

Industrial Building Classification F2 versus F3

What Makes the Difference?

Ryan Fidler, P.Eng.
Structural Engineer

Jarrid Crichton, B.Env.D.
Building Code Specialist

Dennis Hodgkinson, P.Eng., FEC
Senior Partner

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What are Typical Industrial Buildings?

- Warehouses
- Manufacturing Plants
- Vehicle Repair Garages
- Workshops
- Sales Rooms
- Food Processing Plants

What Are Industrial Buildings? Group F, Division 2

NBCC 2010, Division B, Appendix A-3.1.2.1.(1) National Building Code 2010
Examples

The uses listed are described as examples. When conducting a building code review, we use this listing as a starting point in determining occupancy classification.

Aircraft hangars

Box factories

Candy plants

Cold storage plants

Dry cleaning establishments not using flammable or explosive solvents or cleaners

Electrical substations

Factories

Freight depots

Helicopter landing areas on roofs

Laboratories

Laundries, except self-service

Mattress factories

Planing mills

Printing plants

Repair garages

Salesrooms

Service stations

Storage rooms

Television studios not admitting a viewing audience

Warehouses

Wholesale rooms

Woodworking factories

Workshops

What Are Industrial Buildings? Group F, Division 3

NBCC 2010, Division B, Appendix A-3.1.2.1.(1) National Building Code 2010 Examples:

- Creameries
- **Factories**
- **Laboratories**
- Light-aircraft hangars (storage only)
- Power plants
- **Salesrooms**
- Sample display rooms
- Storage garages, including open air parking garages
- **Storage rooms**
- **Warehouses**
- **Workshops**

What Are Industrial Buildings?

NBCC 2010 (Div A, 1.4.1.2)

Industrial Occupancy

the occupancy or use of a building or part thereof for the assembling, fabricating, manufacturing, processing, repairing, or storing of goods and materials

Low-Hazard Industrial Occupancy (Group F, Division 3)

“means an industrial occupancy in which the combustible content is not more than 50 kg/m² or 1200 MJ/m² of floor area”

Medium-Hazard Industrial Occupancy (Group F, Division 2)

“means an industrial occupancy in which the combustible content is more than 50 kg/m² or 1200 MJ/m² of floor area and not classified as a high-hazard industrial occupancy”

High-Hazard Industrial Occupancy (Group F, Division 1)

“means an industrial occupancy containing sufficient quantities of highly combustible and flammable or explosive materials which, because of their inherent characteristics, constitute a special fire hazard”

Fire and Life Safety Requirements F2 vs. F3 Occupancy Classifications

Different building code and construction requirements apply to the same building depending on whether it is classified as an F2 or F3 major occupancy, including:

- Code conformance article, which determines whether a sprinkler system, fire rated assemblies such as roof, mezzanine and fire rated loadbearing structural elements are required or not
- Required construction type and fire ratings of exterior walls for spatial separations and limiting distances as determined by Tables 3.2.3.1.(B & C) and Table 3.2.3.7
- Exiting requirements from mezzanine areas, as described under Article 3.4.2.2

EXAMPLE 1: F2 vs. F3 Conformance Article

For one storey industrial building of combustible construction with an area of 1 600 m², the requirements would be as follows:
(NBCC 2010, F2→ 3.2.2.72 - 3.2.2.77 F3→ 3.2.2.78 - 3.2.2.88)

F2 Classification

Conformance Article: 3.2.2.77

Sprinklers: **Required**

Floor Assemblies: N/A (1 storey)

Combustible Loadbearing Elements Supporting Fire-Rated Assemblies: N/A (1 storey)

F3 Classification

Conformance Article: 3.2.2.83

Sprinklers: **Not Required**

Floor Assemblies: N/A (1 storey)

Combustible Loadbearing Elements Supporting Fire-Rated Assemblies: N/A (1 storey)

EXAMPLE 2: F2 vs. F3 Conformance Article

A one storey industrial building of combustible construction with an area of 1500 m², facing 1 street for firefighting access and mezzanine:

F2 Classification

Conformance Article: 3.2.2.74.

Sprinklers: Not Required

Mezzanines (Combustible): **45 minute Fire-Resistance Rating (F.R.R.)**

Roof Assemblies (Combustible): **45 min F.R.R.**

Combustible Loadbearing Elements Supporting Fire-Rated Assemblies: **45 min F.R.R.**

Loadbearing Elements Supporting Fire Separations: **F.R.R. equals the fire separation**

F3 Classification

Conformance Article: 3.2.2.83.

