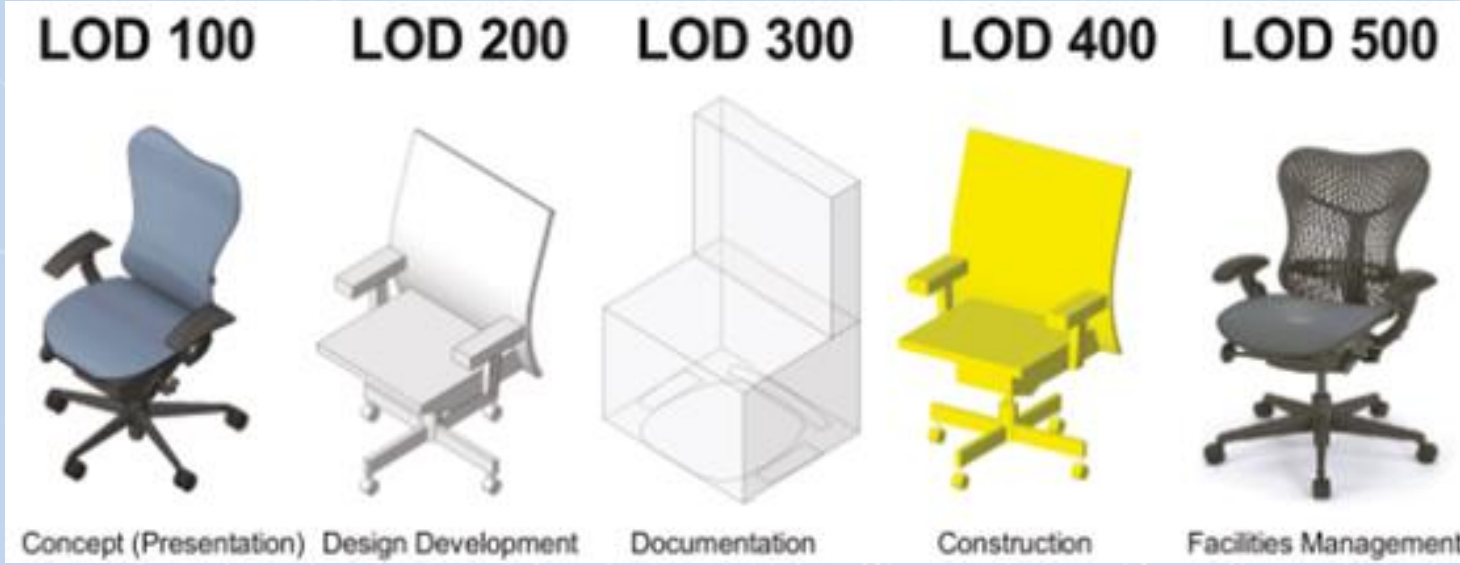




แนวทางการกำหนด LOD สำหรับงาน MEP เพื่อการใช้งานในประเทศไทย

โดย ผศ. ดร. เต๋นชัย วรเดชจำเริญ
กรรมการร่างมาตรฐาน



กวีไกร ศรีหิรัญ (2562)

- **Architect leads LOD**
- **เน้น geometry**
- **ไม่กำหนด information ที่ชัดเจน**
- **Architect information for MEP**
- **LOD-500 ของสถาปนิก ส่งผลกระทบต่อ data exchange ของ MEP**
- **FM ติดปัญหาข้อมูลมาตรฐาน IFC (Industry Foundation Classes, IFC)**



CIC Building Information Modelling Standards

Mechanical, Electrical and Plumbing

4.2 LOD-Information Requirements

This section describes the LOD-information required for a BIM model, it is well noted that project clients / organisations may have their own requirement for LOD-Information. This section sets out a software-neutral approach for determining LOD-I, using samples instead of attempting to giving an exhaustive list of requirement. The BIM standards developed by HKSAR Works Departments should be referred to for further details. These and other relevant publications are given in the CIC BIM Portal <https://www.bim.cic.hk/en/resources/publications> for relevant publications.

CIC Building Information Modeling Standard

The following table lists the attributes commonly attached to individual model elements / objects.

