TECHNICAL STANDARDS & PROCEDURES PT KILANG PERTAMINA INTERNASIONAL DIREKTORAT PROYEK INFRASTRUKTUR

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1. INTRODUCTION

- 1.1 This Project Specification covers the minimum requirements for design, fabrication, assembly, supply, inspection, testing, delivery, installation, commissioning and documentation of HVAC System for Building and shall constitute a part of Request for Quotation or Purchase Order.
- 1.2 This Project Specification along with other referenced documents, drawings includes minimum design requirements for the package. The package shall be operationally complete, including all ancillary equipment required to meet the design and environmental conditions as stated in.

2. SCOPE

- 2.1 This specification covers the minimum requirements for the design, materials, fabrication, and inspection of HVAC System for Building. Unless otherwise specified in this specification, HVAC System for Building shall be designed, fabricated, erected, inspected and tested in accordance with ASHRAE Handbook and Air Moving and other standards per Section 6.0.
- 2.2 Where individual standard customer specification or standard and local codes and regulation are most stringent than these specifications they shall be govern.

3. CONFLICTS AND DEVIATIONS

- 3.1 Any conflicts between this standard and other applicable Engineering Technical

1. PENGANTAR


- 1.1 Spesifikasi Proyek ini mencakup persyaratan minimum untuk desain, fabrikasi, perakitan, pemasokan, inspeksi, pengujian, pengiriman, instalasi, *commissioning* dan dokumentasi Sistem HVAC (*Heating Ventilating and Air Conditioning*) untuk Gedung dan harus merupakan bagian dari Permintaan Penawaran atau Pesanan Pembelian.
- 1.2 Spesifikasi Proyek ini bersama dengan dokumen referensi lainnya, gambar termasuk persyaratan desain minimum untuk *package*. *Package* harus lengkap secara operasional, termasuk semua peralatan tambahan yang diperlukan untuk memenuhi desain dan kondisi lingkungan sebagaimana ditetapkan.

2. LINGKUP

- 2.1 Spesifikasi ini mencakup persyaratan minimum untuk desain, material, fabrikasi, dan inspeksi Sistem HVAC untuk Gedung. Kecuali ditentukan lain dalam spesifikasi ini, Sistem HVAC untuk Gedung harus dirancang, dibuat, didirikan, diperiksa dan diuji sesuai dengan *ASHRAE Handbook and Air Moving* serta standar lainnya sesuai *Section 6.0*.
- 2.2 Jika spesifikasi pelanggan standar individu atau standar dan *code* serta peraturan lokal lebih ketat dari spesifikasi ini, maka spesifikasi tersebut harus diterapkan.

3. KONFLIK DAN DEVIASI

- 3.1 Apabila terdapat konflik antara standar ini dengan *Engineering Technical*

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Standards & Procedures (ETSP), or OWNER standard, codes, and forms shall be resolved in writing by OWNER.

Standards & Procedures (ETSP) yang berlaku lainnya, atau standar PEMILIK, codes dan formulir, maka harus diselesaikan secara tertulis oleh PEMILIK.

3.2 All direct requests to deviate from this standard (ETSP) in writing to OWNER, who shall follow internal OWNER procedure and forward such requests to OWNER for approval.

3.2 Semua permintaan penggunaan standar yang berbeda dari standar ini (ETSP), harus diajukan kepada PEMILIK secara tertulis dengan mengikuti prosedur *internal* PEMILIK untuk mendapatkan persetujuan.

4. ABBREVIATIONS


4. SINGKATAN

4.1 Abbreviations used for this specification shall have the following definitions:

4.1 Singkatan yang digunakan pada spesifikasi ini harus memiliki definisi sebagai berikut:

OSBL	Outside Battery Limit
HVAC	Heating Ventilating and Air Conditioning
ODP	Ozone Depletion Potential
GWP	Global Warming Potential
MERV	Minimum Efficiency Reporting Value
ACCU	Air Cooled Condensing Unit
AHU	Air Handling Unit
PAC	Package Air Conditioner
IAQ	Indoor Air Quality
DWDI	Double Width Double Inlet
AC	Air Conditioning
Ac	Alternating Current
DCS	Distributed Control System
DDC	Direct Digital Control
FGS	Fire and Gas System
LFACP	Local Fire Alarm Control Panel

OSBL	<i>Outside Battery Limit</i>
HVAC	<i>Heating Ventilating and Air Conditioning</i>
ODP	<i>Ozone Depletion Potential</i>
GWP	<i>Global Warming Potential</i>
MERV	<i>Minimum Efficiency Reporting Value</i>
ACCU	<i>Air Cooled Condensing Unit</i>
AHU	<i>Air Handling Unit</i>
PAC	<i>Package Air Conditioner</i>
IAQ	<i>Indoor Air Quality</i>
DWDI	<i>Double Width Double Inlet</i>
AC	<i>Air Conditioning</i>
Ac	<i>Alternating current</i>
DCS	<i>Distributed Control System</i>
DDC	<i>Direct Digital Control</i>
FGS	<i>Fire and Gas System</i>
LFACP	<i>Local Fire Alarm Control Panel</i>

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5. DEFINITIONS

5.1 The following words shall have these special meanings when used herein:

OWNER Owner of the Plant is defined as PT Kilang Pertamina Internasional

CONTRACTOR Defined as the Organization to which PT Kilang Pertamina Internasional assign the work

shall Indicates that the statement is mandatory

should Indicates a recommendation

VENDOR Means any and all persons, firms, partnerships, corporation, bodies, entities or a combination thereof including manufacturer, sub-vendors and suppliers, who are providing goods, and the successors and assigns of such persons, firms, partnerships, corporation, bodies, entities or a combination thereof.

5. DEFINISI

5.1 Penggunaan kata-kata berikut akan memiliki arti khusus sebagai berikut:

PEMILIK Pemilik Kilang didefinisikan sebagai PT Kilang Pertamina Internasional


KONTRAKTOR Didefinisikan sebagai Organisasi yang ditunjuk oleh PT Kilang Pertamina Internasional untuk melakukan suatu pekerjaan

shall Menunjukkan bahwa pernyataan itu wajib

should Menunjukkan rekomendasi

VENDOR Berarti setiap dan semua orang, perusahaan, kemitraan, korporasi, badan, entitas atau kombinasinya termasuk pabrikan, sub-vendor dan pemasok, yang menyediakan barang, dan penerusnya dengan penugasan dari orang, perusahaan, kemitraan, korporasi, badan, entitas atau kombinasinya.

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**SUBCONTRACT
OR** Defined as any person or persons, firm, partnership, corporation or combination thereof engaged by Contractor to perform a specific site activity as part of the overall project.

**SUBKONTRAKT
OR** Diartikan sebagai setiap dan semua orang, perusahaan, kemitraan, korporasi, atau kombinasi yang dikontrak oleh Kontraktor untuk melakukan aktivitas pada lokasi tertentu sebagai bagian dari keseluruhan proyek.

SUBVENDOR Defined as any supplier of equipment and support services for a particular piece of equipment/package to a Vendor.

SUBVENDOR Didefinisikan sebagai pemasok peralatan dan servis pendukung untuk peralatan/package tertentu ke Vendor.

6. CODES AND STANDARDS

The following Codes, Standard and Specifications apply to this specification. When an edition date is not indicated for a code or standard or any update in codes and standards in this specification document, the latest edition and addendum in force at the time of purchase shall apply. Material & equipment shall be as a specification or an equal approved by OWNER.

6.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)


ASHRAE Handbook	HVAC Applications
ASHRAE Handbook	Systems and Equipment
ASHRAE Handbook	Fundamentals

6. CODE DAN STANDAR

Code, standar, dan spesifikasi berikut berlaku untuk spesifikasi ini. Code dan standar harus menggunakan edisi yang terbaru atau edisi yang berlaku pada saat pembelian. Material & peralatan harus sesuai spesifikasi atau setara dengan yang disetujui oleh PEMILIK.

6.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

ASHRAE Handbook	<i>HVAC Applications</i>
ASHRAE Handbook	<i>Systems and Equipment</i>
ASHRAE Handbook	<i>Fundamentals</i>

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ASHRAE STD 15	Safety Code for Mechanical Refrigeration	ASHRAE STD 15	<i>Safety Code for Mechanical Refrigeration</i>
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ASHRAE STD 52	Method of Testing General Ventilation Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter	ASHRAE STD 52	<i>Method of Testing General Ventilation Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter</i>
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ASHRAE STD 52.2	Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size	ASHRAE STD 52.2	<i>Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size</i>
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ASHRAE STD 55	Thermal Environmental Conditions for Human Occupancy	ASHRAE STD 55	<i>Thermal Environmental Conditions for Human Occupancy</i>
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ASHRAE STD 62	Ventilation for Acceptable Indoor Air Quality	ASHRAE STD 62	<i>Ventilation for Acceptable Indoor Air Quality</i>
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ASHRAE STD 111	Practice for Measurement, Testing, Adjusting and Balancing of HVAC systems	ASHRAE STD 111	<i>Practice for Measurement, Testing, Adjusting and Balancing of HVAC systems</i>
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6.2	Air Moving Conditioning Volume 4 & 5	6.2	<i>Air Moving Conditioning Volume 4 & 5</i>
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6.3	American National Standards Institute (ANSI)	6.3	<i>American National Standards Institute (ANSI)</i>
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ANSI/ASME B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings	ANSI/ASME B16.22	<i>Wrought Copper and Copper Alloy Solder Joint Pressure Fittings</i>
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6.4	American Refrigeration Institute (ARI)	6.4	<i>American Refrigeration Institute (ARI)</i>
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6.5	National Fire Protection Association Codes (NFPA)	6.5	<i>National Fire Protection Association Codes (NFPA)</i>
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NFPA 1	National Fire	NFPA 1	<i>National Fire</i>
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	Prevention Code		<i>Prevention Code</i>
NFPA 45	Fire Protections for Laboratories Using Chemicals	NFPA 45	<i>Fire Protections for Laboratories Using Chemical</i>
NFPA 90A	Installation of Air Conditioning and Ventilating Systems	NFPA 90A	<i>Installation of Air Conditioning and Ventilating Systems</i>
NFPA 90B	Standard for the Installation of Warm Air Heating and Air Conditioning Systems	NFPA 90B	<i>Standard for the Installation of Warm Air Heating and Air Conditioning Systems</i>
NFPA 101	Life Safety Code	NFPA 101	<i>Life Safety Code</i>
6.6 Sheet Metal Contractors' (SMACNA)	and Air Conditioning National Association (SMACNA)	6.6 Sheet Metal Contractors' (SMACNA)	<i>and Air Conditioning National Association (SMACNA)</i>
SMACNA	HVAC Duct Construction Standards-Metal and Flexible	SMACNA	<i>HVAC Duct Construction Standards-Metal and Flexible</i>
6.7 International Electro-technical Commission (IEC)		6.7 International Electro-technical Commission (IEC)	<i>Electro-technical Commission (IEC)</i>
IEC79-13	International Electro Technical Commission – Construction and use of rooms or buildings protected by pressurization	IEC79-13	<i>International Electro Technical Commission – Construction and use of rooms or buildings protected by pressurization</i>
6.8 American Society for Testing and Material (ASTM)		6.8 American Society for Testing and Material (ASTM)	<i>for Testing and Material (ASTM)</i>
ASTM B88	Standard Specification for Seamless Copper Water Tube	ASTM B88	<i>Standard Specification for Seamless Copper Water Tube</i>
ASTM A525	Standard Specification for General Requirements for	ASTM A525	<i>Standard Specification for General</i>

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Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process

Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process

ASTM C-612 type IB Standard Specification for Mineral Fiber Block and Board Thermal Insulation

ASTM C-612 type IB *Standard Specification for Mineral Fiber Block and Board Thermal Insulation*

ASTM C-553 type II The Standard Specification for Mineral Fiber Blanket Insulation for Industrial Applications

ASTM C-553 type II *The Standard Specification for Mineral Fiber Blanket Insulation for Industrial Applications*

ASTM C-534/C-534M Type II Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation

ASTM C-534/C-534M Type II *Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation*

6.9 Air Movement and Control Association International, Inc (AMCA)

6.9 Air Movement and Control Association International, Inc (AMCA)

In the absence of a specification requirement or a relevant code, the design shall be in accordance with accepted design methods and good engineering practice.

