Case Study: HVAC System Design & Shop Drawing for The School Project.

Project Name: BAIS SHAINDEL HIGH SCHOOL.

Location: 500 Lewin Avenue Lakewood Township, Ocean County, NJ, USA.

Scope: Mechanical Design + SHOP Drawing.

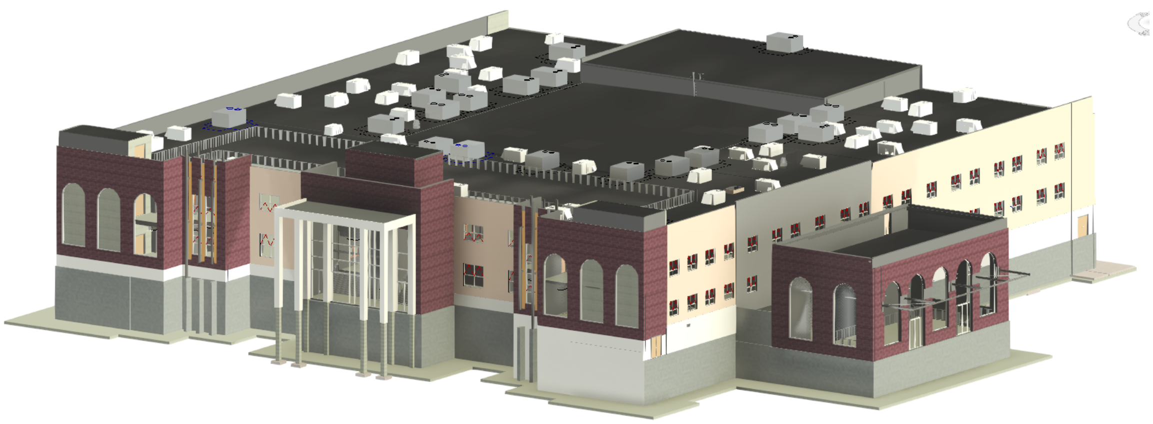
Area: 2,88,000 Square Foot.

Description:

Our mechanical design process was meticulously carried out in accordance with the New York Mechanical Codes and Energy Conservation Codes. Subsequently, we employed Revit Fabrication to create detailed shop drawings. This approach ensures that our mechanical systems not only meet regulatory standards but also adhere to the specific requirements and energy conservation guidelines set forth by the city of New York. We are tasked with creating comprehensive Mechanical Fabrication Drawings with a Building Information Modeling (BIM) model for the 4-story, 2,88,000-square-foot high-rise building at 500 Lewin Avenue Lakewood Township, Ocean County, NJ, USA. The utilization of Revit Fabrication facilitates precision and efficiency in our shop drawings, contributing to the overall success of the project. Our work involves duct design as per given mechanical calculations, Diffuser placement, Duct sizing, Duct shaft finalization, Fabrication Duct routing, Coordination with Architecture and Structure, Duct scheduling, Detailed annotation & tagging, Sheet creation using Autodesk Revit and Navisworks. We utilize Autodesk Docs for documentation and collaboration, ensuring efficient project coordination and clash detection. Our goal is to provide a precise and efficient MEPF BIM model to support the project's success.

Architecture Model:

We have received the Revit Architectural file as input from the client which we linked to our Revit Model. So that we can set the views and do real-time mechanical modeling. It is always essential to have a perfect Revit Architectural model. We have coordinated the architectural shaft as per fabrication ducts.



HVAC System:

A. Load Calculation & Ventilation Calculation.

i) We applied the 2021 International Mechanical Codes for our ventilation calculations, resulting in an estimated ventilation flow rate of approximately 60,000 CFM.

ii) We performed load calculations using Trace-700 software, which yielded a total load of 500 tons. Below is an example of a classroom export from the Trace-700 software for reference.

02-01-Classroom

COOLING COIL PEAK — Peaked at Time: Mo/Hr: 7 / 18; Outside Air: OADB/WB/HR: 84 / 71 / 93
CLG SPACE PEAK — Mo/Hr: 9 / 14; OADB: 82

	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Percent Of Total (%)	Space Sensible Btu/h	Percent Of Total (%)
Envelope Loads						
Skylite Solar	0	0	0	0	0	0
Skylite Cond	0	0	0	0	0	0
Roof Cond	0	7,139	7,139	6	0	0
Glass Solar	11,197	0	11,197	10	18,125	32
Glass/Door Cond	1,373	0	1,373	1	871	2
Wall Cond	0	0	0	0	0	0
Partition/Door	0		0	0	0	0
Floor	0		0	0	0	0
Adjacent Floor	0	0	0	0	0	0
Infiltration	3,672		3,672	3	986	2
Sub Total ==>	16,242	7,139	23,382	20	19,982	36
Internal Loads						
Lights	7,782	1,945	9,727	8	2,457	4
People	37,800	0	37,800	32	21,000	37
Misc	11,550	0	11,550	10	12,041	21
Sub Total ==>	57,131	1,945	59,077	51	35,498	63
Ceiling Load	1,009	-1,009	0	0	563	1
Ventilation Load	0	0	36,237	31	0	0
Adj Air Trans Heat	0		0	0	0	0
Dehumid. Ov Sizing			0	0		
Ov/Undr Sizing	8		8	0	8	0
Exhaust Heat		-1,861	-1,861	-2		
Sup. Fan Heat			0	0		
Ret. Fan Heat		0	0	0		
Duct Heat Pkup		0	0	0		
Underflr Sup Ht Pkup			0	0		
Supply Air Leakage		0	0	0		
Grand Total ==>	74,390	6,215	116,843	100.00	56,052	100.00