Sprinklers: Not Required

Mezzanines: **No Fire Rating Required**

Roof Assemblies: **No Fire Rating Required**

Combustible Loadbearing Elements Supporting Fire-Rated Assemblies: N/A (1 storey)

EXAMPLE 3: F2 vs. F3 Limiting Distance & Spatial Separation Requirements

An example building on a site where the exposing building face is permitted 11% unprotected opening (U.P.O.'s):

F2 Classification

Type of Construction: Combustible Permitted

Type of Cladding: Non-combustible Required

Required Fire-Resistance Rating: **2 Hours**

F3 Classification

Type of Construction: Combustible Permitted

Type of Cladding: Non-combustible Required

Required Fire-Resistance Rating: **1 Hour**

EXAMPLE 4: F2 vs. F3 Limiting Distance & Spatial Separation Requirements

An exposing building face having a limiting distance of 3.0 m, an area of 150 m² and an L/H ratio between 3:1 and 10:1:

F2 Classification

Allowable % of Unprotected Openings: 6%

Type of Construction: **Non-combustible Required**

Type of Cladding: Non-combustible Required

Required Fire-Resistance Rating: **2 Hours**

F3 Classification

Allowable % of Unprotected Openings: 11%

Type of Construction: **Combustible Permitted**

Type of Cladding: Non-combustible Required

Required Fire-Resistance Rating: **1 Hour**

EXAMPLE 5: F2 vs. F3 Mezzanine Egress Requirements

The required quantity of exits or egress stairs for a mezzanine is dependent on the area of, and maximum travel distance from the mezzanine to the top of an egress stair (provided there are at least 2 egress doors in the space below)

F2 Classification

Max allowable travel distance: **10 m**

Max mezzanine area for a single egress stair: **150 m²**

F3 Classification

Max allowable travel distance: **15 m**

Max mezzanine area for a single egress stair: **200 m²**

How Industrial Occupancies are classified?

- Principal Use
- Occupant load
- Public Safety
- Owner's Requirements
- Combustible Content
 - Low-Hazard Industrial Occupancy F3
Combustible content $< 50 \text{ kg/m}^2$ or 1200 MJ/m^2
 - Medium -Hazard Industrial Occupancy F2
Combustible content $> 50 \text{ kg/m}^2$ or 1200 MJ/m^2

What is Fire Load Calculation?

Fire Load (NFPA 557) *the fire load of all movable or secured contents and furnishings and all occupant possessions within a compartment, including all the items that can be placed into a compartment or taken out of it without causing structural damage, expressed in MJ*

Combustible Content (NBCC 2010) *combustible means that a material fails to meet the acceptance criteria of CAN/ULC-S114, "Test for Determination of Non-Combustibility in Building Materials"*

Sample Calculation

$$Q = \frac{\sum(k_i m_i h_i)}{A_f}$$

Where:

Q = total fire load per area m^2 of floor area (MJ)

k_i = proportion of content or building component, i , that is combustible

m_i = mass of item, i (kg)

h_i = calorific value of item, i (MJ/kg)

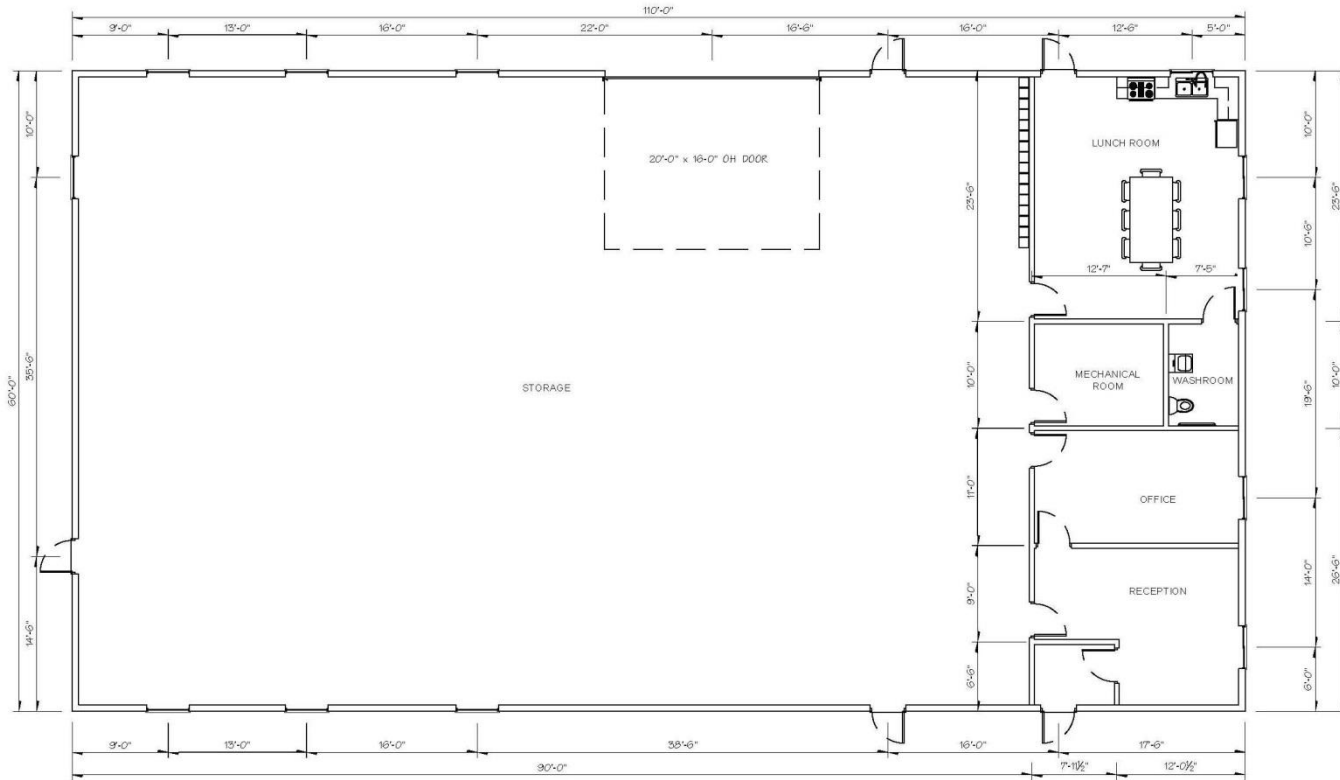
A_f = floor area of fire compartment (m^2)