Type	Information / Attributes	Data Type	Unit	Example	Descriptions	LOD-Information				
						100	200	300	400	500
General Properties	Equipment Type	Text	N/A	Pump	Equipment type (e.g. pump, valves)	R	R	R	R	R
	Equipment Name	Text	N/A	AHU-1F-01	Equipment name* (Follow the rule by the project clients / employers)		R	R	R	R
	Locations	Text	N/A	AHU Room	Locations* (Follow the rule by the project clients / employers)		R	R	R	R
Design Properties	Design properties of the equipment, using a Chiller as an example						R	R	R	R
	Cooling Capacity	Number	kW	214	Cooling capacity of chiller		R	R	R	R
	Rated Power Input	Number	kVA	30	Rated power input		R	R	R	R
Classification Properties	Classification Title	Text	N/A	Chillers	Classification title agreed by project clients / employers if necessary			R	R	R
	Classification Code	Number	N/A	23-33 21 00	Classification coding agreed by project clients / employers if necessary			R	R	R

- Based on LOD-I (basic information)
- HK – LOD information (Manufacturer based guide)



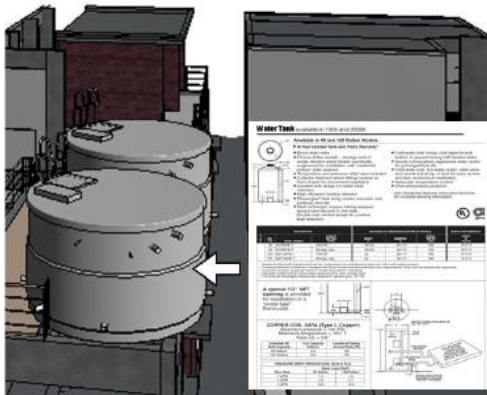
3 BIM DELIVERABLES

- Site model
- Massing model
- Architectural, structural, MEP models
 - For regulatory submissions
 - For coordination and / or clash detection analysis
 - For visualization
 - For cost estimation
- Schedule (material, time etc) and phasing program (in BIM or spreadsheet)
- Construction and fabrication models
- Shopdrawings
- As-built model (in native proprietary or open formats)
- **Data** for facility management
- Other additional value-added BIM services

- สอบทวน international guide – Data or information
- SG – Information transfer guide (Data to FM)

Table 5: Example of a BIM Project Collaboration Map

	Employer	Architect	Consulting Engineers	Contractor / Quantity Surveyor
Conceptual Design	Provide requirements related to form, function, cost and schedule	Begin design intent model with massing concepts with site considerations	Provide feedback on initial building performance goals and requirements	Provide feedback on initial building cost, schedule, and constructability *
Schematic Design	Provide design review and to further refine design requirements	Refine Design Model with new input from Employer, Consulting Engineers, and Construction Manager	Provide schematic modelling, analysis and system iterations as Design Model continues to develop	Provide design review and continued feedback on cost, schedule and constructability*
Detailed Design	Design reviews. Final approval of project design and metrics	Continue to refine Design Model. Introduce consultants models and perform model coordination	Create Discipline-specific Design Models and Analyses	Create Construction Model for simulation, coordination, estimates, and schedule *
Construction	Monitor construction and give input to construction changes and issue	Finalize Design model, Tender Documents and Specifications, Regulatory Code Compliance	Finalize Discipline specific Design Models, Tender Documents and Specifications, Code Compliance	Enhance Construction Model and perform final estimate & construction schedule, Manage bid process
As-Built		Respond to construction RFI's Perform contract administration, update Design Model with changes	Respond to construction RFI's and update Discipline specific Design Models, field conditions, and commissioning	Manage construction with subcontractors and suppliers, inform changes to Design Model
Facility Management	Engage Architect and Facilities Group for handing over	Verify As-built model	Verify As-built model	Prepare As-built model
		Coordinate information exchange through model to Facilities Group	Prepare handover documentation	

<p>Facility Management</p> <ul style="list-style-type: none"> O & M 	<p>1:50</p>	<p>BIM element is modelled as an actual constructed building component or system and is an as-built representation of the actual completed building.</p>  <p>Water storage tank element with attached specification PDF (Source: HDB)</p>
----------------------------------------------------------------------------------------	-------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