Dengan tidak adanya persyaratan spesifikasi atau *code* yang relevan, desain ini harus sesuai dengan metode desain yang diterima dan *engineering practice* yang baik.

All components and materials covered in this specification shall comply with any statutory regulations, by laws and orders enforced by local authorities.

Semua komponen dan material yang tercakup dalam spesifikasi ini harus mematuhi peraturan perundang-undangan, atas hukum dan perintah yang ditegakkan oleh otoritas setempat.

7. VENDOR QUALIFICATION


7. KUALIFIKASI VENDOR

7.1 VENDOR shall have experienced in the design and manufacture of HVAC System for Building and auxiliaries.

7.1 VENDOR harus berpengalaman dalam desain dan pembuatan Sistem HVAC untuk Gedung dan perlengkapannya.

7.2 VENDOR shall have ISO 9001 Quality Management certification within scope

7.2 VENDOR harus memiliki sertifikasi Manajemen Mutu ISO 9001 dalam

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design and manufacture HVAC System for Building equipment which still valid during the project.

- 7.3 *VENDOR* shall comply with applicable standard within this code as listed in section 6.
- 7.4 Equipment and / or any sub-components of the equipment which are prototype shall not be accepted or deployed on the project. Prototype equipment shall not be proposed.
- 7.5 *VENDOR* shall provide sufficient evidence with their bids to demonstrate that the equipment meets these criteria and highlight any aspect of the design that has not been previously implemented with a successful operating record. Any deviations shall require written approval from *OWNER*.
- 7.6 *VENDOR* is listed in *Company Selected Standard* and/or passed selection for this project.

8. GENERAL


- 8.1 All documents, drawings, data sheet, requisition and calculations required by this standard shall use SI units.
- 8.2 HVAC systems shall be designed in accordance with this specification and *ASHRAE Handbook*.
- 8.3 Fresh air requirement to maintain indoor air quality shall be conformed to *ASHRAE Standard 62* (latest edition).
- 8.4 Equipment and material installation shall be designed to provide adequate clearance area to facilitate service, maintenance and repair or

ruang lingkup desain dan pembuatan Sistem HVAC untuk peralatan Gedung yang masih berlaku selama proyek.

- 7.3 *VENDOR* harus mematuhi standar yang berlaku dalam *code* ini sebagaimana tercantum dalam bab 6.
- 7.4 Peralatan dan/atau setiap sub-komponen peralatan yang merupakan prototipe tidak boleh diterima atau dipasang di proyek. Peralatan prototipe tidak boleh diusulkan.
- 7.5 *VENDOR* harus memberikan bukti yang memadai pada penawarannya untuk menunjukkan bahwa peralatan memenuhi kriteria ini dan menyatakan setiap aspek desain yang belum pernah diterapkan sebelumnya dengan catatan operasi yang berhasil. Setiap deviasi harus memerlukan persetujuan tertulis dari *PEMILIK*.
- 7.6 *VENDOR* terdaftar dalam *Company Selected Standard* dan/atau lulus seleksi untuk proyek ini.

8. UMUM

- 8.1 Semua dokumen, gambar, *datasheet*, permintaan dan perhitungan yang dipersyaratkan oleh standar ini harus menggunakan satuan SI.
- 8.2 Sistem HVAC harus dirancang sesuai dengan spesifikasi ini dan *Handbook ASHRAE*.
- 8.3 Persyaratan udara bersih untuk menjaga kualitas udara dalam ruangan harus sesuai dengan *ASHRAE Standard 62* (edisi terakhir).
- 8.4 Instalasi peralatan dan material harus dirancang dengan menyediakan area pembersihan yang memadai untuk memfasilitasi servis, pemeliharaan dan

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replacement of components.

- 8.5 All HVAC systems shall be designed to meet the noise limits imposed by the project specifications. Sound attenuators, internal insulation or other means may be provided to meet noise limit criteria.
- 8.6 A disconnect switch shall be located within sight of and readily accessible from air conditioning equipment. The disconnect switch shall be permitted to be switch shall be located on a wall or column for equipment located both indoor and outdoor.
- 8.7 Equipment or materials which are not specified in this specification, or the individual equipment specifications listed shall require approval by OWNER before their use in the HVAC Systems.

9. DESIGN BASIS


- 9.1 Outdoor design condition
Outdoor design condition for HVAC systems shall refer to respective project Basic Engineering Design Data (BEDD).
- 9.2 Indoor design condition
Indoor design condition shall be complying with recommendation of the ASHRAE handbook, applicable and safety codes and equipment manufacturer requirement.
- 9.3 Design for room positive pressure
Several building shall be designed with positive pressure to prevent ingress of hazardous gases/dust or outdoor humid air.
- 9.4 Design Load Calculation
9.4.1. General Requirements
- HVAC cooling load calculations shall be in accordance with

perbaikan atau penggantian komponen.

- 8.5 Semua sistem HVAC harus dirancang memenuhi batas kebisingan yang ditetapkan oleh spesifikasi proyek. Peredam suara, insulasi internal atau cara lain dapat disediakan untuk memenuhi kriteria batas kebisingan.
- 8.6 Sakelar pemutus harus ditempatkan dalam jarak pandang dan mudah dijangkau dari peralatan AC. Sakelar pemutus yang diizinkan untuk dipasang harus ditempatkan pada dinding atau kolom untuk peralatan yang terletak baik di dalam maupun di luar ruangan.
- 8.7 Peralatan atau bahan yang tidak ditentukan dalam spesifikasi ini, atau spesifikasi peralatan individual yang tercantum harus memerlukan persetujuan PEMILIK sebelum digunakan dalam Sistem HVAC.

9. DASAR DESAIN

- 9.1 Kondisi desain luar ruangan
Kondisi desain luar ruangan untuk sistem HVAC harus mengacu pada *Basic Engineering Design Data (BEDD)* masing-masing proyek.
- 9.2 Kondisi desain dalam ruangan
Kondisi desain dalam ruangan harus sesuai dengan rekomendasi dari ASHRAE *handbook*, *code* keselamatan yang berlaku dan persyaratan peralatan pabrik.
- 9.3 Desain untuk ruangan bertekanan positif
Beberapa gedung harus dirancang dengan tekanan positif untuk mencegah masuknya gas/debu berbahaya atau udara lembab dari luar ruangan.
- 9.4 Perhitungan Beban Desain
9.4.1. Persyaratan Umum
- Perhitungan beban pendinginan HVAC harus

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ASHRAE handbook methods and shall not include more than 10% overall excess capacity due to safety factors or reserve capacity requirements.

- HVAC cooling load calculations shall be performed according to maximum outdoor design condition.
- Calculations shall be computer generated for example using Carrier E20-II Hourly Analysis Program or similar.
- Overall building cooling loads shall be calculated. Zoning, exposure and building mass shall be considered in cooling calculations. The air conditioning systems shall provide comfort conditions in all the room throughout the operating periods. Each zone, room orientation and sensible load shall be calculated.

9.4.2. Cooling Loads


- Cooling load shall be calculated at summer design dry bulb and mean coincident wet bulb temperatures and the supply air requirements shall be determined at these temperatures.
- HVAC Load calculations shall contain the following

sesuai dengan metode ASHRAE *handbook* dan tidak boleh mencakup lebih dari 10% kelebihan kapasitas keseluruhan karena persyaratan faktor keamanan atau kapasitas cadangan.

- Perhitungan beban pendinginan HVAC harus dilakukan sesuai dengan kondisi desain luar ruangan maksimum.
- Perhitungan harus dengan program komputer misalnya menggunakan Program *Carrier E20-II Hourly Analysis* atau yang serupa.
- Beban pendinginan gedung secara keseluruhan harus dihitung. Zonasi, eksposur dan massa gedung harus dipertimbangkan pada perhitungan pendinginan. Sistem pengkondisian udara harus menyediakan kondisi kenyamanan di semua ruangan selama periode operasi. Setiap zona, orientasi ruangan dan beban *sensible* harus dihitung.

9.4.2. Beban Pendinginan

- Beban pendinginan harus dihitung pada desain *temperature dry bulb* musim panas dan temperatur tepat pada *mean temperature wet bulb* serta kebutuhan pasokan udara harus ditentukan pada temperatur ini.
- Perhitungan Beban HVAC harus memuat informasi

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information as a minimum:

- a) Wall, window and roof U-factor number.
- b) Wall, window and roof areas and orientations.
- c) Electrical load input data such as equipment and lighting.
- d) Outside condition of the air (wet bulb and dry bulb temperatures).
- e) Exhaust air quantities for the space (zone) served by the HVAC system.
- f) Entering and leaving coil conditions (wet bulb and dry bulb temperature).
- g) Total system supply air quantity.
- h) Supply air quantity to each of the rooms served by the HVAC system.
- i) Total sensible coil load and space (zone) sensible load.

- Load calculations shall consider all sensible and latent heat sources.


- a) Sensible load shall be calculated for building envelope, people, lights, equipment and for outside air that is introduced into the system by air make-up or by infiltration.

minimal berikut:

- a) Nomor faktor-U dinding, jendela dan atap.
- b) Area dan orientasi dinding, jendela dan atap.
- c) Data input beban listrik seperti peralatan dan penerangan.
- d) Kondisi udara luar (temperatur *wet bulb* dan *dry bulb*).
- e) Kuantitas udara buang untuk ruang (zona) yang dilayani oleh sistem HVAC.
- f) Kondisi masuk dan keluar koil (temperatur *wet bulb* dan *dry bulb*).
- g) Jumlah total sistem pasokan udara.
- h) Pasokan jumlah udara ke setiap ruangan yang dilayani oleh sistem HVAC.
- i) Beban koil *sensible* total dan beban *sensible* ruang (zona).

- Perhitungan beban harus mempertimbangkan semua sumber panas *sensible* dan *latent*.

- a) Beban *sensible* harus dihitung untuk keseluruhan gedung, orang, lampu, peralatan dan untuk udara luar yang dimasukkan ke dalam sistem melalui penambahan udara atau

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dengan infiltrasi.

- b) Latent load shall be calculated for people, outside air and any process in which moisture is given up to the air.

- b) Beban *latent* harus dihitung untuk orang, udara luar dan setiap proses di mana uap air diberikan ke udara.

9.4.3. Psychometric Charts

A psychometrics analysis shall be provided for each air handler with the cooling load calculations. This analysis shall include but not necessarily be limited to:

- a) Mixing temperature of outside and return air streams
- b) Entering air condition at coil
- c) Leaving air condition at coil
- d) Room design condition
- e) Outside design condition
- f) Entering air enthalpy at coil
- g) Leaving air enthalpy at coil.