Fire Load Calculation Reference Material

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Case Study #1

F3 Warehouse with Ancillary Office Space



 **MAIN FLOOR PLAN**
3/32" = 1'-0"

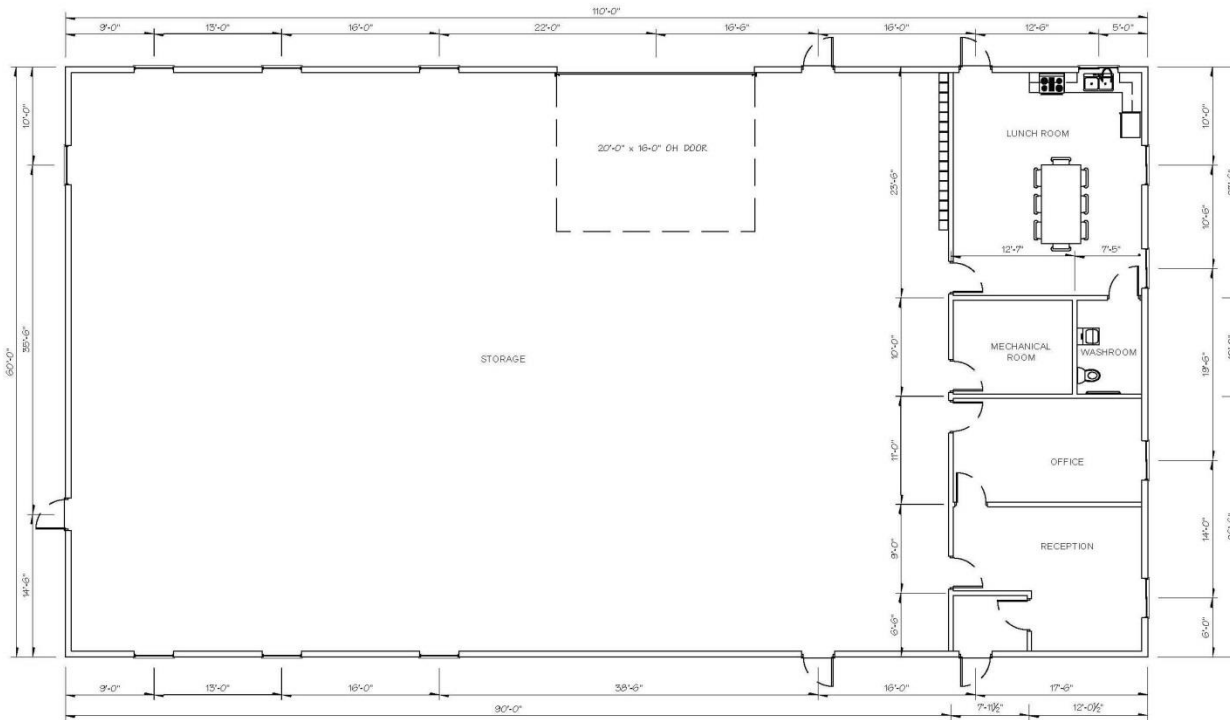
Case Study #1. Calculations

	Forklift (propane)	
Vehicles and Tires		
Typical Mass truck (kg)	1,814	= INPUT
# of Tires forklift	4	
Tire Weight (kg)	175	
Total Tire Weight (kg)	700	
Combustible Weight truck (kg) - Assumed 10% of Total	181	
Fuel Cap (Gal)	18	
Fuel Cap (L)	68	
Fuel Mass	60	
Comb Content of Vehicle (kg)	881	
Total Comb Content w/ Fuel (kg)	941	
Energy of Combustion Plastic (MJ)	7,437	
Energy of Combustion Tire (MJ)	23,100	
Energy of Combustion Fuel (MJ)	2,458	
Total Energy of Combustion of V	30,537	
Total Energy of Combustion (V + Fuel)	32,996	
Number of Vehicles/sets of spare tires	2	
Typ Total Mass (kg)	5,511	
Typical Combustible Mass (kg)	1,763	
Typical Energy of Combustion (MJ)	65,992	
Other Combustible Content	Bond paper	Pallets
Number	24	24
Unit mass (kg)	1,037.00	23.60
Total Mass (kg)	24,888	566
Total EoC (MJ)	405,674	10,762
OFFICE COMBUSTIBLE CONTENT		
Area of Office (sqm)	111	
Average Energy Density by NFPA (MJ/sqm)	1,664	
EoC (MJ)	185,503	
Building Size (ft x ft)	60	110
Total Area of Building (sqm)	613	
Typical Combustible Mass (kg)	27,217	
Typical Energy of Combustion (MJ)	667,930	
Combustible Mass Density (kg/sqm)	44.39	cannot exceed 50 to remain an F3
Energy of Combustion Density (MJ/sqm)	1089	cannot exceed 1200 to remain an F3

Case Study #2

F2 Warehouse with Ancillary Office Space

Building Code Summary



 MAIN FLOOR PLAN
3/32" = 1'-0"

Occupancy Classification:
Group F, Division 2

Conformance Article: 3.2.2.76

Overall Building Area: 613.2 m²

Total Office Area: 111.5 m²

Building Height: 1 storey

Sprinklers required: No

Case Study #2. Calculations

	Forklift (propane)	
Vehicles and Tires		
Typical Mass truck (kg)	1,814	= INPUT
# of Tires forklift	4	
Tire Weight (kg)	175	
Total Tire Weight (kg)	700	
Combustible Weight truck (kg) - Assumed 10% of Total	181	
Fuel Cap (Gal)	18	
Fuel Cap (L)	68	
Fuel Mass	60	
Comb Content of Vehicle (kg)	881	
Total Comb Content w/ Fuel (kg)	941	
Energy of Combustion Plastic (MJ)	7,437	
Energy of Combustion Tire (MJ)	23,100	
Energy of Combustion Fuel (MJ)	2,458	
Total Energy of Combustion of V	30,537	
Total Energy of Combustion (V + Fuel)	32,996	
Number of Vehicles/sets of spare tires	2	
Typ Total Mass (kg)	5,511	
Typical Combustible Mass (kg)	1,763	
Typical Energy of Combustion (MJ)	65,992	

Other Combustible Content

	Bond paper	Pallets	Widgets
Number	20	20	540
Unit mass (kg)	1,037.00	23.60	5.00
Total Mass (kg)	20,740	472	2,700
Total EoC (MJ)	338,062	8,968	137,970