HEATING COIL PEAK — Mo/Hr: Heating Design; OADB: 15

	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)
Envelope Loads			
Skylite Solar	0	0	0.00
Skylite Cond	0	0	0.00
Roof Cond	0	-5,913	5.38
Glass Solar	0	0	0.00
Glass/Door Cond	-8,179	-8,179	7.44
Wall Cond	0	0	0.00
Partition/Door	0	0	0.00
Floor	0	0	0.00
Adjacent Floor	0	0	0.00
Infiltration	-7,815	-7,815	7.11
Sub Total ==>	-15,994	-21,907	19.94
Internal Loads			
Lights	0	0	0.00
People	0	0	0.00
Misc	0	0	0.00
Sub Total ==>	0	0	0.00
Ceiling Load	-654	0	0.00
Ventilation Load	0	-27,963	25.45
Adj Air Trans Heat	0	0	0
Ov/Undr Sizing	0	0	0.00
Exhaust Heat		1,207	-1.10
OA Preheat Diff.		-64,170	58.40
RA Preheat Diff.		0	0.00
Additional Reheat		0	0.00
System Plenum Heat		2,946	-2.68
Underflr Sup Ht Pkup		0	0.00
Supply Air Leakage		0	0.00
Grand Total ==>	-16,649	-109,887	100.00

TEMPERATURES

	Cooling	Heating
SADB	55.0	78.5
Ra Plenum	76.1	71.3
Return	76.1	71.3
Ret/OA	77.9	63.0
Fn MtrTD	0.0	0.0
Fn BldTD	0.0	0.0
Fn Frict	0.0	0.0

AIRFLOWS

	Cooling	Heating
Diffuser	2,891	2,891
Terminal	2,891	2,891
Main Fan	2,891	2,891
Sec Fan	0	0
Nom Vent	1,450	1,450
AHU Vent	1,450	1,450
Infil	123	123
Min Stop/Rh	0	0
Return	3,014	3,014
Exhaust	1,573	1,573
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS

	Cooling	Heating
% OA	50.2	50.2
cfm/ft²	0.96	0.96
cfm/ton	237.29	
ft²/ton	246.22	
Btu/hr·ft²	48.74	-38.02
No. People	105	

COOLING COIL SELECTION

	Total Capacity ton	Total Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB °F	Enter WB °F	Enter HR gr/lb	Leave DB °F	Leave WB °F	Leave HR gr/lb
Main Clg	11.2	134.4	79.5	2,891	77.9	66.4	79.0	55.0	51.1	49.5
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	1.0	11.8	11.6	1,450	87.0	71.9	93.8	79.8	69.8	93.7
Total	12.2	146.2								

AREAS

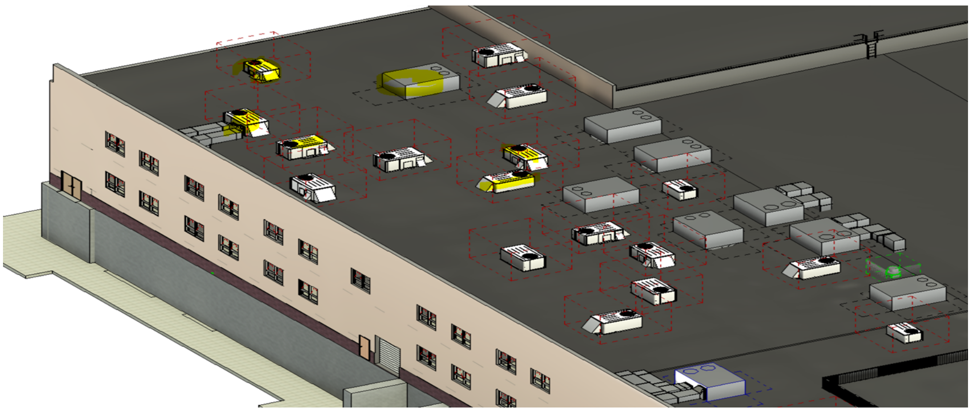
	Gross Total	Glass ft²	Glass (%)
Floor	3,000		
Part	0		
Int Door	0		
ExFlr	0		
Roof	3,000	0	0
Wall	356	356	100
Ext Door	0	0	0