(IV) ACMV BIM ELEMENTS

	Element	Elements or Parameters needed by each non-ACMV discipline
ACMV Equipment	Air Handling unit	
	Chiller unit	
	Variable refrigerant unit	
	Cooling Tower	
	Split-type indoor & outdoor air conditioning units	
	Exhaust or extract air fans	
	Fresh air fans	
	Other fans such as jet fans	
ACMV Distribution	Heat Exchanges for projects with District Cooling	
	Exhaust air ducts (excluding hangars)	
	Fresh air ducts (excluding hangars)	
	Supply air ducts (excluding hangars)	
	Return air ducts (excluding hangars)	
	Transfer air ducts (excluding hangars)	
	Diffusers, air-boots, air grilles, air filters, registers	
Fire dampers, motorized dampers, volume control dampers, CO ₂ sensors, CO sensors		

- SG – Data to FM (O&M)
- กำหนดข้อมูลพื้นฐานตามคำแนะนำ

- Find out ACMV and SN guide for FM users
- Non-standardized elements in Thailand

EIT BIM Standard

Information Standard

- Responsibility and Roles
- Common Data Environment
- Standard Method
 - File Naming
 - Origin and orientation
 - Drawing sheet templates
 - Annotation

EIT BIM for MEP



1. **ชั้นแบบร่างเบื้องต้น (Schematic)**
2. **ชั้นพัฒนาแบบรายละเอียด (Design Development)**
3. **ชั้นแบบก่อสร้าง (Construction Document)**
4. **ชั้นแบบสำหรับงานก่อสร้าง (Shop Drawing)**
5. **ชั้นแบบรายละเอียดงานก่อสร้าง (As Built)**

(V) MEP BIM MODELLING GUIDELINES

a. ACMV

Stages	Elements	Modelling Guidelines	Remarks
Conceptual	System distribution lines	Use line diagrams to show the entire system distribution Include equipment symbols in the line diagrams.	Output: Schematic diagrams
	Space objects	Use box objects to represent spaces required for MEP systems Add names and colours to the space objects.	
Preliminary Design	Zone Objects, Air Handling Unit, Chiller Unit Variable refrigerant flow unit,	Zone the spaces that have common design requirements with colour legends on plans. Model each element using the correct BIM generic object	Output: Preliminary Model Shows main distribution

Design–bid–build (DBB) also known as Design–tender - traditional method with separate entities for the design and construction of a project.