9.4.3. Grafik Psikometri

Analisis psikometrik harus dilakukan untuk setiap penanganan udara dengan perhitungan beban pendinginan. Analisis ini harus mencakup tetapi tidak terbatas pada:

- a) Pencampuran temperatur aliran udara luar dan balik
- b) Kondisi udara masuk koil
- c) Kondisi udara keluar koil
- d) Kondisi desain ruangan
- e) Kondisi desain luar ruangan
- f) Entalpi udara masuk koil
- g) Entalpi udara keluar koil.

9.5 Design for Indoor Air Quality and Ventilation


The requirement of the make-up air will take into account the following minimum requirements:

- Minimum fresh air quantity shall be according to ASHRAE 62 latest edition.
- Minimum requirement for keep room positive pressure in specified building.
- Make up air to substitute the air exhausted by fan in toilet, pantry, battery room, laboratory apparatus and other room where exhaust fan to be installed.

9.5 Desain untuk Kualitas Udara Dalam Ruangan dan Ventilasi

Persyaratan penambahan udara akan memperhitungkan persyaratan minimum berikut:

- Kuantitas udara bersih minimum harus sesuai dengan ASHRAE 62 edisi terbaru.
- Persyaratan minimum untuk menjaga tekanan positif ruangan di gedung tertentu.
- Penambahan udara untuk menggantikan udara yang dikeluarkan oleh fan di toilet, *pantry*, ruang baterai, peralatan laboratorium dan ruangan lain dimana *exhaust fan* dipasang.

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- Air leakage that caused by ex-filtration.
- Kebocoran udara yang disebabkan oleh ex-filtrasi.
- Ventilation rate required in each room.
- Laju ventilasi yang dibutuhkan di setiap ruang.
- Fresh air intakes shall not be located where air contaminants are brought in from sources such as laboratory hood exhausts, vent pipes, vehicle exhausts, and kitchen exhausts. The distance from the air intake to sources of contamination, prevailing wind speed and direction and objects that might influence air flow should be considered in this evaluation.
- Tempat pemasukan udara bersih tidak boleh ditempatkan dimana kontaminan udara dibawa dari sumber seperti udara buang laboratorium, pipa ventilasi, knalpot kendaraan, dan udara buang dapur. Jarak dari tempat pemasukan udara ke sumber kontaminasi, kecepatan dan arah angin yang ada serta benda-benda yang mungkin mempengaruhi aliran udara sebaiknya dipertimbangkan dalam evaluasi ini.
- Fresh air intake system shall be complete with filter unit. The filters consist of pre filter and final filter. Minimum efficiency filter shall be according to the outdoor condition and indoor design condition. ASHRAE Standard 52.2 shall be use as reference.
- Sistem tempat pemasukan udara bersih harus dilengkapi dengan unit filter. Filter terdiri dari pre filter dan final filter. Efisiensi minimum filter harus sesuai dengan kondisi desain luar dan dalam ruangan. Standar ASHRAE 52.2 harus digunakan sebagai referensi.
- All toilets, shower rooms, locker/change rooms and pantry/kitchen shall be exhausted or ventilated.
- Semua toilet, kamar mandi, ruang ganti/penyimpanan pakaian dan *pantry*/dapur harus mengalirkan udara keluar atau berventilasi.
- If wet battery is provided, battery room shall be exhausted or ventilated to limited hydrogen concentration inside battery room. Battery room exhaust shall be taken from a point where air flow circulation takes occur inside battery room.
- Jika baterai basah disediakan, ruang baterai harus mengalirkan udara keluar atau berventilasi hingga konsentrasi hidrogen terbatas di dalam ruang baterai. Tempat pengeluaran udara pada ruang baterai harus terletak pada titik dimana sirkulasi aliran udara terjadi di dalam ruang baterai.

9.6 Electrical Design

- 400 V Ac Distribution Network (MCC/ Distribution Panel)

9.6 Desain Elektrikal

- Jaringan Distribusi 400 V Ac (*MCC*/Panel Distribusi)

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- Voltage: 380 V - 3-phase – 3-wire
Frequency: 50 Hz ($\pm 2\%$) (for motors)
- 230 V Ac Distribution Network (for dampers)
- Power Control System such for thermostat, actuator damper, humidity control and others will be designed and developed within HVAC control.
- Tegangan: 380 V – 3 fase – 3 *wire*
Frekwensi: 50 Hz ($\pm 2\%$) (untuk motor)
- Jaringan Distribusi 230 V Ac (untuk *damper*)
- Sistem Kontrol Daya seperti thermostat, *actuator damper*, kontrol kelembaban dan lain-lain akan dirancang dan dikembangkan dalam kontrol HVAC.

10. HVAC EQUIPMENT DESCRIPTION


10.1 General

- 10.1.1 Refrigerant shall be containing the zero ODP and low GWP. Refrigerant R-22 shall be avoided.
- 10.1.2 HVAC equipment and material shall be suitable for industrial type.
- 10.1.3 HVAC equipment shall be design according to hazardous classification.
- 10.1.4 The main air conditioning system supplied for buildings may be used of the following:
- a) Individual AC system, such as wall mounted AC split, floor standing, cassette and ceiling mounted AC unit.
 - b) Centralized AC system, such as split ACCU-AHU Unit, Rooftop Packaged Unit and Chiller Unit.
 - c) Ventilation Air System consist of pressurized fan, exhaust

10. DESKRIPSI PERALATAN HVAC

10.1 Umum

- 10.1.1.Refrigeran harus mengandung ODP nol dan GWP rendah. Refrigeran R-22 harus dihindari.
- 10.1.2.Peralatan dan bahan HVAC harus sesuai untuk jenis industri.
- 10.1.3.Peralatan HVAC harus dirancang berdasarkan klasifikasi *hazardous*.
- 10.1.4.Sistem pendingin udara utama yang disediakan untuk gedung dapat digunakan sebagai berikut:
- a) Sistem AC individual, seperti AC *split* yang dipasang di dinding, berdiri di lantai, *cassette* dan unit AC yang dipasang di langit-langit.
 - b) Sistem AC Sentral seperti *split ACCU-AHU Unit*, *Rooftop Packaged Unit* dan *Chiller Unit*.
 - c) Sistem Ventilasi Udara dari kipas bertekanan, kipas pengeluaran udara dan

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fan and roof fan.

kipas pada atap.

d) Electric Duct Heater, purpose for room humid control.

d) Pemanas *Electric Duct*, bertujuan untuk mengatur kelembaban udara ruangan.

10.2 Individual AC System

10.2 Sistem AC Individu

10.2.1. Individual AC unit (or Ductless) shall consist of a wall/ceiling/cassette/floor standing mounted evaporator section, matching outdoor condensing section, complete with insulated refrigerant piping, power and control wiring, unit-mounted controls, mounting supplies and condensate piping. Condenser coils shall be constructed of copper tubes and aluminium with gold fin coating.

10.2.1. Unit A/C individu (atau tanpa *duct*) harus terdiri dari bagian *evaporator* yang dipasang di dinding/ langit-langit/ *cassette*/ lantai, disesuaikan dengan bagian kondensasi luar ruangan, lengkap dengan pipa pendingin berinsulasi, *wiring* dari listrik dan kontrol, kontrol yang terpasang di unit, perlengkapan pemasangan dan perpipaan kondensat. Koil kondensor harus dibuat dari *tube* tembaga dan *fin* aluminium dengan lapisan *gold*.

10.2.2. Wall/ceiling/cassette-mounted evaporator section shall be factory assembled and wired, with tangential flow fan and multi-speed motor. Evaporator coil shall consist of enhanced copper tubes and aluminum fins and shall be pressured tested at the factory. Expansion device shall be located at the fan coil unit. Air filter shall be pleated washable type. A condensate pan with anti-corrosion coating and drain shall be provided.

10.2.2. Bagian evaporator yang dipasang di dinding/ langit-langit/ *cassette* harus dirakit dan dipasang di pabrik, dengan kipas aliran *tangential* dan motor *multi-speed*. Koil evaporator harus terdiri dari *tube* tembaga dan *fin* aluminium serta harus diuji tekanan di pabrik. Perangkat ekspansi harus ditempatkan di unit koil kipas. Filter udara harus tipe yang dapat dilipat dan dicuci. *Pan* kondensat dan saluran pembuangan harus dilapisi anti-korosi.

10.3 Centralized AC System


10.3 Sistem AC Sentral

10.3.1. Cabinet & Frame

10.3.1. *Cabinet* dan Rangka

Frame and panels: Provide draw-through air handling unit with

Rangka dan panel: Sediakan hasil akhir standar unit rangka

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frame and panels with standard finish. Panels shall be easily removable for servicing of all equipment contained within the unit without harming gaskets, insulation, or finish surface. Panels of solid double insulated shall not be load bearing and shall be removable without the need to support the unit casing. Galvanizing shall be hot dipped conforming to ASTM A525. Frame shall be of rigid construction, suitable braced and capable of supporting coils, blowers, other required equipment, and accessories.

All doors and panels gaskets shall be high quality bulb type for air-tight seal and shall retain their structural integrity and sealing capability after repeated assembly and disassembly. The air handling unit shall be modular and including components shall be in compliance with NFPA 90A.

10.3.2. Insulation

Duct, plenum and piping for air distribution system shall be insulated according to ASHRAE 90.1.

Manufacturer shall provide a written warranty stating that the air handling unit casing shall not condense water on the exterior of the unit at design conditions. The air handling unit panels shall be removable to allow easy access


dan panel untuk penanganan udara atau *air handling*. Panel harus mudah dilepas untuk memperbaiki semua peralatan yang ada di dalam tanpa merusak gasket, insulasi atau *finish surface*. Panel *solid double insulated* tidak boleh menahan beban dan harus dapat dilepas tanpa perlu menyangga *casing* unit. Galvanisasi harus dilakukan *hot dipped* sesuai dengan ASTM A525. Rangka harus dari konstruksi yang keras, dengan penguat yang sesuai dan mampu menopang koil, blower, peralatan lain yang diperlukan serta aksesoris.

Semua gasket pintu dan panel harus tipe *bulb* berkualitas tinggi sebagai *seal* kedap udara dan harus mempunyai ketahanan struktural dan kemampuan kerapatan yang baik setelah perakitan maupun pembongkaran berulang. Unit *air handling* harus modular dan komponennya harus sesuai dengan NFPA 90.

10.3.2. Insulasi

Duct, plenum dan perpipaan untuk sistem distribusi udara harus dipasang insulasi menurut ASHRAE 90.1.

Pabrikan harus memberikan *warranty* tertulis yang menyatakan bahwa *casing* unit *air handling* tidak mengembunkan air di bagian luar unit pada kondisi desain. Panel unit *air handling* harus dapat dilepas untuk

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inside the unit.

memudahkan akses ke dalam unit.

10.3.3. Evaporator Fan

Forward curved or backward curved DWDI or Airfoil (AF) DWDI Class II centrifugal fan, statically and dynamically balanced. Fan housing shall be heavy gauge galvanized steel construction. Fans shall be provided with grease fittings for lubricating ball bearings and shall be extended to accessible location outside the fan section. Fan motor and drive shall be internally spring isolated on a structural steel base complete with flexible connection.