HEATING COIL SELECTION

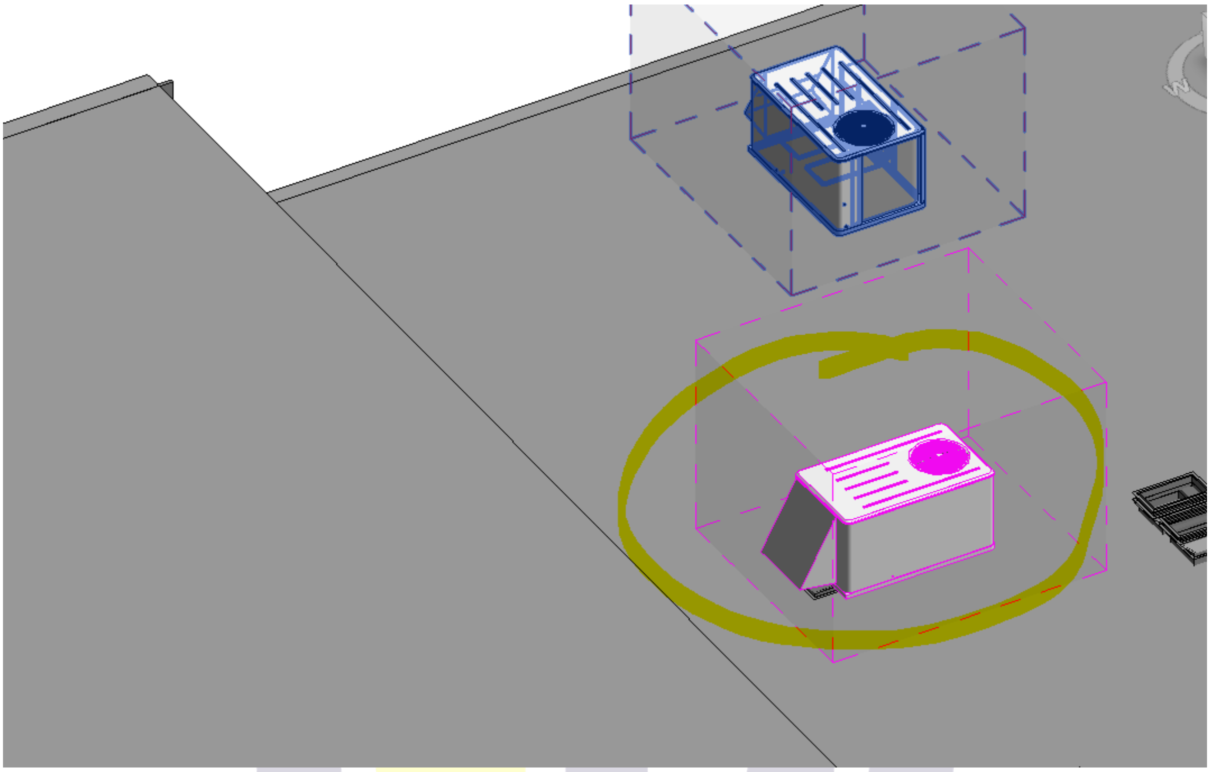
	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-49.9	2,891	63.0	78.5
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	-64.2	1,450	15.0	54.7
Total	-114.1			

b) HVAC System.

i) Heating and Cooling: We supplied gas-fired rooftop units for the school building, each with a capacity ranging from 10 tons to 25 tons. These units are all situated on the roof. To enhance energy efficiency, we opted for the air-side economizer feature, eliminating the need for chillers, and capitalizing on the local climate conditions.



ii) Bathroom and General Exhaust: We implemented an energy recovery wheel in the bathroom exhaust system, successfully conserving energy. In this setup, each bathroom and the general exhaust are routed to an Energy Recovery Ventilator (ERV), which then ventilates the corridor by harnessing the recovered temperature from the exhaust air.



c) To effectively utilize the energy conservation code for energy savings, we implemented the following steps:

i) Demand Control Ventilation: We integrated a demand control ventilation system, which adjusts the ventilation rate based on occupancy levels, ensuring that the building receives the necessary fresh air while minimizing unnecessary energy consumption.

ii) Supply Air Temperature Reset in the RTU: We employed supply air temperature reset in the Rooftop Units (RTUs). This feature helps maintain comfort while optimizing the HVAC system's energy efficiency by adjusting the supply air temperature according to the building's actual heating and cooling needs.

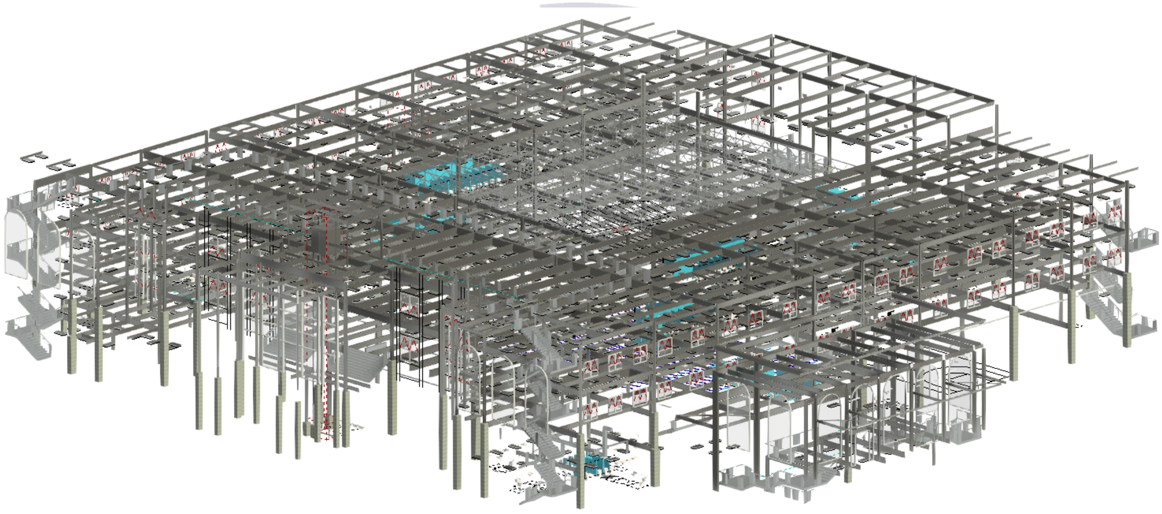
iii) Airside Economizer: To capitalize on favorable outdoor conditions, we utilized the airside economizer option in the HVAC system. This allowed us to reduce the reliance on mechanical cooling and take advantage of natural air cooling when outdoor temperatures permit, thus saving on energy costs.