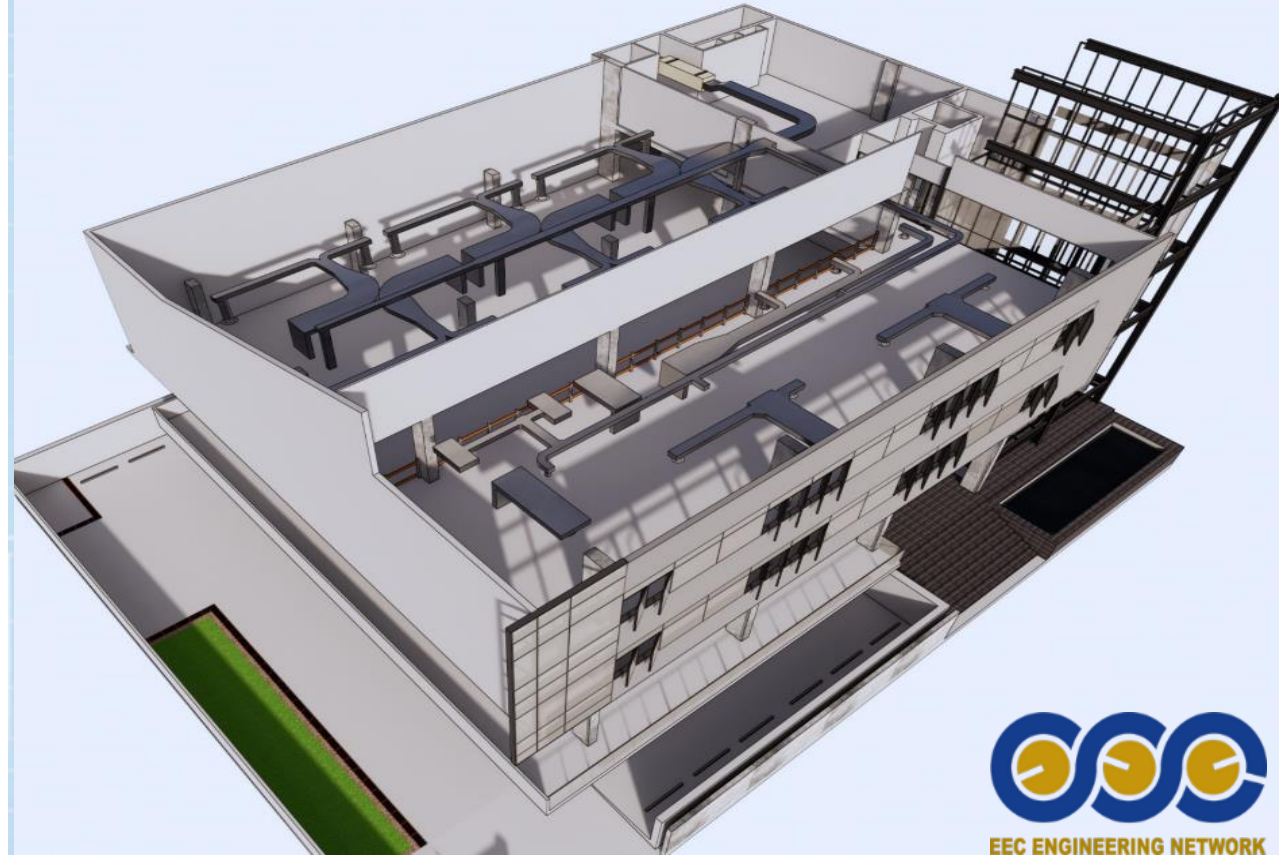
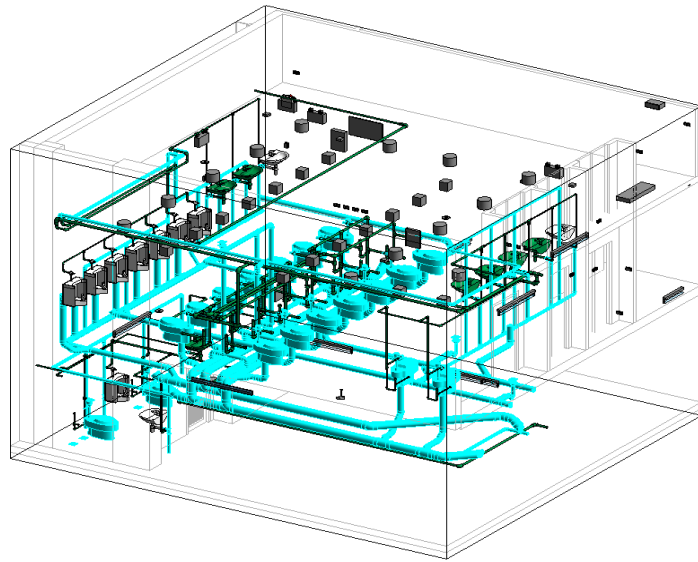
- **Material approve to FM as static data (data transfer in a DBB process)**

Stages	Elements	Modelling Guidelines	Remarks
Detailed Design	Main elements of Preliminary Design	Use CP83 symbols and colour standards	Output: Detailed model for e-Submission and Tender
	Fire dampers, Motorized dampers, Volume control dampers Split-type indoor & outdoor air conditioning units Exhaust or extract air fans Fresh air fans Other fans such as jet fans Diffusers, air-boots, air grilles, air filters, registers Fan Coil unit Switch boards, Control, BMS & DDC panels BMS control & monitoring modules	Model each element using object correspond to actual component with actual size, material, type code and performance criteria. Include insulation to reflect actual size for coordination purpose. System routing should be connected with fittings. Unavailable BIM objects that are modelled using different objects should be identified accordingly, e.g. use proper names and colours. Downward slopes of the pipes should be modelled realistically. Required fittings allowances, cross-over spaces and maintenance spaces should be considered. Fasteners and hangers are not necessary. Commercial product libraries can be used to the extent allowed by the modelling software. Fire rating should be included in the fire damper objects. Pipe Accessories should follow the CP83 symbols in plan views. For design coordination, documents such as coordinated services plans, sections, elevations, etc. should be derived from the	For BIM e-Submission, please also refer to submission guidelines Services should be coordinated with architecture model Proposed position of mechanical components base on calculation or analysis e.g. air terminals, FCU should be approved by the architect.