10.3.3. *Evaporator Fan*

Bentuk lengkungan ke depan maupun ke belakang atau *Airfoil (AF) fan* sentrifugal sesuai DWDI Class II, seimbang secara statis dan dinamis. *Fan housing* harus konstruksi baja dengan *heavy gauge galvanized*. *Fan* harus dilengkapi dengan perlengkapan pelumas gemuk untuk *ball bearing* dan harus menjangkau lokasi yang dapat diakses di luar bagian fan. Motor dan penggerak *fan* harus diisolasi pada bagian dalam struktur baja dengan *flexible connection*.

10.3.4. Motor Fan

Furnished standard 1500 rpm, 50 Hz motor. Motor shall be equipped with ball bearings having an L-10 average bearing life, based on design of 50,000 hours. Motor shall be mounted on adjustable slide based and be vibration isolated from unit's frame. Provide motor starters, overload, disconnect switch etc. unless otherwise specified.

10.3.4. *Motor Fan*


Standar motor dengan putaran 1500 rpm dan frekwensi 50 Hz. Motor harus dilengkapi dengan *ball bearing* yang memiliki umur rata-rata L-10, berdasarkan desain 50.000 jam. Motor harus dipasang pada alas geser yang dapat diatur dan mengisolasi getaran rangka unit. Dilengkapi starter motor, kelebihan beban, sakelar pemutus dan lain-lain kecuali ditentukan lain.

10.3.5. Drive

Rated for 150% of initial connected load, statically and dynamically balance keyed with variable and adjustable pitch cast iron motor sheave. Fan drive and motor kW shall be calculated including the external pressure

10.3.5. Penggerak

Penilaian 150% beban terhubung awal, keseimbangan statis dan dinamis dikunci dengan variabel dan pengaturan *pitch cast iron motor sheave*. Daya kW motor penggerak kipas harus dihitung termasuk adanya penurunan

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drop and wet cooling coil.

10.3.6. Evaporator Coil and Refrigerant Accessories

Direct expansion (DX) coils shall be constructed of seamless copper tubing mechanically expanded into copper fin collars in corrosive environment. For extremely corrosive area, coil shall be factory coated with anti corrosive coating. Copper tubes with aluminum fins allowed only in non corrosive environment. All fins shall be continuous within the coil casing to eliminate carryover inherent with a split fin design. Fins shall be die formed plate type. Headers are seamless copper with die formed tube holes. Connections shall be outside diameter sweat copper and includes a refrigerant distributor. Expansion devices shall be located closed to the coil. Coil section shall be designed and constructed to facilitate removal of coil for maintenance and replacement. Casing shall be die formed channel frame and provided with adequate tube supports to prevent tube sagging or vibrating. Headers and venturi type liquid distributor tubes shall be seamless copper.

Air test coil under water according to VENDOR recommendation


tekanan eksternal dan koil pendingin pada kondisi basah.

10.3.6. Koil Evaporator dan Perlengkapan Refrigeran

Koil *Direct Expansion* (DX) harus dibuat dari *tube* tembaga *seamless* yang diekspansi secara pembentukan mekanis pada *fin collar* tembaga untuk lingkungan korosif. Untuk area yang sangat korosif, koil harus dilakukan *factory coated* dengan lapisan anti korosi. *Tube* tembaga dengan *fin* aluminium hanya diperbolehkan di lingkungan yang tidak korosif. Semua *fin* harus berkesinambungan menyelubungi koil untuk mengeliminasi desain *fin* yang terputus. *Fin* harus tipe *die-formed plate*. *Header* merupakan tembaga *seamless* dengan *die formed*. Sambungan pada diameter luar dan termasuk distributor refrigeran harus dengan tembaga. Perangkat ekspansi harus ditempatkan dekat dengan koil. Bagian koil harus dirancang dan dikonstruksi untuk dapat dilepas guna pemeliharaan dan penggantian. *Casing* harus rangka *channel* dengan *die formed* dan dilengkapi *tube support* yang memadai untuk mencegah *tube sagging* atau bergetar. *Header* dan tube distributor cairan tipe venturi harus tembaga *seamless*.

Pengujian coil menggunakan udara di dalam air harus

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mengikuti rekomendasi
VENDOR.

10.3.7. Filters

Pre filter and Final Filter should refer to Project Specification and Minimum Efficiency Reporting value (MERV) Rating Number.

10.3.7. Filter


Pre-filter dan Final Filter harus mengacu pada Spesifikasi Proyek dan *Minimum Efficiency Reporting Value* (MERV) Rating Number.

10.3.8. Air-Cooled Condensing Unit:

Outdoor-mounted, air-cooled DX condensing unit suitable for on-the-ground and outdoor installation. Unit may have single or dual independent refrigerant circuits and shall consist of single or multiple fully hermetic reciprocating or scroll compressors, air-cooled coils, propeller-type condenser fans, and a control box. Unit shall be used in refrigeration circuit matched with an air handling unit with direct-expansion coils. Factory enclosure shall be all factory wiring, piping, controls, compressors, holding charge, and special features required prior to field start-up. Unit cabinet shall be constructed of galvanized steel and coated with a pre-painted, baked enamel finish. Unit access panels shall be hinged for control box service access. Panels shall be of 16-gauge minimum galvanized steel exterior panels. Galvanizing shall be hot dipped conforming to ASTM A525.

10.3.8. Unit Kondensasi Pendingin Udara

Unit kondensasi DX pendingin udara yang dipasang di luar ruangan cocok untuk pemasangan di lapangan atau tempat terbuka dan di luar ruangan. Unit dapat memiliki sirkuit pendingin independen tunggal atau ganda dan harus terdiri dari kompresor *reciprocating* hermetic atau *scroll* tunggal atau ganda, koil berpendingin udara, kipas kondensor tipe *propeller*, dan *control box*. Unit harus digunakan dalam sirkuit pendingin yang dipasangkan dengan unit *air handling* dengan koil *direct expansion*. Fabrikasinya harus meliputi semua fabrikasi *wiring*, perpipaan, kontrol, kompresor, *holding charge*, dan fitur khusus yang diperlukan sebelum *start-up* lapangan. *Unit cabinet* harus dibuat dari baja galvanis dan dilapisi dengan lapisan *baked enamel* yang telah dicat sebelumnya. Panel akses unit harus berengsel untuk akses servis *control box*. Panel harus dari panel eksterior dengan minimal *16-gauge minimum galvanized*

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steel. Galvanisasi harus dilakukan *hot dipped* sesuai dengan ASTM A525.

10.3.9. Condensor Fan

Condenser fans shall be direct-drive propeller type, discharging air vertically upward. Motors shall be drip proof with permanently lubricated sealed bearings, 3-phase type with class B insulation, unless otherwise specified. Fan blades shall be statically and dynamically balanced. Condenser-fan openings shall be equipped with anti corrosive-coated steel wire safety guards.

10.3.9. Kipas Kondensor

Kipas kondensor harus tipe *propeller* penggerak langsung, menyalurkan udara keluar secara vertikal ke atas. Motor harus *drip proof* dengan bantalan tertutup yang dilumasi secara permanen, tipe 3 fase dengan insulasi kelas B, kecuali ditentukan lain. Bilah kipas harus seimbang secara statis dan dinamis. Buka kipas kondensor harus dilengkapi dengan pelindung pengaman kawat baja berlapis anti korosi.

10.3.10. Compressor

Compressors shall be reciprocating, fully hermetic types, and shall be equipped with operating oil charge, suction and discharge shutoff valves, and a factory-sized crankcase heater to control oil dilution, unless otherwise specified. Compressor shall be mounted on rubber/spring vibration isolators with an isolation efficiency of no less than 95%.

10.3.10. Kompresor


Kompresor harus tipe *reciprocating*, tipe *fully hermetic* dan harus dilengkapi pengisian oli, *shutoff valve* saluran masuk dan keluar serta pemanas bak mesin untuk mengontrol pengenceran oli, kecuali ditentukan lain. Kompresor harus dipasang karet/pegas isolator getaran dengan efisiensi isolasi tidak kurang dari 95%.

10.3.11. Condenser Coil

Condenser coils shall be constructed of aluminum fins with brass coating mechanically bonded to internally grooved, seamless copper tubes which are then cleaned, dehydrated, and sealed.

10.3.11. Koil Kondensor

Koil kondensor harus dibuat dari fin aluminium dengan lapisan emas yang diikat secara mekanis pada tube tembaga *seamless* beralur internal yang kemudian dibersihkan, dikeringkan, dan

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disegel.

10.3.12. Refrigeration Circuit Component

Refrigeration circuit components shall include hot gas muffler, hot gas bypass stub tubes, high-side pressure relief device, liquid line shutoff valve, suction and discharge shutoff valves, gauge ports, charging valves, filter drier, holding charge of refrigerant, and compressor oil. Single-circuit units shall have suction line accumulators.

10.3.13. Filter Dryer

Filter driers shall be provide for refrigerant circuit system. Refrigerant piping, both suction and discharge, shall be suitably insulated.

10.3.14. Control Device

Minimum control functions shall include: compressor short-cycling prevention, capacity control on the lead compressor be by suction cut-off un-loaders in response to compressor suction pressure, and head pressure control for mild ambient temperature operation through fan cycling.

10.3.15. Safety Device

Minimum safety devices shall include: low suction pressure cut-out, condenser fan motors protected against overloads or single-phase condition by internal overloads, low oil pressure cut-out, electrical

10.3.12. Komponen Sirkuit Refrigerasi

Komponen sirkuit refrigerasi harus mencakup knalpot gas panas, *bypass stub tube* gas panas, *high-side pressure relief device*, *liquid line shutoff valve*, *suction* dan *discharge shutoff valve*, *port* pengukur, *valve* pengisian, saringan pengering, tempat pengisian refrigeran dan oli kompresor.

10.3.13. Saringan Pegering

Saringan pengering harus disediakan untuk sistem sirkuit refrigeran. Perpipaian refrigeran, baik pada *suction* maupun *discharge*, harus diinsulasi dengan baik.


10.3.14. Peralatan Kontrol

Fungsi kontrol minimum harus mencakup: pencegahan *short-cycling* kompresor, kontrol kapasitas pada kompresor utama dengan *suction cut-off un-loader* sebagai respons terhadap tekanan hisap kompresor, dan kontrol tekanan *head* pada pengoperasian temperatur lingkungan yang ringan dengan kipas.

10.3.15. Perangkat Keselamatan

Perangkat keselamatan minimum harus mencakup: *low suction pressure cut-out*, motor kipas kondensor yang terlindung dari beban lebih atau kondisi satu fasa oleh beban lebih internal, *low oil*

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overload protection through the use of definite-purpose contactors and magnetic trip circuit breakers, and high discharge pressure cut-out. Low and high discharge pressure cut-outs shall have adjustable pressure settings.

pressure cut-out, electrical overload protection dengan penggunaan *definite-purpose contactor and magnetic trip circuit breaker* dan *high discharge pressure cut-out*. *Low and high discharge pressure cut-out* harus memiliki pengaturan tekanan yang dapat disesuaikan.

10.3.16. Control / Power Panel

The control/power panels located outdoors shall meet IP 55 minimum to provide sufficient protection from sand and dust infiltrations. All cable entries to and from these panels shall go through sealed cable glands and heat shrink. Panel doors shall be equipped with sealing gasket that can sustained Black bulb temperature.

10.3.16. Panel Kontrol Daya

Panel kontrol/daya yang terletak di luar ruangan harus memenuhi minimum IP 55 untuk memberikan perlindungan yang memadai dari infiltrasi pasir dan debu. Semua kabel masuk dan keluar panel ini harus *sealed cable gland and heat shrink*. Pintu panel harus dilengkapi dengan *sealing gasket* yang dapat menahan temperatur *Black bulb*.