OFFICE COMBUSTIBLE CONTENT

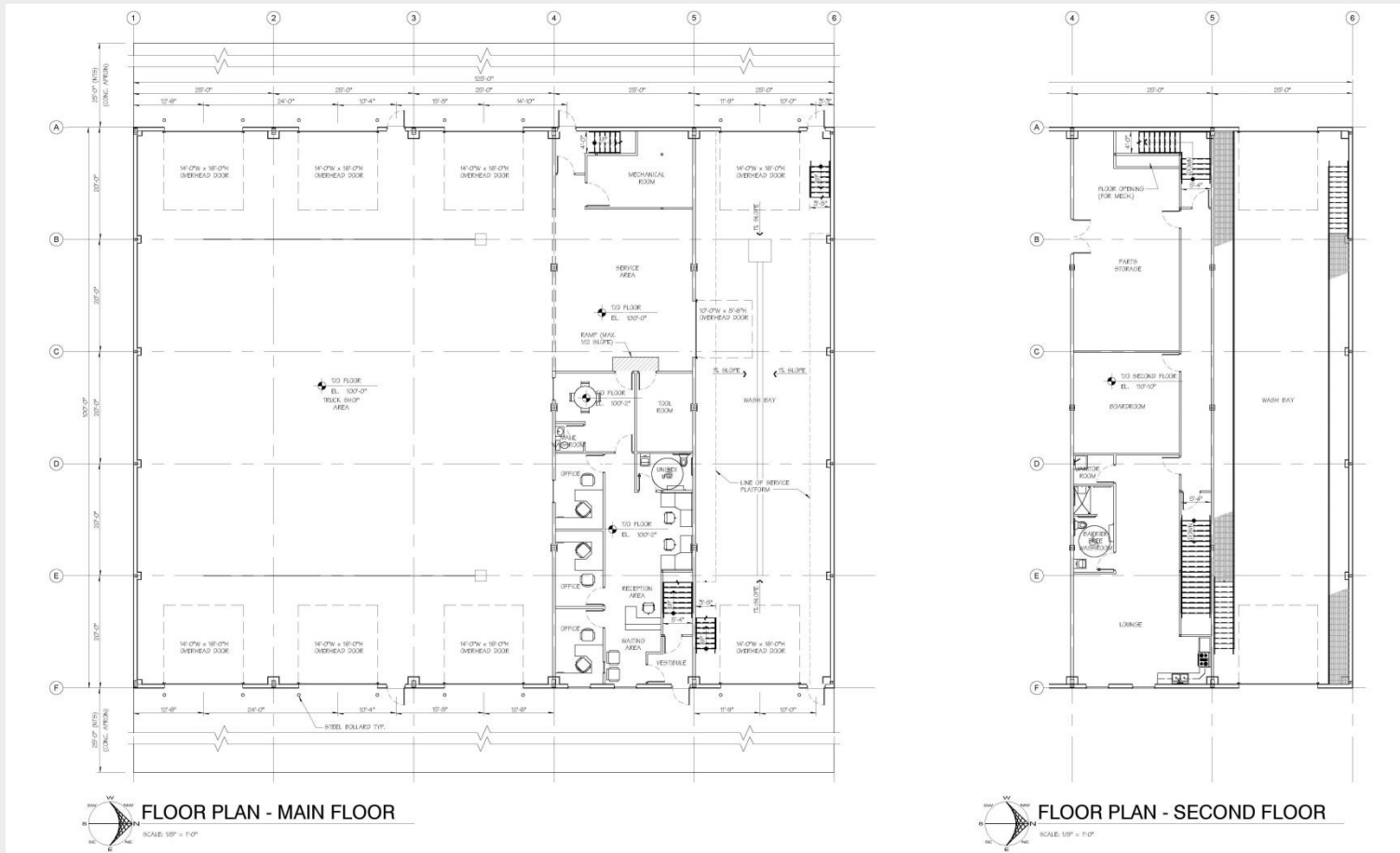
Area of Office (sqm)	111
Average Energy Density by NFPA (MJ/sqm)	1,664
EoC (MJ)	185,503

Building Size (ft x ft)	60	110
Total Area of Building (sqm)	613	

Typical Combustible Mass (kg)	25,675
Typical Energy of Combustion (MJ)	736,494
Combustible Mass Density (kg/sqm)	41.87 cannot exceed 50 to remain an F3
Energy of Combustion Density (MJ/sqm)	1201 cannot exceed 1200 to remain an F3