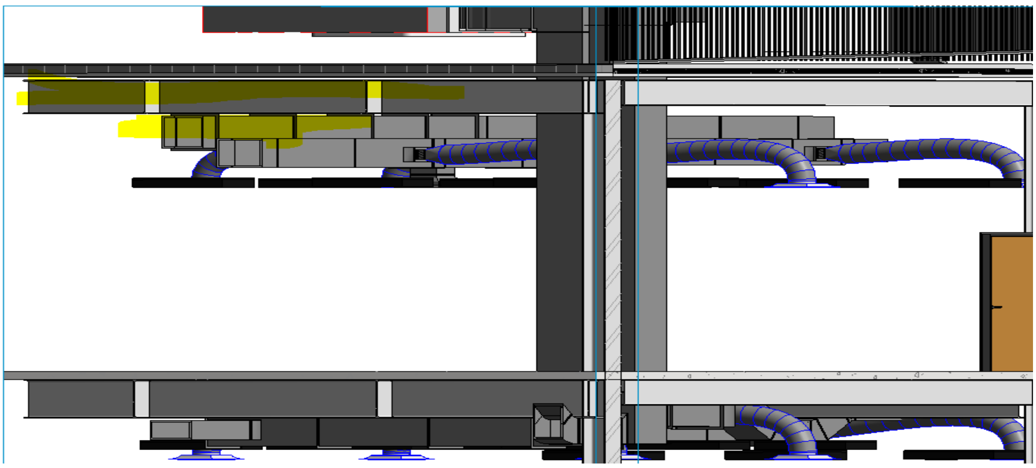
iv) Energy Recovery Wheel: We incorporated energy recovery wheels into the system to recover and reuse the energy from exhaust air, reducing the overall energy consumption and promoting sustainability.

By implementing these strategies, we aimed to comply with energy conservation codes, conserve energy, and achieve cost savings in electricity bills.

Structure Model:

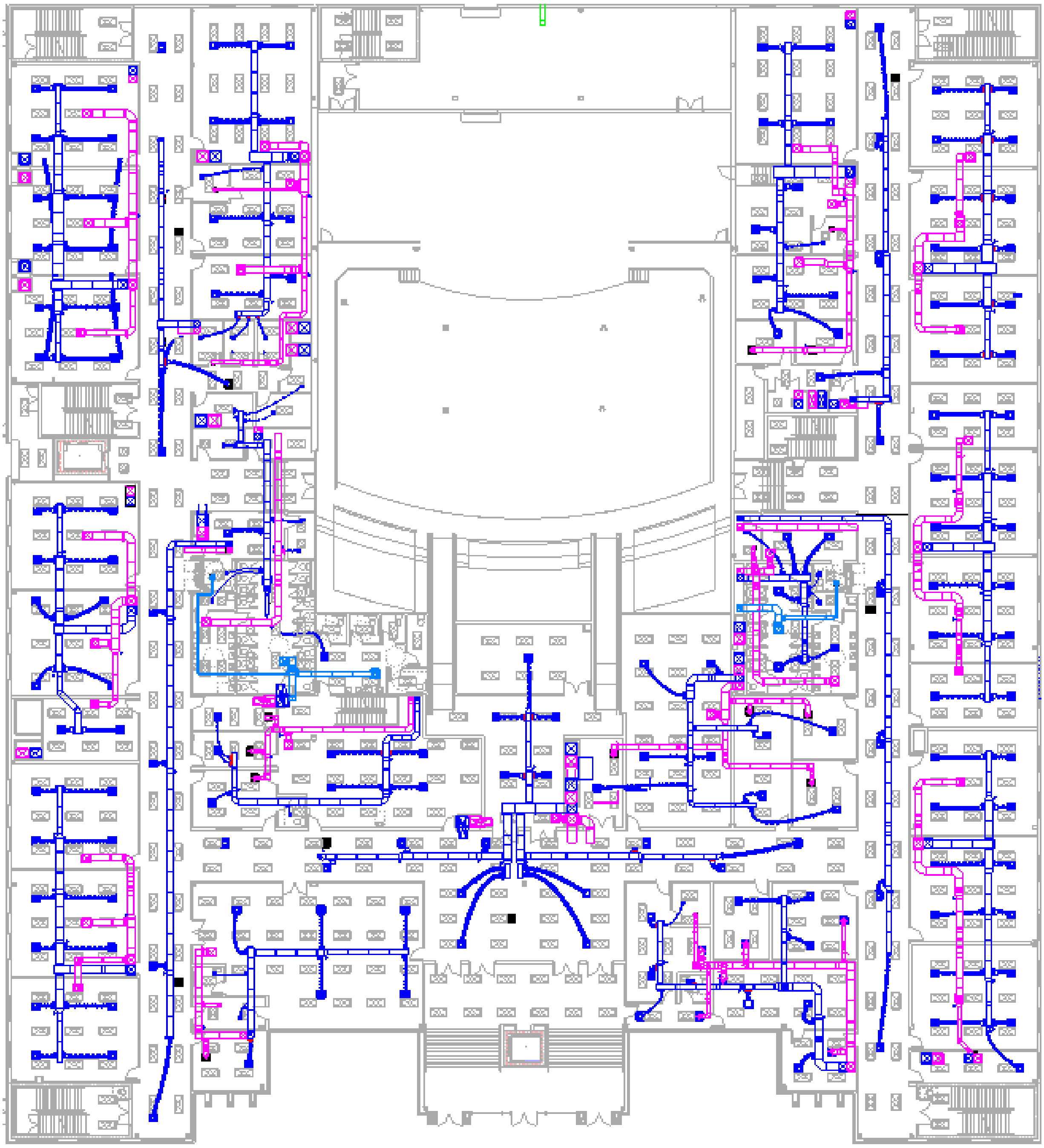
We have received the Revit Structural file as input from the client which we linked to our Revit Fabrication Model. We have coordinated the mechanical fabrication ducts with the structural I beam and structural column.