10.3.17. Miscellaneous Equipment

Unit Vibration Isolators: Provide color-coded open spring mount vibration isolators with stiff springs (horizontal stiffness equal to vertical stiffness). The set of vibration isolators shall provide an adequate static deflection to result in an isolating efficiency of 95 %.

10.3.17. Peralatan Lain-Lain

Unit Isolator Getaran: Menyediakan isolator getaran pegas terbuka berkode warna dengan pegas kaku (kekakuan horizontal sama dengan kekakuan vertikal). Set isolator getaran harus memberikan defleksi statis yang memadai untuk menghasilkan efisiensi isolasi 95%.

10.4 Electric Duct Heater


10.4.1. Housing of duct heater shall be hot dipped galvanized steel.

10.4 Pemanas Listrik untuk *Duct*

10.4.1. *Housing* pemanas listrik *duct* harus baja galvanis yang dicelup panas.

10.4.2. Electric duct heat strips shall be

10.4.2. *Strip* pemanas listrik untuk *duct*

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insertion type, finned tubular design, complete with all required safeties and controls. Heaters shall be sized for heating duty for the zone/area requirements.

harus tipe *insertion*, desain *finned tubular*, lengkap dengan semua keamanan dan kontrol yang diperlukan. Pemanas ukurannya harus sesuai dengan *heating duty* untuk persyaratan zona/area.

10.4.3. Heating elements shall consist of a coil, 80% nickel, 20% chromium, Grade A resistance wire, centered in a stainless-steel tube filled with granular magnesium oxide. A stainless-steel fin is helically wound onto the tube.

10.4.3. *Elemen* pemanas harus koil 80% nikel, 20% kromium, kawat resistansi Grade A, yang di ujung-tengahnya tube *stainless-steel* yang diisi dengan magnesium oksida granular. *Fin stainless-steel* dililitkan secara heliks pada tube.

10.4.4. Heaters frames and terminal boxes shall be corrosion resistant steel and the terminal box shall be IP 31 construction, unless otherwise specified.

10.4.4. Rangka pemanas dan kotak terminal harus dari baja tahan korosi dan kotak terminal harus konstruksi IP 31, kecuali ditentukan lain.

10.4.5. Heaters shall be furnished with triple over-temperature protection. Primary protection shall be by disc type and linear, automatic reset thermal cut-out. Linear type manual reset thermal cut-out with back-up contactors (as required) shall be provided.

10.4.5. Pemanas harus dilengkapi dengan *triple over-temperature protection*. Perlindungan utama harus tipe *disc* dan pemutus termal *reset* otomatis linier. Pemutus termal *reset* manual tipe linier dengan kontaktor cadangan (sesuai kebutuhan) harus disediakan.

10.4.6. Heaters shall be provided with the following controls, as a minimum: thermal cut-outs, airflow switch, contactors, fuses, control circuit transformer, and built-in self-acting door interlocked disconnect switch.


10.4.6. Pemanas harus dilengkapi dengan kontrol berikut, minimal: pemutus termal, sakelar aliran udara, kontaktor, sekering, transformator sirkuit kontrol dan sakelar pemutus *built-in self-acting door interlocked disconnect switch*.

10.5 Exhaust Fan

10.5 *Exhaust Fan*

10.5.1. Fan housing shall be galvanized steel sheet and shall be fastened

10.5.1. *Fan housing* harus berupa lembaran baja Galvanis dan harus dirangkai dengan

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with suitable seam or welded.

kelingan atau dilas yang sesuai.

10.5.2. Fan hub and blade shall be made from aluminum or steel. Fabricated plastic blade allows used to corrosive area.

10.5.2. *Hub* dan bilah kipas harus terbuat dari aluminium atau baja. Bilah plastik memungkinkan digunakan untuk area korosif.

10.5.3. Motor shall be isolated from air stream.

10.5.3. Motor harus diisolasi dari aliran udara.

10.5.4. Shaft bearing shall be permanent lubricated, sealed and self alignment.

10.5.4. Bantalan poros harus tipe pelumasan permanen, tertutup dan *self alignment*.

10.5.5. Disconnection switch shall be mounted in fan housing. Thermal overload protection, factory wired shall be provided.

10.5.5. Sakelar pemutus harus dipasang di *fan housing*. Harus menggunakan kabel pelindung kelebihan beban termal.

10.5.6. Exhaust louver continue wave (c/w) and bird screen shall be provided. Both material made from aluminum.

10.5.6. Kisi dan *bird screen* tempat udara keluar harus disediakan. Kedua bahan tersebut terbuat dari aluminium.

10.5.7. If required fans shall be equipped with back draft damper and motorized damper.

10.5.7. Jika diperlukan, kipas harus dilengkapi dengan peredam *draft* belakang dan peredam bermotor.

10.6 Filter

10.6 *Filter*

10.6.1. Housing of filter unit shall be made from hot dipped galvanized steel sheet, other material shall be propose to OWNER for approval.


10.6.1. *Housing* unit filter harus dibuat dari lembaran baja yang dicelup Galvanis panas, material lainnya harus diajukan kepada PEMILIK untuk persetujuan.

10.6.2. Filter unit shall be provided door for maintenance access.

10.6.2. Unit filter harus ada pintu untuk akses pemeliharaan.

10.6.3. Filters installed close to an air inlet should be protected from the weather by suitable louvers. Wire mesh screen size maximum shall be 12 mm.

10.6.3. Filter yang dipasang di dekat saluran udara masuk disarankan dilindungi dari cuaca dengan kisi-kisi yang sesuai. Ukuran kawat mesh saringan maksimum 12 mm.

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10.6.4. Disposable factory fabricated mechanical panel filters shall meet the following requirements:

- Filter media shall be interlaced glass fibers sprayed with non-flammable adhesive.
- Filter Frame shall be cardboard with perforated metal retainer.

10.6.5. Extended surface disposable panel filters shall meet the following requirements:

- Filter media shall be a fibrous material formed into deep V-shaped pleats held by a self – supporting wire grid.
- Filter frame shall be non-flammable cardboard.

10.6.6. All filters shall meet the requirements of UL 900 Class 2 for combustibility and smoke generated as a minimum. Systems serving critical areas carrying flammable gasses may need the additional fire resistance of Class 1 filters.

10.6.7. Filtering efficiencies shall be in accordance with ASHRAE STD 52.2 and ASHRAE HVAC Application Handbook.

10.6.8. Pre-filter shall be refer to ASHRAE 52.1 or MERV Rating in accordance with ASHRAE Standard 52.2.

10.6.9. Final-filter shall be refer to

10.6.4. Saringan merupakan hasil fabrikasi sekali pakai harus memenuhi persyaratan berikut:

- Bahan saringan harus *interlaced glass fibers* disemprot dengan perekat yang tidak mudah terbakar.
- Rangka saringan harus dari karton dengan logam penahan berlubang.

10.6.5. *Extended surface* saringan sekali pakai harus memenuhi persyaratan berikut:

- Bahan saringan harus berupa material berserat yang dibentuk menjadi lipatan berbentuk V dengan tulangan jaringan kawat.
- Rangka saringan harus dari karton yang tidak mudah terbakar.


10.6.6. Semua saringan harus memenuhi persyaratan minimum UL 900 Kelas 2 untuk pembakaran dan asap yang dihasilkan. Sistem untuk area kritis yang membawa gas mudah terbakar memerlukan tambahan Saringan tahan api Kelas 1.

10.6.7. Efisiensi penyaringan harus sesuai dengan ASHRAE STD 52.2 dan ASHRAE HVAC *Application Handbook*.

10.6.8. Pre-filter harus mengacu pada ASHRAE 52.1 atau MERV Rating sesuai dengan Standar ASHRAE 52.2.

10.6.9. Final-filter harus mengacu pada

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ASHRAE 52.1 or MERV Rating in accordance with ASHRAE Standard 52.2.

ASHRAE 52.1 atau MERV Rating sesuai dengan Standar ASHRAE 52.2.

11. DUCT DESIGN

11.1 General

11.1.1. Duct shall be constructed in accordance with SMACNA Duct Construction Standards Latest Edition.

11.1.2. Duct design, reinforcement and joining method shall be in accordance with SMACNA Duct Construction Standards Latest Edition.

11.2 Ductwork

Air distribution systems shall be designed in accordance with ASHRAE Fundamentals Handbook, duct design section. Supply air ductwork shall be designed by equal friction for a maximum pressure drop of 0.8 Pa (gauge) per meter where space conditions allow. Return, general exhaust and outside air duct shall be sized for maximum pressures drop of 0.7 Pa (gauge) per meter where space conditions allow. All ductwork and fittings shall be fabricated in accordance with the latest edition of the SMACNA Duct Construction Standards and based on the design static pressure of the system. Flexible duct shall not be used for or in return or exhaust systems. As a minimum provide the following in ductwork design:

1. Air outlets and inlets shall be shown on the drawings and indicated in the schedules. Manufacturer's standard diffusers, registers and grilles shall be used.

11. DESAIN DUCT

11.1 Umum


11.1.1. *Duct* harus dikonstruksi mengikuti Standar Konstruksi *Duct* SMACNA.

11.1.2. Desain *Duct*, rangka penguat dan metode penyambungan harus mengikuti Standar Konstruksi *Duct* SMACNA Edisi Terbaru.

11.2 Ductwork

Sistem distribusi udara harus dirancang sesuai dengan ASHRAE *Fundamentals Handbook*, bab desain *duct*. Peranan udara suplai harus dirancang dengan gesekan yang sama dengan penurunan tekanan maksimum 0,8 Pa (*gauge*) per meter jika kondisi ruang memungkinkan. Udara kembali, buangan dan udara di luar *duct* harus sama dengan penurunan tekanan maksimum 0,7 Pa (*gauge*) per meter di mana kondisi ruang memungkinkan. Semua peranan udara dan *fitting* harus difabrikasi sesuai dengan Standar Konstruksi *Duct* SMACNA edisi terbaru dan berdasarkan desain tekanan statis dari sistem. Fleksibel *duct* tidak boleh digunakan untuk sistem udara balik atau udara buang. Pada desain *ductwork* minimum dilengkapi hal berikut:

1. Saluran keluar dan masuk udara harus ditunjukkan pada gambar dan ditunjukkan pada daftar. *Diffuser*, *register* dan kisi-kisi standar pabrikan harus digunakan.

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| <ol style="list-style-type: none"> 2. Volume dampers shall be installed in all branches from mains and risers and in the branches to outlets and inlet grille openings. 3. Provide volume dampers ahead of flexible duct serving supply air grilles, registers, and diffusers. 4. Volume dampers at duct take off or at other locations shall be to equivalent gages heavier than the duct. 5. Fresh air intakes shall be designed and located to minimize dust and sand intrusion. 6. Low leakage isolation dampers shall be provided in the outside air intake duct for all buildings provided with gas detection in the outside air duct. The dampers shall close and seal off the outside air intake when the HVAC system is in the re-circulation mode. | <ol style="list-style-type: none"> 2. <i>Volume damper</i> harus dipasang pada semua cabang utama dan anak cabang serta cabang ke keluaran dan masukan kisi-kisi bukaan. 3. Sediakan <i>volume damper</i> di depan fleksibel <i>duct</i> yang melayani kisi-kisi udara suplai register, dan <i>diffuser</i>. 4. <i>Volume damper</i> pada lokasi awal atau di lokasi lain <i>duct</i> harus diatur setara atau lebih. 5. Tempat udara bersih masuk harus dirancang dan ditempatkan untuk meminimalkan pada area bebas debu dan pasir. 6. <i>Low leakage isolation damper</i> harus dipasang pada <i>duct</i> tempat masuknya udara luar pada semua gedung serta dilengkapi dengan deteksi gas. <i>Damper</i> harus menutup erat dari masuknya udara luar ketika sistem HVAC dalam mode resirkulasi. |
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11.3 Insulation

11.3.1. Insulation type for duct work consists of blanket and sheet (fiber board) insulation. Board insulation applied for external insulation for outdoor duct, expose duct and plenum. Board insulation also to be used for lining or internal insulation. Blanket insulation applied to all duct unless as specified for board insulation.