Case Study #3

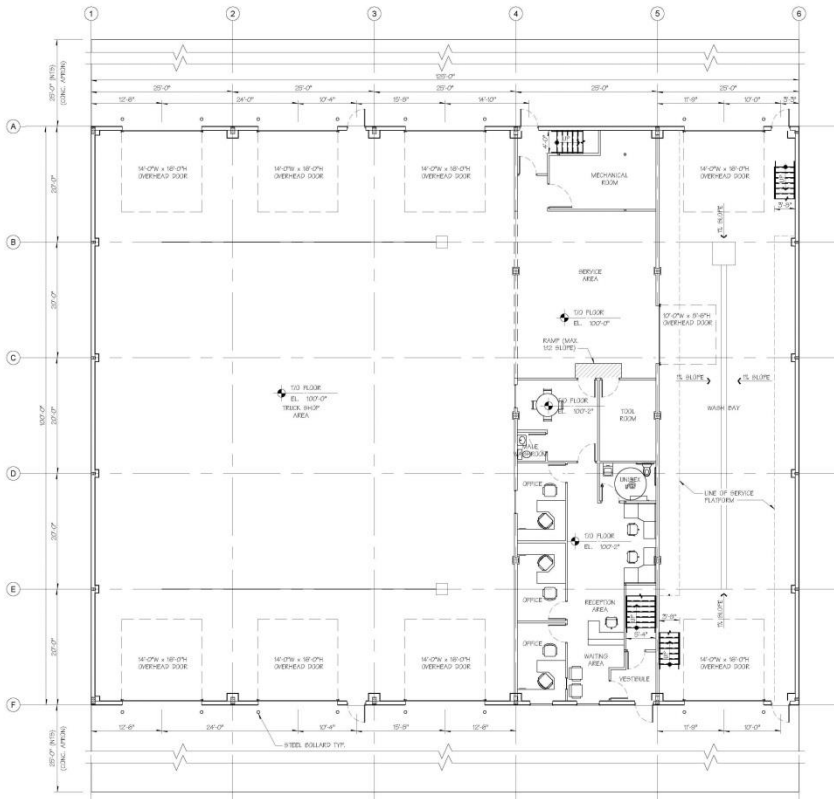
F3 Transport Company Shop



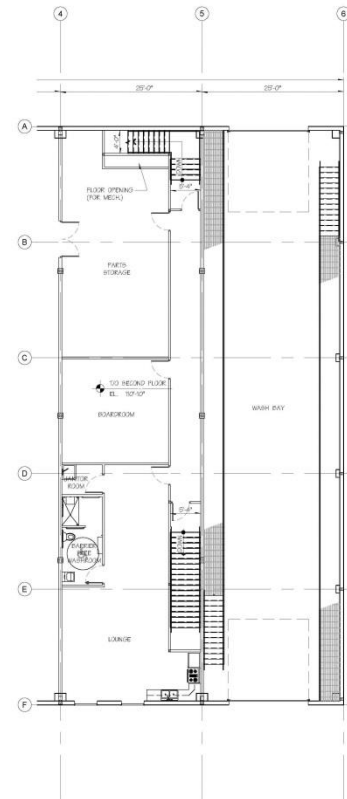
Case Study #3

F3 Transport Company Shop

Building Code Summary



FLOOR PLAN - MAIN FLOOR
SCALE: 1/8" = 1'-0"



FLOOR PLAN - SECOND FLOOR
SCALE: 1/8" = 1'-0"