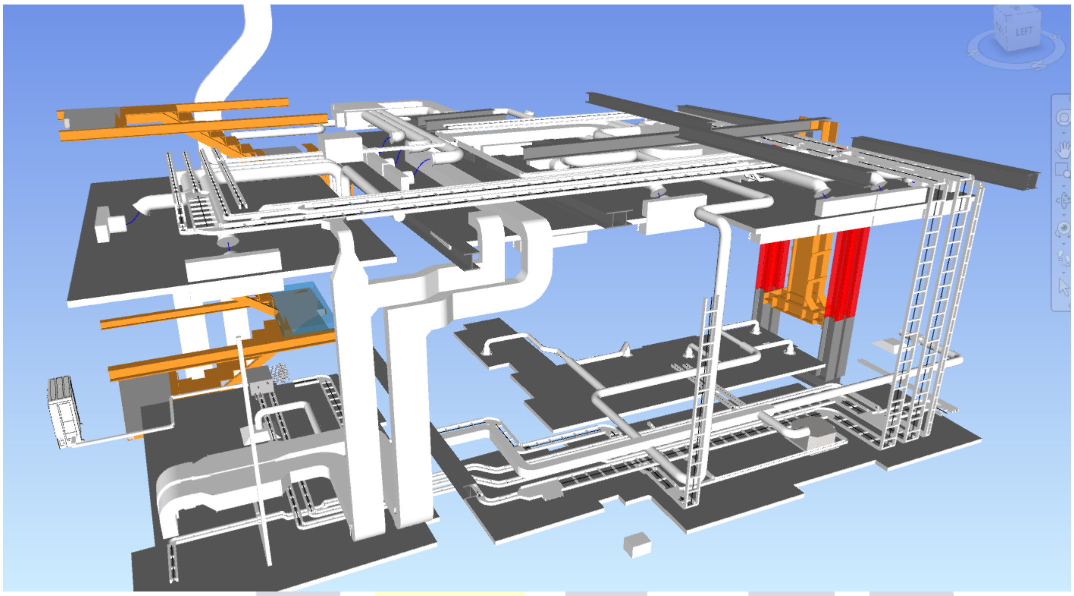
Mechanical Shop Drawings:

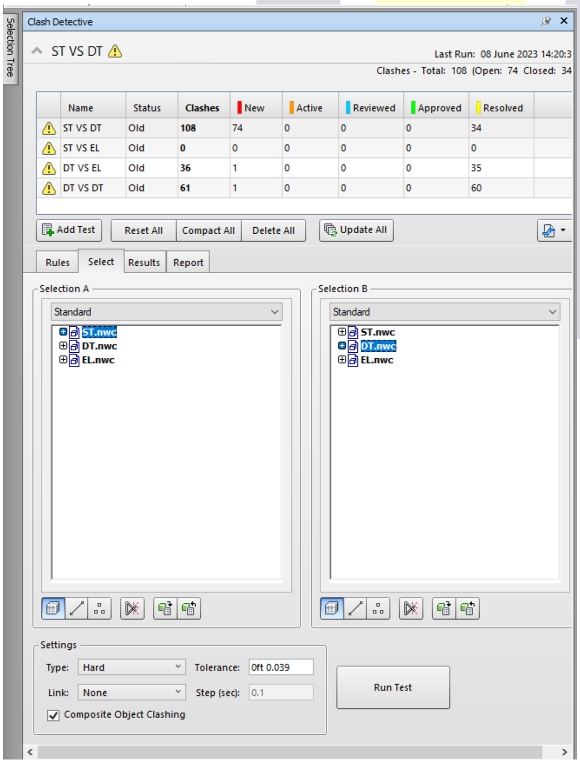
Once the design was completed and received approval from the Department of Building, a contractor was appointed, and we were recommended by the client to proceed with creating the shop drawings. In this phase, we adhered to SMACNA (Sheet Metal and Air Conditioning Contractors' National Association) standards for duct fabrication. We also received specific duct length requirements from the client to accommodate the installation process, which was crucial due to their machining requirements.



Coordination using Navisworks:

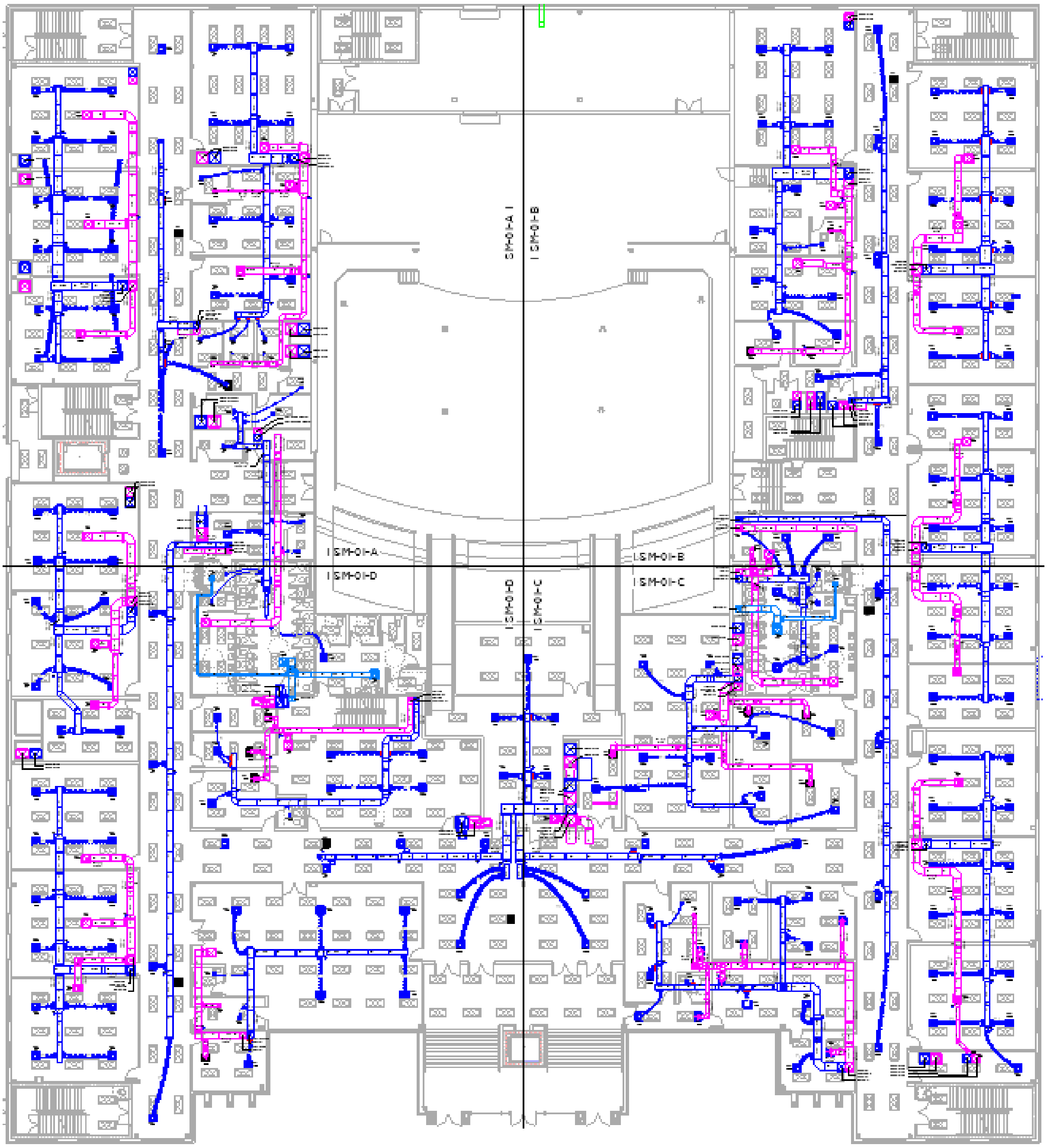
After completing the ductwork, we exported the ASMEPF Revit models to Navisworks (NWC format) to perform clash detection. This step is crucial for identifying and resolving any conflicts or clashes that may have arisen during the design and installation process, ensuring the smooth functioning of the HVAC system and the overall success of the project.