11.3.2. Fiber board insulation shall be comply with ASTM C-612 type IB


11.3.3. Blanket insulation shall be comply with ASTM C-553 type II

11.3 Insulasi

11.3.1. Jenis insulasi untuk untuk *duct* terdiri dari insulasi *blanket* dan lembaran (papan berserat). Insulasi lembaran atau papan diterapkan untuk insulasi eksternal untuk duct luar ruangan, *expose duct* dan *plenum*. Insulasi papan juga digunakan untuk pelapis atau insulasi internal. Insulasi *blanket* diterapkan pada semua *duct* kecuali jika ditentukan insulasi papan.

11.3.2. Insulasi lembaran berserat harus sesuai dengan ASTM C-612 tipe IB.

11.3.3. Insulasi *blanket* harus sesuai dengan ASTM C-553 tipe II.

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11.3.4. Flexible elastomer shall be comply ASTM C-534/C-534M Type II

11.3.4. *Flexible elastomer* harus sesuai dengan ASTM C-534/C-534M tipe II.

11.3.5. Insulation not required for fresh air duct and exhaust duct from toilet, pantry storage etc.

11.3.5. Insulasi tidak diperlukan untuk *duct* udara bersih dan *exhaust duct* dari toilet, dapur dll.

11.3.6. All insulation of duct shall be wrapped with aluminum foil. Aluminum foil shall be double sided, medium weight, fire resistant EVA adhesive-bonded, fully scrim-reinforced, reflective aluminum foil laminate.

11.3.6. Semua insulasi pada *duct* harus dibungkus dengan aluminium *foil*. Aluminium *foil* harus dua sisi, berat sedang, dengan perekat EVA (*Ethylene Vinyl Acetate*) tahan api, *fully scrim-reinforced*, *reflective aluminum foil laminate*.

11.4 Accessories

11.4 Aksesoris

11.4.1. Access Doors

11.4.1. Pintu Akses

- Access doors shall be provided where access is necessary for service or inspection.
- Access doors shall be provided for fire dampers. Access doors for fire dampers shall be provided downstream of the fire damper.

- Pintu akses harus disediakan jika akses diperlukan untuk servis atau inspeksi.
- Pintu akses harus disediakan untuk *fire damper*. Pintu akses untuk *fire damper* harus disediakan di bagian hilir.

11.4.2. Fire Dampers

11.4.2. Fire Damper

- Fire Dampers shall be located per NFPA 90A and local fire code requirements.
- Fire Dampers shall be tested and label with UL 555, fail safe motorize type with thermo electric fusible links for rated 74°C.


- *Fire Damper* harus ditempatkan sesuai NFPA 90A dan persyaratan kode atau standar kebakaran setempat.
- *Fire Damper* harus diuji dan diberi label UL 555, tipe *fail safe motorize* dengan *fusible* termoelektrik untuk nilai 74 °C.

11.4.3. Balancing Dampers

11.4.3. Balancing Damper

Balancing Dampers shall be provided for supply, return, exhaust and fresh air ducts for system balancing. Balancing dampers shall

Balancing Damper harus disediakan untuk suplai, pengembalian, pembuangan dan udara bersih pada *duct*

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be provided for branch duct entries or take-offs from the main duct.

untuk penyeimbangan sistem. Peredam penyeimbang harus disediakan untuk entri saluran cabang atau lepas landas dari saluran utama.

11.4.3. Back Draft Dampers

Back Draft Dampers shall be parallel blade, horizontal orientation, single piece or overlap style.

11.4.4. *Back Draft Damper*

Back Draft Damper harus bilah paralel, orientasi horizontal, bentuk *single* atau tumpang tindih.

11.4.5. Flexible Duct and Connection

- Flexible Connection shall be provided between ductwork and equipment to isolate the duct from the equipment vibrations.
- Flexible connection shall meet the requirements of SMACNA HVAC Duct Construction Standards-Metal and Flexible and compliance with UL 181

11.4.5. Fleksibel *Duct* dan Koneksi

- Koneksi fleksibel harus disediakan antara *ductwork* dan peralatan untuk mengisolasi *duct* dari getaran peralatan.
- Koneksi fleksibel harus memenuhi persyaratan *SMACNA HVAC Duct Construction Standards-Metal and Flexible* serta memenuhi UL 181.

11.4.6. Turning Vanes

Turning vanes shall be applied at short radius elbow or other part as specified on HVAC drawing.

11.4.6. *Turning Vanes*

Turning vane harus diterapkan pada siku radius pendek atau bagian lain seperti yang ditentukan pada gambar HVAC.

12. REFRIGANT PIPING

12.1 Material

12.1.1. Pipe Materials:


- Copper Tubing for Refrigerant pipe: Minimum Type "L", hard drawn temper straight lengths and seamless copper tube ASTM B88.
- Condensate drain pipe shall be

12. PERPIPAAN REFRIGERAN

12.1 Material

12.1.1. Material Pipa

- Tube tembaga untuk pipa refrigeran: Minimum tipe "L", hard drawn temper straight length dan tube tembaga *seamless* ASTM B88.
- Pipa pembuangan kondensat harus menggunakan PVC

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used PVC class AW.

(Polyvinyl Chloride) kelas AW (mampu menahan tekanan hingga 10 kg/cm²).

12.1.2. Fittings:

Wrought Copper Fittings, ANSI/ASME B 16.22, and stream lined pattern.

12.1.2. *Fitting*

Wrought Copper Fittings, ANSI/ASME B 16.22, dan mengikuti pola aliran.

12.1.3. Joining Materials:

Brazing Filler Metals AWS A5.8, Classification BAg-1 (Silver).

12.1.3. Material Penyambung

Brazing Filler Metals AWS A5.8, Classification BAg-1 (Silver).

12.1.4. Insulation:

Flexible close cell expanded electrometric insulation.

12.1.4. Insulasi

Flexible close cell expanded electrometric insulation.

12.2 Valves

12.2 Valve

12.2.1. Ball Valve

Full port welded body with seal cap and Teflon gaskets.

12.2.1. *Ball Valve*

Full port welded body with seal cap dan gasket Teflon.

12.2.2. Solenoid Valves:

Forged brass, with Teflon valve seat, two way straight through pattern and solder end connections refer to ARI 760. Provide manual operator to open valve. Furnish complete with NEMA 1 solenoid enclosure with ½-inch conduit adapter and 220 volt, 50 Hz normally closed holding coil.

12.2.2. *Solenoid Valve*


Kuningan tempa, dengan dudukan valve Teflon, pola dua arah lurus dan sambungan ujung solder merefer ARI 760. Buat operator manual untuk membuka valve. Lengkapi dengan solenoid NEMA 1 dan adaptor saluran ½ inci dan 220 volt, 50 Hz serta koil penahan normally closed.

12.2.3. Thermal Expansion Valves:

Thermostatic adjustable, modulating type size as requirements and factory set for proper evaporator superheat requirements. Valves shall have copper fittings for solder end connections, complete with sensing bulb. A distributor having a side connection for hot gas bypasses line, and external equalizer line.

12.2.3. Thermal Expansion Valve

Thermostatic adjustable, modulating type size sebagaimana dipersyaratkan dan diset dari pabrik sebagai persyaratan evaporator superheat yang tepat. Valve harus memiliki fitting tembaga dengan sambungan solder, lengkap dengan bulb penginderaan. Distributor yang memiliki sambungan samping

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untuk saluran bypass gas panas, dan saluran equalizer eksternal.

12.3 Refrigerant Piping Specialties

12.3.1. Refrigerant piping shall be water tube size hard seamless copper tubing type ACR conforming to ASTM B280 with seamless wrought copper solder type fittings as per ANSI/ASME B16.22.

12.3.2. Moisture/Liquid Indicators (Sight Glass)

34.5 bar maximum operation pressure, 93°C maximum operating temperature, forged brass body, with moisture indicating sight glasses and solder end connections.

12.3.3. Liquid Line driers

34.5 bar maximum operation pressure, steel shell, flange ring and spring, ductile iron cover plate with steel cap screws and wrought copper fittings for solder end connections. Furnish complete with replaceable filter-drier core kit, including gaskets.

12.3 Spesialisasi Perpipaan Refrigeran

12.3.1. Pipa refrigeran harus berupa tube tembaga *hard seamless water tube size* tipe ACR yang sesuai dengan ASTM B280 dengan fitting jenis solder tembaga tempa *seamless* sesuai ANSI/ASME B16.22.

12.3.2. Indikator Embun/Cairan (*Sight Glass*)

Tekanan operasi maksimum 34,5 bar, suhu operasi maksimum 93°C, bodi kuningan tempa, dengan *sight glass* penunjuk kelembapan dengan sambungan *solder*.

12.3.3. Line Pengereng Cairan


Tekanan operasi maksimum 34,5 bar, *shell* baja, *flange ring* dan *spring*, *ductile iron cover plate* dengan sekrup tutup baja dan *wrought copper fitting* dengan sambungan solder. Lengkapi dengan *filter-drier core kit* yang dapat diganti, termasuk gasket.

13. HVAC CONTROL AND INSTRUMENTATION

CONTRACTOR shall design, furnish and install a complete system of operational controls. Furnish a detailed control schematics and wiring diagram showing all electrical connections and control devices. All relays and switches shall be panel-mounted and properly labeled.

13. KONTROL DAN INSTRUMENTASI HVAC

KONTRAKTOR harus merancang, melengkapi dan memasang sistem kontrol operasional yang lengkap. Lengkapi skema kontrol rinci dan *wiring diagram* pengkabelan yang menunjukkan semua sambungan listrik dan perangkat kontrol. Semua relai dan sakelar harus dipasang di panel dan diberi label dengan benar.

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All wiring shall meet Project Specification and International Electrotechnical Commission (IEC) and any local or State code having jurisdiction in the area.

Semua *wiring* harus memenuhi Spesifikasi Proyek dan *International Electrotechnical Commission* (IEC) dan setiap kode lokal atau Negara yang memiliki yurisdiksi di area tersebut.

13.1 Control Panel

All control devices for the HVAC system that are located outdoors shall be housed in IP 55 enclosures and bottom cable entry. Enclosures that are located indoor in an unclassified area shall be IP 42 gasketed. The enclosure/panel shall be designed and pre-wired to provide the following as a minimum:

- Electrical/Electronic control devices for the HVAC system including relays, motor starters, etc. On the face of each control panel, the following instruments and switches shall be provided.
- Start/Stop push-buttons or switches with indicator lights to indicate operation, failure or malfunction of fans, pressures, temperatures, compressor and other HVAC equipment.