Occupancy Classification:
Group F, Division 3

Conformance Article:
3.2.2.81

Overall Building Area:
1161.3 m²

Total Office Area:
325 m²

Building Height:
2 storeys

Sprinklers required:
No

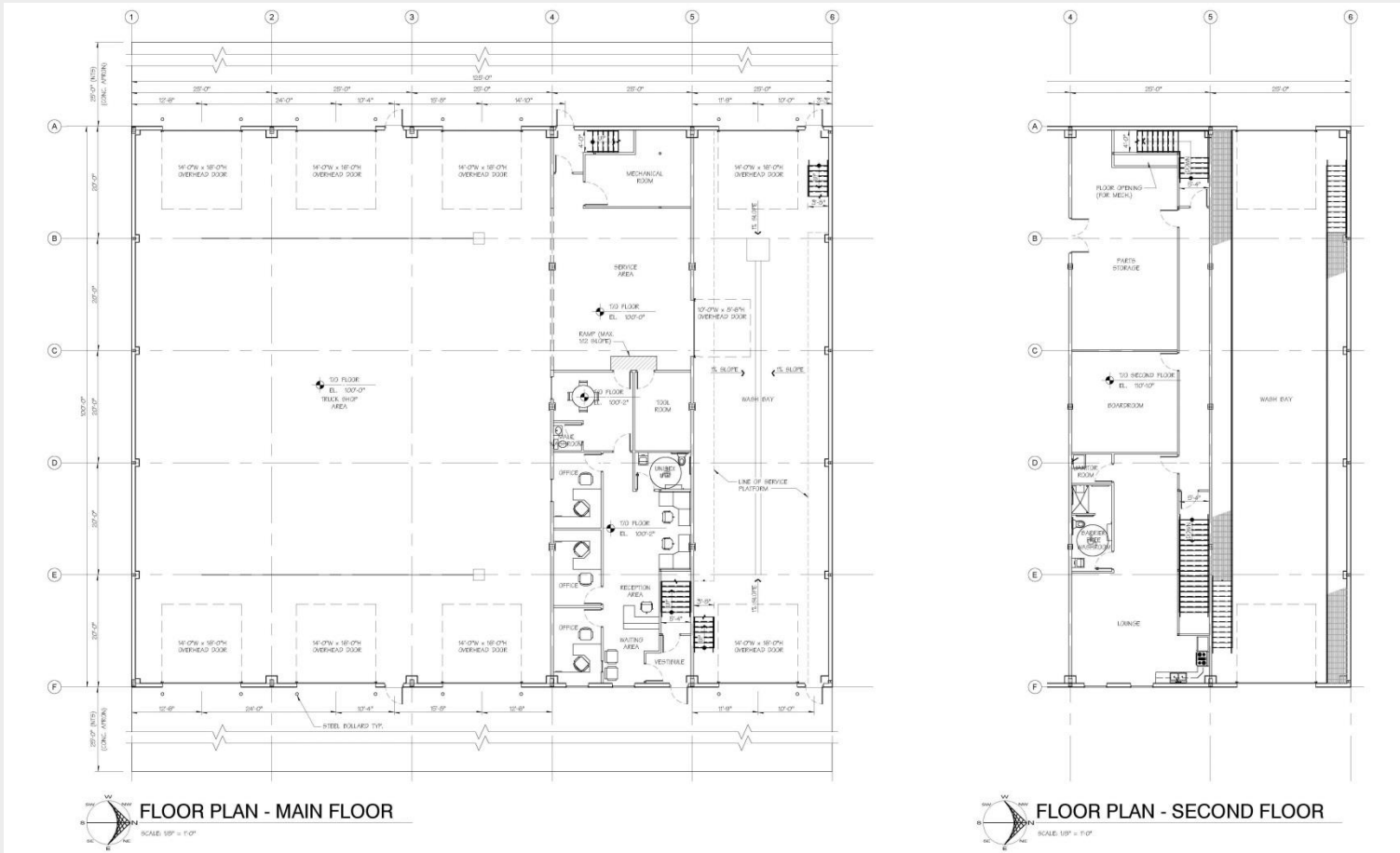
Case Study #3. Calculations

Vehicles and Tires	Semi + Trailer Forklift			= INPUT		
	(diesel)	(propane)	Spare Tires			
Typical Mass truck (kg)	7,258	1,814				
Typical Mass trailer (kg)	5,987					
# of Tires truck	10	4	12			
# of Tires trailer	12					
Tire Weight (kg)	68	175	68			
Total Tire Weight (kg)	1,496	700	816			
Combustible Weight truck (kg) - Assumed 10% of Total	726	181	0			
Combustible Weight trailer (kg) - Assumed 2% of Total	120					
Fuel Cap (Gal)	317	18				
Fuel Cap (L)	1,200	67	0			
Fuel Mass	1,056	33	0			
Comb Content of Vehicle (kg)	2,342	881	816			
Total Comb Content w/ Fuel (kg)	3,398	914	816			
Energy of Combustion Plastic (MJ)	34,666	7,427	0			
Energy of Combustion Tire (MJ)	49,368	23,100	26,928			
Energy of Combustion Fuel (MJ)	43,296	1,663	0			
Total Energy of Combustion of V	84,034	30,537	26,928			