การเป็นเทียบระหว่าง CIC Building Information Modeling Standard และ EIT Standard

CIC	EIT Standard 010237-20	MEP LOD	MEP LOD-G	MEP-LOD-I
General properties	ชั้นแบบร่างเบื้องต้น (Schematic)	100	มวลของอาคาร พร้อมการวางตำแหน่งเครื่องจักรงาน MEP ในลักษณะของ 3 มิติโดยสังเขป	ขนาด ตำแหน่งที่ตั้งของงานระบบ MEP พอสั่งเซป และชนิดของอุปกรณ์ MEP (equipment name)
Design property	ชั้นพัฒนาแบบรายละเอียด (Design Development)	200	ภาพที่รับรู้ถึงการใช้วัสดุ เช่นการเดินอุปกรณ์งานระบบที่มีขนาดใหญ่ แสดงผลทาง 3 มิติ	ขนาดของเครื่องจักร เช่น ขนาดต้น ความเย็น, ขนาดกำลังไฟฟ้า ชนิดของอุปกรณ์
Classification property				
Manufacturer property	ชั้นแบบก่อสร้าง (Construction Document)	300	ชนิดและอุปกรณ์เพื่อการขอยื่นการประมูลงาน และการขออนุมัติ	รายละเอียด classification เช่น 1) General data 2) Material layer 3) Typical object
Condition property	ชั้นแบบสำหรับงานก่อสร้าง (Shop Drawing)	350	แบบขยายเครื่องจักร ในลักษณะของ 3 มิติที่มีระดับความละเอียด พร้อมการติดตั้งจริง	Manufacturing property ค่าตัวแปรที่เกี่ยวข้องก่อนการ commissioning ระบบเครื่องจักร (condition property)
Specification property				
Verification property	ชั้นแบบรายละเอียดงานก่อสร้าง (As Built)	400	Model Element หรือ open BIM data ที่พร้อมใช้สำหรับ data transfer ส่งไปยังงาน FM (IFC)	ข้อมูลประกอบด้วย design, manufacturing, condition และ specification property พร้อมใช้ในงาน FM

ตัวอย่างการใช้ MEP-LOD-I จากอาคารตัวอย่าง

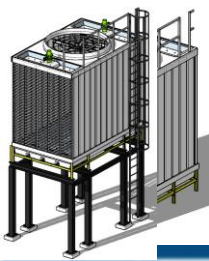


Asst. Prof. Dr. Denchai Woradechjumroen



Mr. Takorn Vasupokin




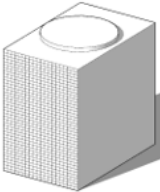
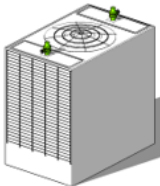


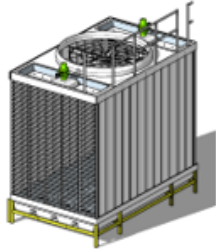

LOD – I (cooling tower)



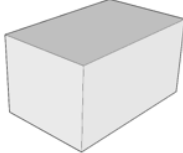
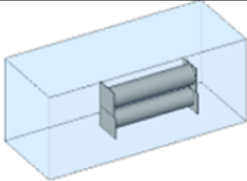
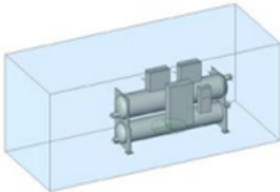
วิศวกรรมแห่งชาติ 2565
National Engineering 2022

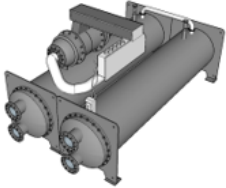
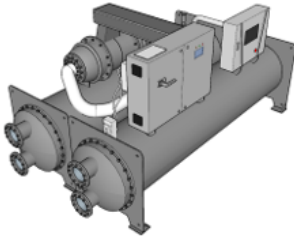