A 220 volts ac, 1 phase, 50 Hz (Line to Neutral) from UPS with redundant feeder control power supply shall be furnished to the control panel. Dry contacts, for alarm and shutdown signals shall be provided. Provide one voltage free contact in the control panel for the start/stop of each motor and wire to an input/output terminal strip for motor starter controls. All electrical wiring within panel shall be in accordance with the International Electrotechnical Commission (IEC).

13.1 Panel Kontrol

Semua perangkat kontrol untuk sistem HVAC yang terletak di luar ruangan harus ditempatkan pada panel IP 55 dan entri kabel melalui bawah. Panel yang terletak di dalam ruangan di area yang tidak terklasifikasi harus diberi gasket IP 42. Panel harus dirancang dan dipasang kabel terlebih dahulu untuk memenuhi hal-hal berikut minimal:

- Perangkat kontrol Listrik/Elektronik untuk sistem HVAC termasuk relai, starter motor, dll. Pada bagian depan setiap panel kontrol harus disediakan instrumen dan sakelar.
- Tombol tekan Start/Stop atau sakelar dengan lampu indikator untuk menunjukkan pengoperasian, kegagalan atau malfungsi *fan*, tekanan, suhu, kompresor dan peralatan HVAC lainnya.

Kontrol suplai daya 220 volt ac, 1 fasa, 50 Hz (*Line to Neutral*) dari UPS dengan dua feeder harus dilengkapi pada panel kontrol. *Dry contact*, untuk sinyal alarm dan *shutdown* harus disediakan. Sediakan satu *voltage free contact* di panel kontrol untuk start/stop setiap motor dan kabel ke strip terminal input/output untuk kontrol starter motor. Semua kabel listrik di dalam panel harus sesuai dengan International Electrotechnical Commission (IEC).

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All voltage free contacts shall be rated at 230 volts ac, 10 ampere minimum. The control panel located indoor shall be both top and bottom cable entry.

Semua *voltage free contact* harus 230 volt ac, minimum 10 ampere. Panel kontrol yang terletak di dalam ruangan entri kabel harus atas dan bawah.

13.2 Control & Electrical Wiring

Furnish and install all low voltage control wiring required for the temperature control systems. The term "wiring" shall be construed to include the furnishing and installation of conduit, wire, conduit fittings and boxes, control device mounting hardware, switches, relays, terminal strips, panels and all appurtenances required for complete and ready to operate systems. Control devices mounted in devices such as dampers, motors, linkages, auxiliary switches, thermostats, smoke detectors, etc. shall also be mounted and wired. All sensing element, signal alarm and multiplex control wiring shall be low voltage (24 volts ac).

All wiring shall meet International Electrotechnical Commission (IEC) and any local or state code having jurisdiction in this area. Wiring shall be minimum of 16 AWG 600 volt rated and installed in minimum 19 mm (3/4") rigid galvanized conduit. All wiring outside of enclosures, to and from controls, instruments and accessories shall be in rigid or flexible conduit. All wiring connections shall be protective metal boxes or tight fitting enclosures with screwed, bolted or locked covers.


Conduit systems shall be electrically continuous throughout their runs and shall be installed as to form a smooth bore inside all couplings and fittings.

13.2 Kontrol & Kabel Listrik

Lengkapi dan pasang semua kabel kontrol tegangan rendah yang diperlukan dengan sistem kontrol suhu. Istilah "wiring atau pengkabelan" harus ditafsirkan mencakup penyediaan dan pemasangan *conduit*, kabel, *conduit fitting* dan kotak, *mounting* perangkat kontrol, sakelar, relai, *terminal strip*, panel dan semua peralatan yang diperlukan lengkap untuk sistem siap dioperasikan. Perangkat kontrol dipasang pada perangkat seperti *damper*, motor, *linkage*, *auxiliary switch*, termostat, detektor asap dll juga harus dipasang dan dikabelkan. Semua elemen penginderaan, alarm sinyal dan *multiplex control wiring* harus tegangan rendah (24 volt ac).

Semua *wiring* harus memenuhi International Electrotechnical Commission (IEC) dan kode lokal atau negara bagian yang memiliki yurisdiksi di area ini. Pengkabelan harus minimal 16 AWG 600 volt dan dipasang pada *conduit* galvanis *rigid* minimal 19 mm (3/4"). Semua *wiring* di luar panel, ke dan dari kontrol, instrumen dan aksesori harus dalam *conduit rigid* atau fleksibel. Semua sambungan *wiring* harus pada kotak logam pelindung atau penutup yang rapat dengan penutup yang disekrup, dibaut atau dikunci.

Sistem *conduit* harus kontinu secara elektrik sepanjang prosesnya dan harus dipasang sedemikian rupa sehingga membentuk lubang halus di dalam semua sambungan dan alat

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Flexible metal conduit shall be installed at all conduits to damper motor connections and where necessary to provide for equipment movement, vibration isolation and equipment change-out.

kelengkapan.

Conduit fleksibel logam harus dipasang pada semua *conduit* untuk sambungan *damper* motor dan bila perlu untuk menyediakan pergerakan peralatan, isolasi getaran dan penggantian peralatan.

13.3 Electric Modulating Thermostat

Electric modulating thermostats shall be 3 wire low voltage proportional controllers containing a vapor filled bellows actuating a potentiometer wiper in a 24 volt ac circuit. Thermostats shall have adjustable or fixed proportioning ranges as shown on the drawings. Provide with a locking cover and without thermometer.

13.3 *Electric Modulating Thermostat*

Electric modulating thermostat harus berupa pengontrol proporsional tegangan rendah 3 kawat yang berisi *vapor filled bellows actuating a potentiometer wiper* dalam rangkaian 24 volt ac. Termostat harus memiliki rentang proporsi yang dapat disesuaikan atau tetap seperti yang ditunjukkan pada gambar. Sediakan penutup pengunci dan tanpa termometer.

13.4 HVAC Interface


This section describes the minimum requirements for interface of HVAC control system with other systems.

13.4 *HVAC Interface*

Bab ini menjelaskan persyaratan minimum untuk sistem *interface* kontrol HVAC dengan sistem lain.

- HVAC Shutdown Command (from LFACP): Hardwire connection shall be provided between the building's LFACP and the building's DDC. The DDC shall include normally open, close to alarm 24VDC volt contact for digital inputs. The DDC shall initiate an automatic shutdown of the complete HVAC system on receiving this command from LFACP, including close of fire dampers located in fire rated walls. Refer to ETSP RP-ETS-INS-GS-0031-00 Fire and Gas System General Specification for further details.
- HVAC Shutdown Confirmation (to LFACP): Hardwire connection shall be

- Perintah *Shutdown* HVAC (dari LFACP): Sambungan kabel harus disediakan antara gedung LFACP dan gedung DDC. DDC secara normal harus terbuka, kemudian akan menutup pada alarm kontak 24VDC volt dari *digital input*. DDC harus menginsiasi otomatis *shutdown* menyeluruh sistem HVAC saat menerima perintah ini dari LFACP, termasuk penutupan *fire damper* yang terletak pada dinding tahan api. Lihat ETSP RP-ETS-INS-GS-0031 *Fire and Gas System General Specification* untuk rincian lebih lanjut.
- Konfirmasi *Shutdown* HVAC (ke LFACP): Sambungan kabel harus

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provided between the building's DDC and the building's LFACP. The DDC shall include normally close, open to alarm 24VDC volt free contact for digital outputs. The DDC shall send the alarm to LFACP to confirm the complete shutdown of HVAC system including close of all fire dampers located in fire rated walls after a HVAC Shutdown Command (from LFACP). Refer to ETSP RP-ETS-INS-GSFire and Gas System General Specification for further details.

- HVAC Recirculation Command (from FGS): Hardwire connection shall be provided between the FGS and the building's DDC in buildings provided with flammable, or toxic gas detection The DDC shall include normally open, close to alarm 24VDC volt contact for digital inputs. The DDC shall initiate recirculation operation mode of the HVAC system (air intake shutdown) on receiving this command from FGS, including shut down of all fans and close of motorized dampers dedicated exclusively to the outdoor air intake. Refer to ETSP RP-ETS-INS-GS-0031-Fire and Gas System General Specification for further details.
- HVAC Recirculation Confirmation (to FGS): Hardwire connection shall be provided between the building's DDC and the FGS. The DDC shall include normally close, open to alarm 24VDC volt free contact for digital outputs. The DDC shall send the alarm to FGS to confirm the complete air intake

disediakan antara gedung DDC dan gedung LFACP. DDC secara normal harus tertutup, kemudian akan terbuka pada alarm lepas kontak 24VDC volt dari *digital output*. DDC harus mengirimkan alarm ke LFACP untuk mengonfirmasi *shutdown* total sistem HVAC termasuk penutupan semua *fire damper* yang terletak di dinding tahan api setelah Perintah *Shutdown* HVAC (dari LFACP). Lihat ETSP RP-ETS-INS-GSFire and Gas System General Specification untuk rincian lebih lanjut.

- Perintah Resirkulasi HVAC (dari FGS): Sambungan kabel harus disediakan antara FGS dan gedung DDC di gedung yang dilengkapi dengan deteksi gas yang mudah terbakar atau beracun. DDC secara normal harus terbuka, kemudian akan tertutup pada alarm kontak 24VDC volt dari *output digital*. DDC akan menginisiasi mode operasi resirkulasi dari sistem HVAC (*air intake shutdown*) saat menerima perintah ini dari FGS, termasuk mematikan semua kipas dan menutup *dampers* bermotor yang diperuntukan khusus untuk *outdoor air intake*. Lihat ETSP RP-ETS-INS-GS-0031Fire and Gas System General Specification untuk rincian lebih lanjut.
- Konfirmasi Resirkulasi HVAC (ke FGS): Sambungan kabel harus disediakan antara gedung DDC dan FGS. DDC secara normal harus tertutup, kemudian akan terbuka pada alarm lepas kontak 24VDC volt dari *output digital*. DDC akan mengirimkan alarm ke FGS untuk

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shutdown after a HVAC Recirculation Command (from FGS). Refer to ETSP RP-ETS-INS-GS-0031 Fire and Gas System General Specification for further details.

mengkonfirmasi *air intake shutdown* secara lengkap setelah Perintah Resirkulasi HVAC (dari FGS). Lihat ETSP RP-ETS-INS-GS-0031 *Fire and Gas System General Specification* untuk rincian lebih lanjut.