Total Energy of Combustion (V + Fuel)	127,330	32,200	26,928			
Number of Vehicles/sets of spare tires	4	1	1			
Typ Total Mass (kg)	66,570	2,728	816			
Typical Combustible Mass (kg)	9,366	914	816			
Typical Energy of Combustion (MJ)	509,321	32,200	26,928			
Other Combustible Content	Oil	Acetylene	Diesel	Kerosene	Solvent	Potatoes
Volume (L)	2,130	9,900	20	20	35	
Density (kg/L)	0.86	0.00	0.88	0.75	0.77	
Mass (kg)	1,832	12	18	15	27	12,973
Total EoC (MJ)	71,440	556	722	690	780	49
OFFICE COMBUSTIBLE CONTENT						
Area of Office (sqm)	325					
Average Energy Density by NFPA (MJ/sqm)	1,664					
EoC (MJ)	540,800					
Building Size (ft x ft)	100	125				
Total Area of Building (sqm)	1,161					
Typical Combustible Mass (kg)	25,972					
Typical Energy of Combustion (MJ)	1,183,486					
Combustible Mass Density (kg/sqm)	22.36	cannot exceed 50 to remain an F3				
Energy of Combustion Density (MJ/sqm)	1019	cannot exceed 1200 to remain an F3				

Case Study #4

F2 Transport Company Shop

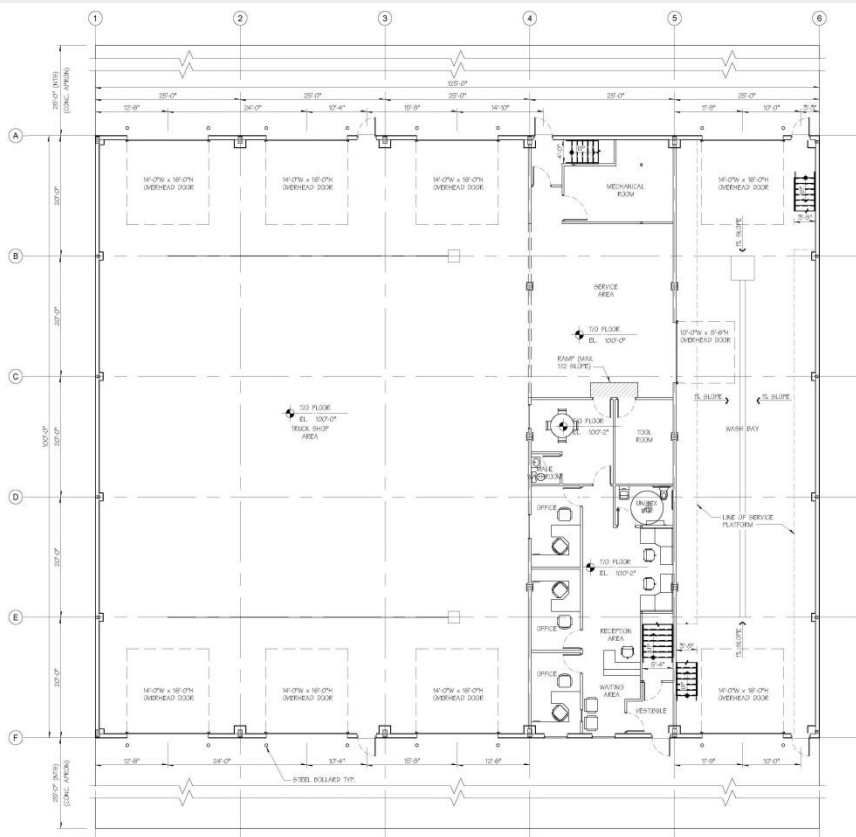
(same structure as Case Study #3)