LOD-G	LOD-I	Details	Simple Shape
100	-Concept and schematic	Overall shape	
200	-Generic element -Nominal size and dimensions	-Overall shape -Space for access and maintenance	
300	-Proposed Specific element -Actual size and dimensions, location	- Water inlet and outlet, power fan, support - Space for access and maintenance	

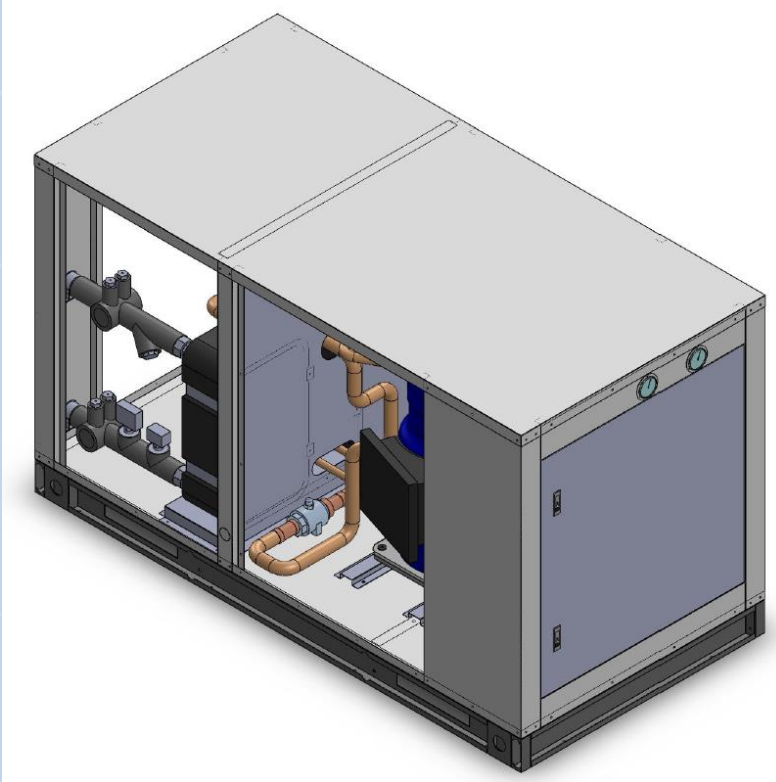
LOD-G	LOD-I	Details	Simple Shape
350	-Approved specific element -Actual size and dimensions -Follow product catalogue -Sufficient detail for fabrication	- Water inlet and outlet, power fan, support - Space for access and maintenance - Sufficient detail for fabrication	
400	-Approved specific element -Actual size and dimensions -Follow product catalogue -Sufficient detail for fabrication - Maintenance report - Commissioning report	- Water inlet and outlet, power fan, support - Space for access and maintenance - Sufficient detail for fabrication -Commissioning data	

LOD – I (Chiller)

LOD-G	LOD-I	Details	Simple Shape
100	-Concept and schematic	Overall shape	
200	-Generic element -Nominal size and dimensions	-Overall shape -Space for access and maintenance	
300	-Proposed Specific element -Actual size and dimensions, location	- Chiller Water inlet and outlet, power, support - Compressor, evaporator and condenser conditions - Space for access and maintenance	

LOD-G	LOD-I	Details	Simple Shape
350	-Approved specific element -Actual size and dimensions -Follow product catalogue -Sufficient detail for fabrication	- Chiller Water inlet and outlet, power, support - Compressor, evaporator and condenser conditions - Space for access and maintenance - Sufficient detail for fabrication	
400	-Approved specific element -Actual size and dimensions -Follow product catalogue -Sufficient detail for fabrication - Maintenance report - Commissioning report	- Chiller Water inlet and outlet, power, support - Compressor, evaporator and condenser conditions - Space for access and maintenance - Sufficient detail for fabrication -Commissioning data	

IFC data format – w/o property



Family Types

Type name: [dropdown]

Search parameters [input]

Parameter	Value	Formula	Lock
Constraints			
Default Elevation	0.0	=	<input type="checkbox"/>
Identity Data			
Type Image		=	
Keynote		=	
Model		=	
Manufacturer		=	
Type Comments		=	
URL		=	
Description		=	
Assembly Code		=	
Cost		=	

Manage Lookup Tables

How do I manage family types?