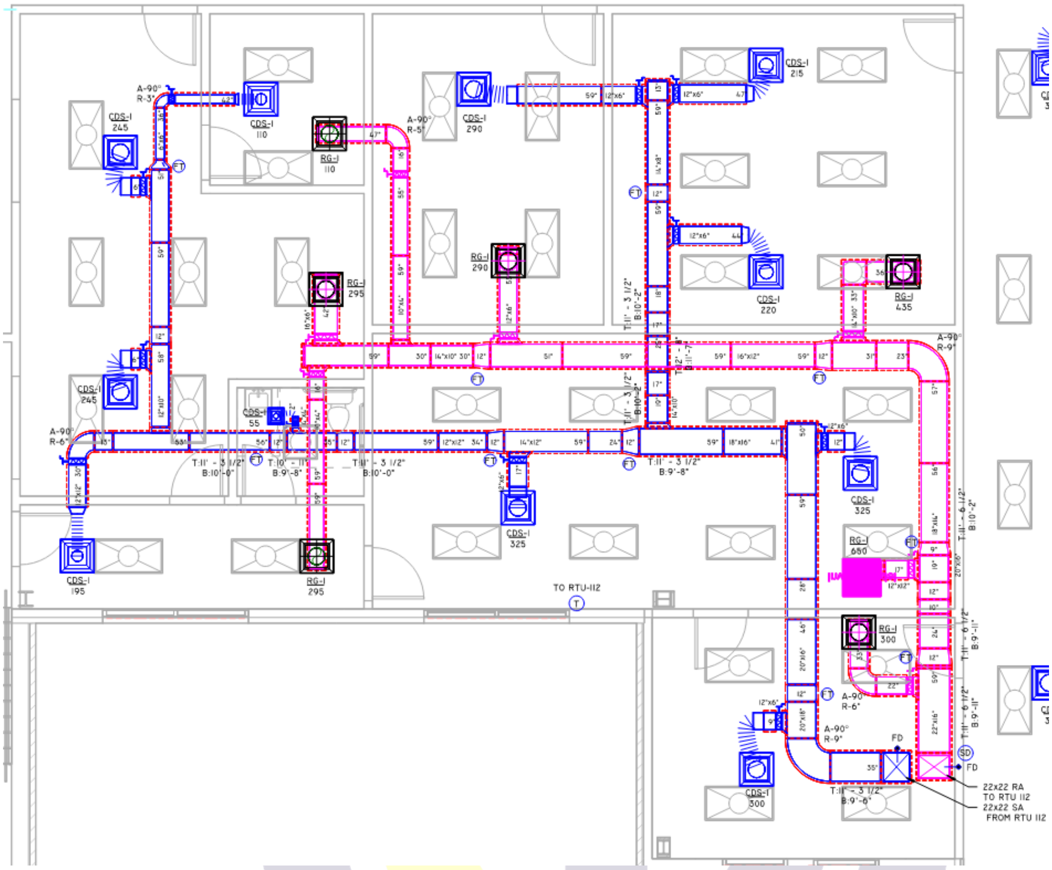


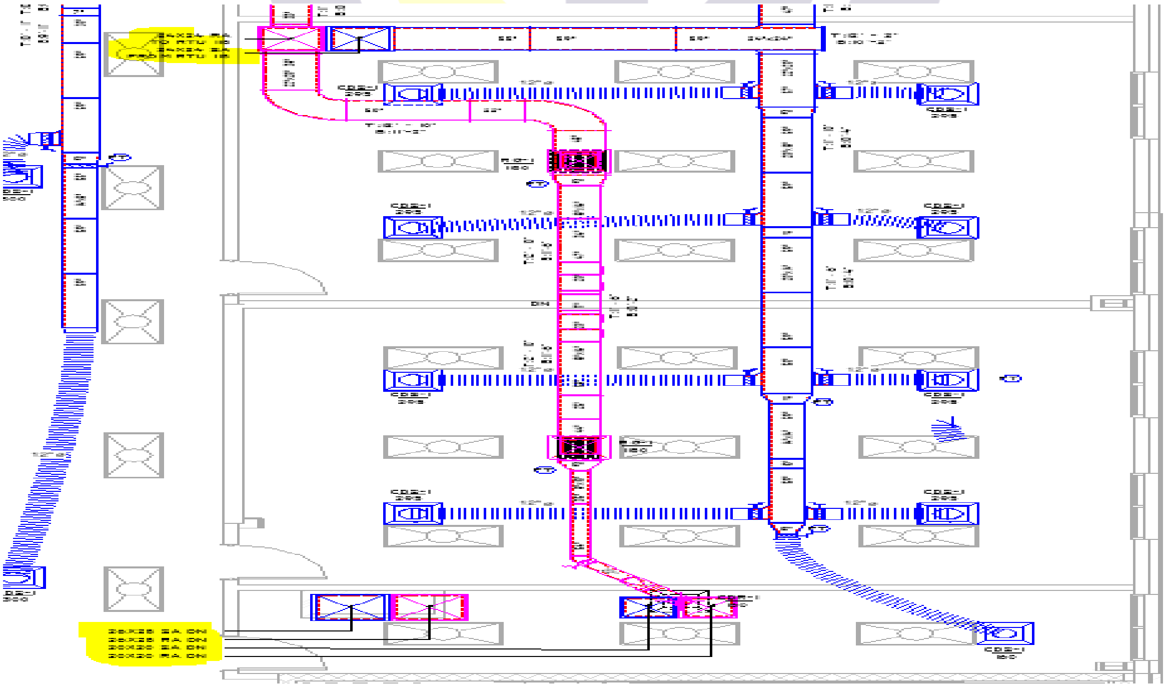
Mechanical Fabrication Sheet View:

After achieving a clash-free model, we proceeded with the detailed annotation and tagging process. This step involved adding comprehensive labels, annotations, and tags to the model to provide clear and organized information for construction and maintenance purposes.



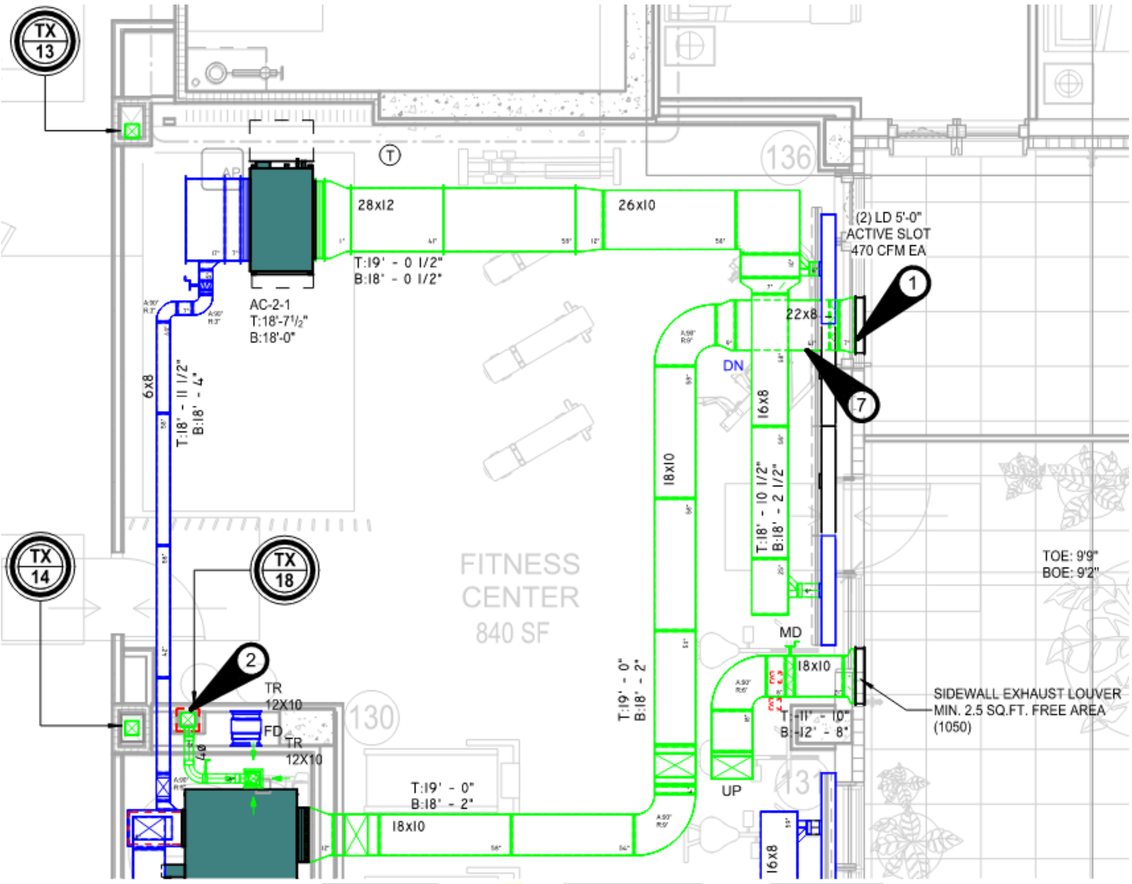
Detailed view from Zone 112:

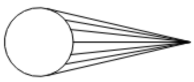




Addressing Conflicts Using Flags:

It is a standard practice for us to raise red flags when there are conflicts between our HVAC design and the architectural or structural aspects of the project. This proactive approach ensures that architects and contractors are made aware of any potential clashes or issues that need resolution, promoting effective communication and collaboration among all project stakeholders.