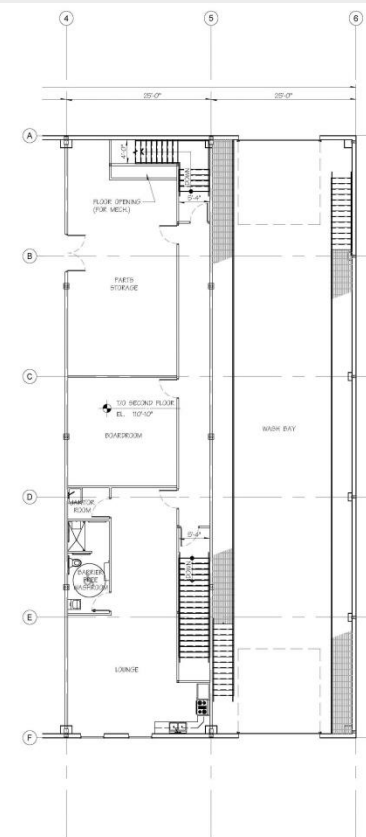
Case Study #4

F2 Transport Company

Building Code Summary



FLOOR PLAN - MAIN FLOOR
SCALE: 1/8" = 1'-0"



FLOOR PLAN - SECOND FLOOR
SCALE: 1/8" = 1'-0"

Occupancy Classification:
Group F, Division 2

Conformance Article:
3.2.2.74

Overall Building Area:
1161.3 m²

Total Office Area:
325 m²

Building Height:
2 storeys

Sprinklers required:
No

Case Study #4. Calculations

Vehicles and Tires	Semi +	Forklift	Spare	
	Trailer (diesel)	(propane)	Tires	
Typical Mass truck (kg)	7,258	1,814		= INPUT
Typical Mass trailer (kg)	5,987			
# of Tires truck	10	4	106	
# of Tires trailer	12			
Tire Weight (kg)	68	175	68	
Total Tire Weight (kg)	1,496	700	7,208	
Combustible Weight truck (kg) - Assumed 10%	726	181	0	
Combustible Weight trailer (kg) - Assumed 2%	120			
Fuel Cap (Gal)	317	18		
Fuel Cap (L)	1,200	67	0	
Fuel Mass	1,056	33	0	
Comb Content of Vehicle (kg)	2,342	881	7,208	
Total Comb Content w/ Fuel (kg)	3,398	914	7,208	
Energy of Combustion Plastic (MJ)	34,666	7,437	0	
Energy of Combustion Tire (MJ)	49,368	23,100	237,864	
Energy of Combustion Fuel (MJ)	43,296	1,663	0	
Total Energy of Combustion of V	84,034	30,537	237,864	
Total Energy of Combustion (V + Fuel)	127,330	32,200	237,864	
Number of Vehicles/sets of spare tires	4	1	1	
Typ Total Mass (kg)	66,570	2,728	7,208	
Typical Combustible Mass (kg)	9,366	914	7,208	
Typical Energy of Combustion (MJ)	509,321	32,200	237,864	

Other Combustible Content	Oil	Acetylene	Diesel	Kerosene	Solvent	Potatoes
Volume (L)	2,130	9,900	20	20	35	
Density (kg/L)	0.86	0.00	0.88	0.75	0.77	
Mass (kg)	1,832	12	18	15	27	12,973
Total EcC (MJ)	71,440	556	722	690	780	49

OFFICE COMBUSTIBLE CONTENT	
Area of Office (sqm)	325 (accounts for office areas on main and second floor)
Average Energy Density by NFPA (MJ/sqm)	1,664
EcC (MJ)	540,800
Building Size (ft x ft)	100 125
Total Area of Building (sqm)	1,161
Typical Combustible Mass (kg)	32,364
Typical Energy of Combustion (MJ)	1,394,422
Combustible Mass Density (kg/sqm)	27.87 cannot exceed 50 to remain an F3
Energy of Combustion Density (MJ/sqm)	1201 cannot exceed 1200 to remain an F3

THANK YOU

Questions?

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Professional Services – Practical Solutions

Ryan Fidler, P.Eng.
Structural Engineer

Jarrid Crichton, B.Env.D.
Building Code Specialist

Dennis Hodgkinson, P.Eng., FEC
Senior Partner

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