OK Cancel Apply

Properties

- Characteristics**
 - ContainedInStructure: IfcBuildingStorey 'Level 6' (0bF_8TBRzE_fwB7ME422bG)
- General Data**
 - Class: IfcBuildingElementProxy
 - GlobalId: 0yh68Esb9Da9w7nnQTvwx6
 - Name: MTL-M_Vertical Pump_50:MTL-M_Vertical Pump_50:5499
- Geometrical Representation**
 - Body: MappedRepresentation [Brep]
 - Bounding Box (Altezza): 1.0662 [Meters]
 - Bounding Box (Lunghezza): 0.3000 [Meters]
 - Bounding Box (Spessore): 0.2750 [Meters]
 - Box: BoundingBox
 - SurfaceColor: [0, 128, 192, 255]
 - Volume: 0.0408 [Metri Cubi]
 - Z Max: 16.8662 [Meters]
 - Z Min: 15.8000 [Meters]
- IfcObjectPlacement**
 - Axis: [0.0000; 0.0000; 1.0000]
 - Location: [9.672941818; 7.0865876539; 0.1500] [Metri Cubi]
 - PlacementRelTo: IfcBuildingStorey 'Level 6'
 - RefDirection: [1.0000; 0.0000; 0.0000]
- IfcOwnerHistory**
- Material**
- Layer**
- Properties**
- TypeObject Characteristics**
- TypeObject Geometry**
- TypeObject Material**
- TypeObject Property**
 - Constraints**
 - Default Elevation: 0.0000 [metri]
 - Identity Data**
 - Assembly Code
 - Assembly Description
 - Code Name
 - OmniClass Number: 23.75.00.00
 - OmniClass Title: Climate Control (HVAC)
 - Type Name: MTL-M_Vertical Pump_50
 - Mechanical**
 - Classification: None

BIM

IFC

IFC data format – with property

UNI-Aire®

Physical and Electrical Data

Model	WCU - PHE	024
Power Supply	V/Ph/Hz	380 / 3 / 50
Nominal Cooling Capacity	MBH	288
Power Consumption	KW	19.005
Efficiency @ Full load *	EER	15.02
	COP	4.40
Compressor	EER	22.68
	COP	6.64
Compressor	Type	Hermetic (Scroll DC Inverter)
	Hp.	33.2
	Qty./Unit	1
	Rate Load Amps. (A)	61
Inverter	Type	Driver DC Inverter
	Qty./Unit	1
Refrigerant	Type	R-410A
	Charge	Holding
	HPS/Setting (Auto) psig	440
	LPS/Setting (Auto) psig	130
Water Cooled Condenser	Type	Plat heat exchanger
	Qty./Unit	1
	Water Flow Rate (GPM) **	72.00
	Entering Water Temp. (F) **	90
	Leaving Water Temp. (F) **	100
	Water Pressure Drop (Ft.WG) **	16.05
	No. of Water Passer	-
Water Chiller	Type	Plat heat exchanger
	Qty./Unit	1
	Water Flow Rate (GPM) **	57.60
	Entering Water Temp. (F) **	55
	Leaving Water Temp. (F) **	45
	Water Pressure Drop (Ft.WG) **	7.68
	No. of Water Passer	-
Dimension	L	2300
	W	1000
	H	1200

Note
 MBH = 1000 BTUH
 FOR SI. UNIT, COOLING CAPACITY (KW) = (MBH x 1000) / 3412
 * RATED IN ACCORDANCE WITH AHRI STANDARD 550/590 AT STANDARD RATING CONDITIONS
 ** NOMINAL VALUES

Family Types

Type name: [dropdown]

Search parameters [input]