THIS SYMBOL INDICATES A NOTE TO THE ARCHITECT OR ENGINEER. IF NOT ADDRESSED, THE ISSUE WILL BE CONSIDERED ACCEPTED AS SHOWN.

1	ENGINEER TO PROVIDE LOUVER SIZE.
2	DUCT CONFLICT WITH WALL. ARCHITECT/ENGINEER TO SUGGEST.
3	ENGINEER/ARCHITECT TO CONFIRM THE ELEVATION OF THE UNIT.
4	ENGINEER TO CONFIRM THE ORIENTATION.
5	ENGINEER TO VERIFY ALL DUCT CONNECTION TO ERV.
6	ENGINEER TO CONFIRM CEILING HEIGHT.
7	DUCT CONFLICTS WITH CEILING. ENGINEER/ARCHITECT TO SUGGEST.

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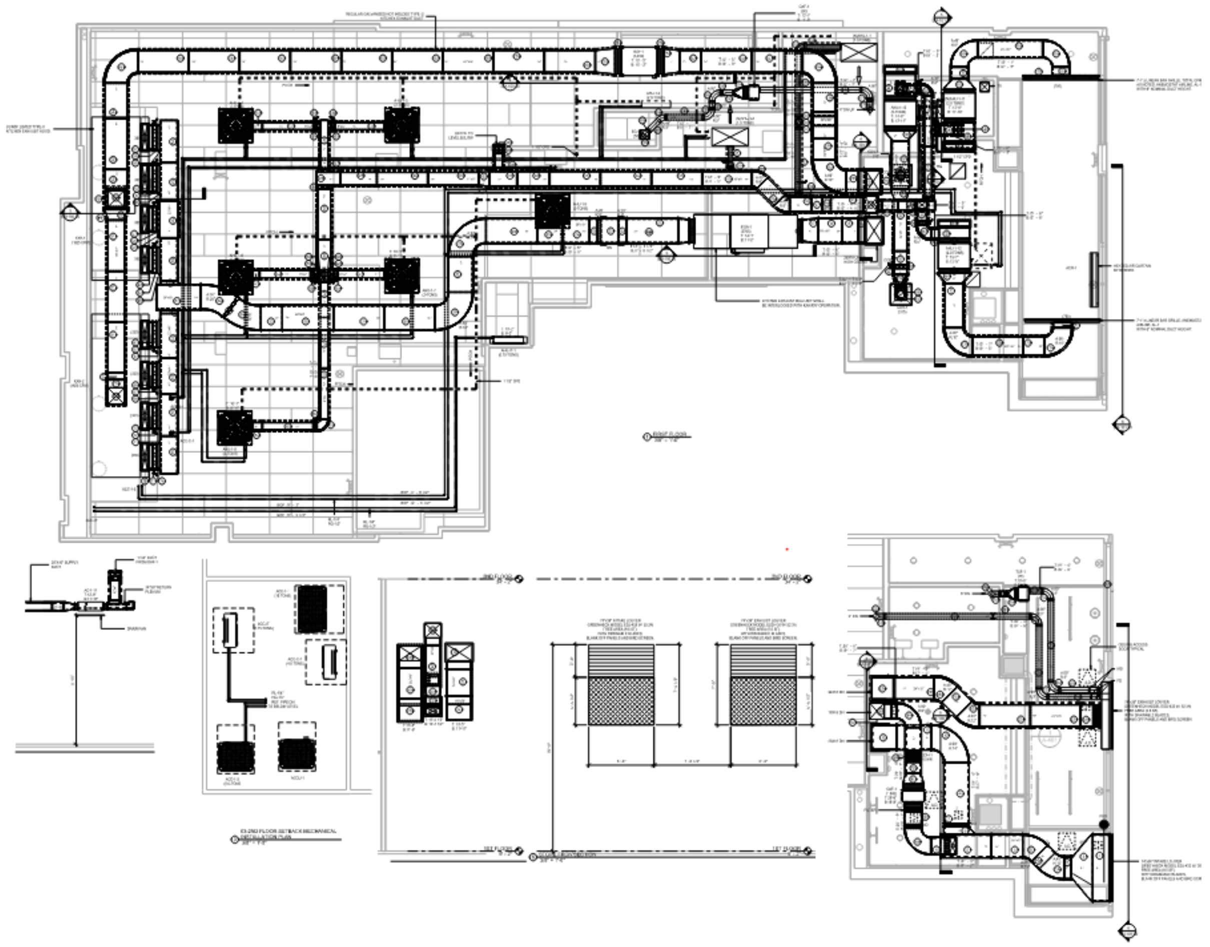
Quantity Take off:

We assigned a unique part number to each duct fitting and accurately determined the quantity required for fabrication. This method of labeling and quantifying duct fittings streamlines the manufacturing process, ensuring that the correct components are produced and assembled as needed for the project.



DUCTWORK QUANTITY TAKEOFF

Mark	Size	Length	Fabrication Fitting Description

DUCTWORK QUANTITY TAKEOFF

Mark	Size	Length	Fabrication Fitting Description

DUCTWORK QUANTITY TAKEOFF

Mark	Size	Length	Fabrication Fitting Description