- HVAC Shutdown Command (from FGS): Hardwire connection shall be provided between the FGS and the building's DDC for buildings provided with flammable, hydrogen or toxic gas detection. The DDC shall include normally open, close to alarm 24VDC volt contact for digital inputs. The DDC shall initiate an automatic shutdown of the complete HVAC system on receiving this command from FGS, including close of fire dampers located in fire rated walls. Refer to ETSP RP-ETS-INS-GS-0031 Fire and Gas System General Specification for further details.
- HVAC Shutdown confirmation (to FGS): Hardwire connection shall be provided between the building's DDC and the FGS. The DDC shall include normally close, open to alarm 24VDC volt free contact for digital outputs. The DDC shall send the alarm to FGS to confirm the complete shutdown of HVAC system including close of all fire dampers located in fire rated walls after a HVAC Shutdown Command (from FGS). Refer to ETSP RP-ETS-INS-GS-0031 Fire and Gas System General Specification for further details.
- Battery Room Full Exhaust (from FGS):
- Perintah *Shutdown* HVAC (dari FGS): Sambungan kabel harus disediakan antara FGS dan gedung DDC untuk gedung yang dilengkapi dengan deteksi gas yang mudah terbakar, hidrogen atau beracun. DDC secara normal harus terbuka, kemudian akan menutup untuk alarm kontak 24VDC volt dari *digital input*. DDC harus menginisiasi *shutdown* otomatis sistem HVAC secara menyeluruh saat menerima perintah ini dari FGS, termasuk penutupan *fire damper* yang terletak di dinding tahan api. Lihat ETSP RP-ETS-INS-GS-0031 *Fire and Gas System General Specification* untuk rincian lebih lanjut.
- Konfirmasi *Shutdown* HVAC (ke FGS): Sambungan kabel harus disediakan antara gedung DDC dan FGS. DDC secara normal harus tertutup, kemudian akan terbuka pada alarm lepas kontak 24VDC volt dari *digital output*. DDC harus mengirimkan alarm ke FGS untuk mengkonfirmasi *shutdown* total sistem HVAC termasuk penutupan semua *fire damper* yang terletak di dinding yang tahan api setelah Perintah *Shutdown* HVAC (dari FGS). Lihat ETSP RP-ETS-INS-GS-0031 *Fire and Gas System General Specification* untuk rincian lebih lanjut.
- *Battery Room Full Exhaust* (dari

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Hardwire connection shall be provided between the FGS and the building's DDC in buildings provided with hydrogen gas detection. The DDC shall include normally open, close to alarm 24VDC volt contact for digital inputs. The DDC shall initiate battery room full exhaust operation mode of the HVAC system on receiving this command from FGS, including simultaneous operation of both exhaust fans (duty and standby) at battery room. Refer to ETSP RP-ETS-INS-GS-0031 Fire and Gas System General Specification for further details.

- HVAC Common Fault Alarm (to DCS): Hardwire connection shall be provided between the DCS and the building's DDC. The DDC shall include normally close, open to alarm 24VDC volt free contact for digital outputs. The DDC shall send the alarm to DCS in case of fault of any equipment of the HVAC system. Refer to ETSP RP-ETS-INS-GS-0031-00-2021 Fire and Gas System General Specification for further details.
- Essential Room High Temperature Alarm (to DCS): Hardwire connection shall be provided between the DCS and the building's DDC. The DDC shall include normally close, open to alarm 24VDC volt free contact for digital outputs. The DDC shall send the alarm to DCS in case of the temperature of any of the rooms in the building containing essential equipment exceeds 2°C the higher limit of its design temperature range. Refer to RP-ETS-INS-GS-0031-00-2021 Fire

FGS): Sambungan kabel harus disediakan antara FGS dan gedung DDC di gedung yang dilengkapi dengan deteksi gas hidrogen. DDC secara normal harus terbuka, kemudian akan tertutup pada alarm kontak 24VDC volt dari *digital input*. DDC akan menginisiasi mode operasi *battery room full exhaust* dari sistem HVAC saat menerima perintah ini dari FGS, termasuk operasi simultan dari kedua *exhaust fan* (yang sedang beroperasi dan siaga) di ruang baterai. Lihat ETSP RP-ETS-INS-GS-0031 *Fire and Gas System General Specification* untuk rincian lebih lanjut.

- HVAC *Common Fault Alarm* (ke DCS): Sambungan kabel harus disediakan antara DCS dan gedung DDC. DDC secara normal harus tertutup, kemudian akan membuka pada alarm lepas kontak 24VDC volt dari *digital output*. DDC harus mengirimkan alarm ke DCS jika terjadi kesalahan pada peralatan sistem HVAC. Lihat ETSP RP-ETS-INS-GS-0031-00-2021 *Fire and Gas System General Specification* untuk rincian lebih lanjut.
- *Essential Room High Temperature Alarm* (ke DCS): Sambungan kabel harus disediakan antara DCS dan gedung DDC. DDC secara normal harus tertutup, kemudian akan terbuka pada alarm lepas kontak 24VDC volt dari *digital output*. DDC harus mengirimkan alarm ke DCS jika temperatur salah satu ruangan di gedung yang berisi peralatan penting melebihi 2°C batas yang lebih tinggi dari kisaran temperatur desainnya. Lihat ETSP RP-ETS-

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and Gas System General Specification for further details and Indoor Design Conditions as per Project Specification

INS-GS-0031-00-2021 *Fire and Gas System General Specification* untuk rincian lebih lanjut dan Kondisi Desain Dalam Ruangan sesuai Spesifikasi Proyek.

13.5 Control Transformer

Transformers shall have 24 Volt Ac secondary and VA rating shall be 1.5 times the required load.

13.5 Transformator Kontrol

Transformator harus memiliki tegangan sekunder 24 Volt Ac dan rating VA harus 1,5 kali beban yang diperlukan.

13.6 Miscellaneous Electric Relay

Due to the difference between manufacturers and the methods of achieving a control function, all intermediate reversing and other relays may not be shown which are necessary to achieve the sequence of operation described, and the normally open/closed function of the device. All such relays and devices shall be included as a part of the system.

13.6 *Miscellaneous Electric Relay*

Wajar ada perbedaan antara pabrikan dan metode untuk mencapai fungsi kontrol, semua relai *intermediate reversing* dan lainnya mungkin tidak ditampilkan yang diperlukan untuk mencapai urutan operasi yang dijelaskan, dan fungsi perangkat yang secara normal terbuka/tertutup. Semua relai dan perangkat tersebut harus dimasukkan sebagai bagian dari sistem.

13.7 Interlock Relays

Interlock relays required for interface between air conditioning units, electric heaters, fans, etc., shall be the industrial type with screw terminals. Relays shall provided with LED indicator, gold plated contact, the proper number of states and include an enclosure. The interlock relays shall be installed in the control panel.

13.7 *Interlock Relay*

Interlock relay yang diperlukan untuk *interface* antara unit pendingin udara, pemanas listrik, kipas dan lain-lain, harus tipe industri dengan *screw terminal*. *Relay* harus dilengkapi dengan indikator LED, kontak *gold plated*, jumlah status dan termasuk penutup yang tepat.

14. VENDOR DATA REQUIREMENTS


14.1 VENDOR shall supply all drawings and data necessary to install the HVAC System for Building completely.

14.2 The Manufacturer shall supply full operational instructions, erection and dismantling instructions, maintenance instructions and a parts manual.

14. PERSYARATAN DATA VENDOR

14.1 VENDOR harus menyediakan semua gambar dan data yang diperlukan untuk memasang Sistem HVAC untuk Gedung secara lengkap.

14.2 Pabrikan harus menyediakan instruksi operasional lengkap, instruksi pemasangan dan pembongkaran, instruksi pemeliharaan serta data manual suku cadang.

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14.3 VENDOR shall supply necessary electronic copies of drawings, technical specifications, instruction manuals etc. as specified by the OWNER.

14.3 VENDOR harus menyediakan salinan elektronik yang diperlukan dari gambar, spesifikasi teknis, manual instruksi, dan lain-lain seperti yang ditentukan oleh PEMILIK.

15. INSPECTION AND TEST

All supplied equipment shall be fully inspected and tested, based on the project requirements defined within the related project specification, material requisition, and equipment datasheets, to the maximum extent possible prior to the final installation on the site.

The inspection and tests will include material tests, performance tests, and final inspection.

The equipment VENDOR will prepare documentation to the extent of inspection, tests and surveillance requirements, within the Inspection and Test Plan (ITP), and submit it for review and approval from CONTRACTOR and OWNER.

15.1 Factory Acceptance Test

15.1.1. Factory acceptance tests (FAT) shall be carried out on equipment as identified on the Purchase Order. This is also determined by the VENDOR surveillance quality level.

15.1.2. A full FAT may be witnessed by the CONTRACTOR and the OWNER at the VENDOR's works as specified on agreed ITP.

15.1.3. HVAC Package shall be tested with air fluid requirements.

15. INSPEKSI DAN PENGUJIAN

Semua peralatan yang dipasok harus diinspeksi dan diuji sepenuhnya, berdasarkan persyaratan proyek yang ditentukan dalam spesifikasi proyek terkait, permintaan material, dan *datasheet* peralatan, semaksimal mungkin sebelum pemasangan akhir di lokasi.

Inspeksi dan pengujian akan mencakup pengujian material, pengujian kinerja, dan inspeksi akhir.


VENDOR peralatan akan menyiapkan dokumentasi dan persyaratan inspeksi, pengujian dan pengawasan, dalam *Inspection and Test Plan* (ITP), dan menyerahkannya untuk ditinjau dan disetujui oleh KONTRAKTOR serta PEMILIK.

15.1 Factory Acceptance Test

15.1.1. *Factory Acceptance Test (FAT)* harus dilakukan pada peralatan seperti yang diidentifikasi pada Pesanan Pembelian. Hal ini juga ditentukan oleh tingkat pengamatan mutu VENDOR.

15.1.2. *FAT* sepenuhnya dapat disaksikan oleh KONTRAKTOR dan PEMILIK di tempat kerja VENDOR sebagaimana ditentukan pada ITP yang disepakati.

15.1.3. Paket HVAC harus diuji dengan cairan udara yang

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Limitations for the testing of equipment shall be raised to the CONTRACTOR during bidding stage and approved by OWNER on the recorded deviation/clarification list and noted in the FAT procedure.

dipersyaratkan. Batasan untuk pengujian peralatan harus disampaikan kepada KONTRAKTOR selama tahap penawaran dan disetujui oleh PEMILIK pada daftar deviasi/klarifikasi yang tercatat dan dicatat dalam prosedur FAT.

15.1.4. Full reports of all FAT activities and results shall be submitted to the CONTRACTOR for review and approval. Applicable certificates shall also be provided with the report.

15.1.4. Laporan lengkap dari semua kegiatan dan hasil FAT harus diserahkan kepada KONTRAKTOR untuk ditinjau dan disetujui. Sertifikat yang berlaku juga harus disertakan pada laporan.

15.1.5. Any faults and errors which occur during the FAT shall be noted in the report and shall be rectified prior to shipment. Depending on severity a retest may be required to be determined by the CONTRACTOR.

15.1.5. Setiap kegagalan dan kesalahan yang terjadi selama FAT harus dicatat dalam laporan dan harus diperbaiki sebelum pengiriman. Tergantung pada tingkat keparahan, pengujian ulang mungkin diperlukan untuk ditentukan oleh KONTRAKTOR.

15.2 Site Acceptance Test

15.2 Site Acceptance Test

15.2.1. Where required, Site Acceptance Tests (SAT) shall be performed under the supervision of the CONTRACTOR and OWNER. VENDOR representatives will be required on site to rectify any equipment faults.


15.2.1. Jika diperlukan, *Site Acceptance Tests (SAT)* harus dilakukan di bawah pengawasan KONTRAKTOR dan PEMILIK. Perwakilan VENDOR akan diminta di lokasi untuk memperbaiki kesalahan peralatan apa pun.

16. WARRANTY AND GUARANTEE

16. WARRANTY DAN GUARANTEE

16.1 The VENDOR shall guarantee the mechanical design and performance of all equipment supplied under this specification.

16.1 VENDOR harus memberi *guarantee* desain mekanis dan kinerja semua peralatan yang dipasang berdasarkan spesifikasi ini.

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16.2 *VENDOR* shall provide warranty that all equipment, material, and workmanship shall be free of defect for a period of 12 (twelve) months after commissioning.

16.2 *VENDOR* harus memberikan *warranty* bahwa semua peralatan, material dan pengerjaan harus bebas dari cacat untuk jangka waktu 12 (dua belas) bulan setelah *commissioning*.

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