Parameter	Value	Formula	Lock
Constraints			
Dimensions			
L	2300.00	=	<input type="checkbox"/>
W	1000.00	=	<input type="checkbox"/>
H	1200.00	=	<input type="checkbox"/>
IFC Parameters			
lfcExportAs	lfcChiller	=	
Data			
COOLING CAPACITY	293 KW	=	
POWER SUPPLY	380 V / 3 Ph / 50 Hz	=	
NOMINAL COOLING CA	288 MBH	=	
POWER CONSUMPTIO	19.005 KW	=	
EFFICIENCY @ FULL LO	4.40 COP	=	
EFFICIENCY @ FULL LO	15.02 EER	=	
EFFICIENCY @ LOAD PR	6.64 COP	=	
EFFICIENCY @ LOAD PR	22.68 EER	=	
INVERTER TYPE	DRIVER DC Inverter	=	
COMPRESSOR TYPE	HERMETIC (SCROLL DC	=	
COMPRESSOR Hp.	33.2 Hp.	=	
COMPRESSOR Rate Loa	61 A	=	
REFRIGERANT TYPE	R-410A	=	
REFRIGERANT HPS	440 HPS/Setting (Auto)	=	
REFRIGERANT LPS	130 LPS/Setting (Auto) p	=	
WATER COOLED COND	PLAT HEAT EXCHANGE	=	
WATER COOLED COND	72 GPM	=	
WATER COOLED COND	90 F	=	
WATER COOLED COND	100 F	=	
WATER COOLED COND	16.05 Ft.WG	=	
WATER CHILLER TYPE	PLAT HEAT EXCHANGE	=	
WATER CHILLER WATE	57.60 GPM	=	
WATER CHILLER ENTER	55 F	=	
WATER CHILLER LEAVI	45 F	=	
WATER CHILLER WATER	7.68 Ft.WG	=	

BIM Manage Lookup Tables

OK Cancel Apply

Properties

- Characteristics
 - ContainedInStructure: IfcBuildingStorey 'Level 6' (0bf_8TBRzE_fw7ME422bG)
- General Data
 - Class: IfcFlowMovingDevice
 - GlobalId: OTmD2ywgP4891yFPB1H5fK
 - Name: Plumbing_Pumps_Dab-Pumps_CM-50:CM 50-510 T:621569
- Geometrical Representation
 - IfcObjectPlacement
 - Axis: [0.0000; 0.0000; 1.0000]
 - Location: [7.352941818; 6.9065876539; 0.0000000013] [Metri Cubi]
 - IfcBuildingStorey 'Level 6': [1.0000; 0.0000; 0.0000]
- IfcOwnerHistory
- Material
- Layer
- Properties
- TypeObject Characteristics
- TypeObject Geometry
- TypeObject Material
- TypeObject Property
- Constraints
 - Default Elevation: 0.0000 [metri]
- Data
 - ACTUAL CALCULATED FLOW: 13.2m3/h
 - ACTUAL IMPELLER DIAMETER: 240 mm
 - CURVE TOLERANCE: ISO 9906:1999 ANNEX A
 - DENSITY: 998.2 kg/m2
 - ENCLOSURE CLASS (IEC34-5): 55 (Protect. water jets/duct)
 - KINEMATIC VISCOSITY: 1 mm2/s
 - LIQUID TEMPERATURE: 20.0000 [Chilo THERMALTRANSMITTANCEUNIT Gram \ Kelvin Second³]
 - LIQUID TEMPERATURE RANGE: 120.0000 [Chilo THERMALTRANSMITTANCEUNIT Gram \ Kelvin Second³]
 - MOTOR EFFICIENCY AT 1/2 LOAD: 87.6-85.6%
 - MOTOR EFFICIENCY AT 3/4 LOAD: 87.7-87.2%
 - MOTOR EFFICIENCY AT FULL LOAD: 86.7%
 - PIPE CONNECTION: DN 50
 - POWER (P2) REQUIRED BY PUMP: 2.2 kW
 - PRESSURE STAGE: PN 16
 - PUMPED liquid: Water
 - RATED CURRENT: 4.9 A
 - RATED POWER - P2: 2.2 kW
 - RATED SPEED: 1450 rpm
 - RESULTING HEAD OF THE PUMP: 18.7 m
 - SHAFT SEAL: BAQE
 - SPEED FOR PUMP DATA: 1450 rpm

Catalog

IFC



IFC data format – with property

BIM viewer by FM operators

