

## **C.2 CASE STUDY OF IMPROVEMENT ON EXISTING BUILDING**

Case studies on existing buildings and newly constructed buildings has been conducted to grasp increasing of cost and fire safety level through applying the fire preventive requirements of the Building Standard Law in Japan.

It should be noted that the case studies could broadly contribute yardstick, but every building has particular characteristics itself and various factors of the building affect the fire safety. There is no generalized verification method, covering the all factors, to evaluate fire safety of buildings.

Thus, the results of case studies should be the particular cases to confirm additional cost and increasing safety level, which cannot be treated as general cases.

### **C.2.1 Target Buildings for the Case Study**

#### **(1) Phase 1 and 2**

The target buildings of Phase 1 and 2 are selected 30 buildings, which have a drawing sheet, from 126 buildings of Component 1 survey.

#### **(2) Phase 3**

Reviewing the statistics of building permission in the past 10 years, targeted new buildings includes three kinds of building uses, such as hotel, hospital, and complex building, which has recorded rather large in the same period.

General conditions of the three buildings for the case study are presented in the following table.

**Newly Constructed Buildings: Building Description and Fire Condition**

Items	Hotel	Hospital	Complex
No. Of Floor (floor)	25 stories	6 stories	5 stories
Floor Area (m <sup>2</sup> )	1 <sup>st</sup> –4 <sup>th</sup> 1,900m <sup>2</sup> 5 <sup>th</sup> –25 <sup>th</sup> 1,400m <sup>2</sup>	1 <sup>st</sup> 4,000m <sup>2</sup> , 2 <sup>nd</sup> 3,000m <sup>2</sup> 3 <sup>rd</sup> –6 <sup>th</sup> 1,500m <sup>2</sup>	1 <sup>st</sup> –5 <sup>th</sup> 2,300m <sup>2</sup>
Total Floor Area (m <sup>2</sup> )	37,000m <sup>2</sup>	13,000m <sup>2</sup>	13,000m <sup>2</sup>
Building use	1st floor reception desk, restaurant, command center, 2nd-4 <sup>th</sup> banquet, 5 <sup>th</sup> –25 <sup>th</sup> are used for guest room	1st floor reception desk, restaurant, command center, 2nd floor 3 <sup>rd</sup> –5 <sup>th</sup> are used for sick room	1 <sup>st</sup> –4 <sup>th</sup> shopping center, restaurant, 5 <sup>th</sup> floor Theater, Game corner
Fire outbreak	2:00AM Inside of the middle rubbish shoot of the first floor and the second floor at 2:00AM	0:31AM Outbreak at 0:30AM from the second floor room part of linen electric boiler	11:00PM Outbreak at 11:00PM from shop repairing the first floor.

Existing buildings also cover three building uses, including multi-story housing, shop house, and factory, of which building owners usually do not have sufficient capital to improve the fire safety level of the buildings.

**Existing Constructed buildings: Building Description and Fire condition**

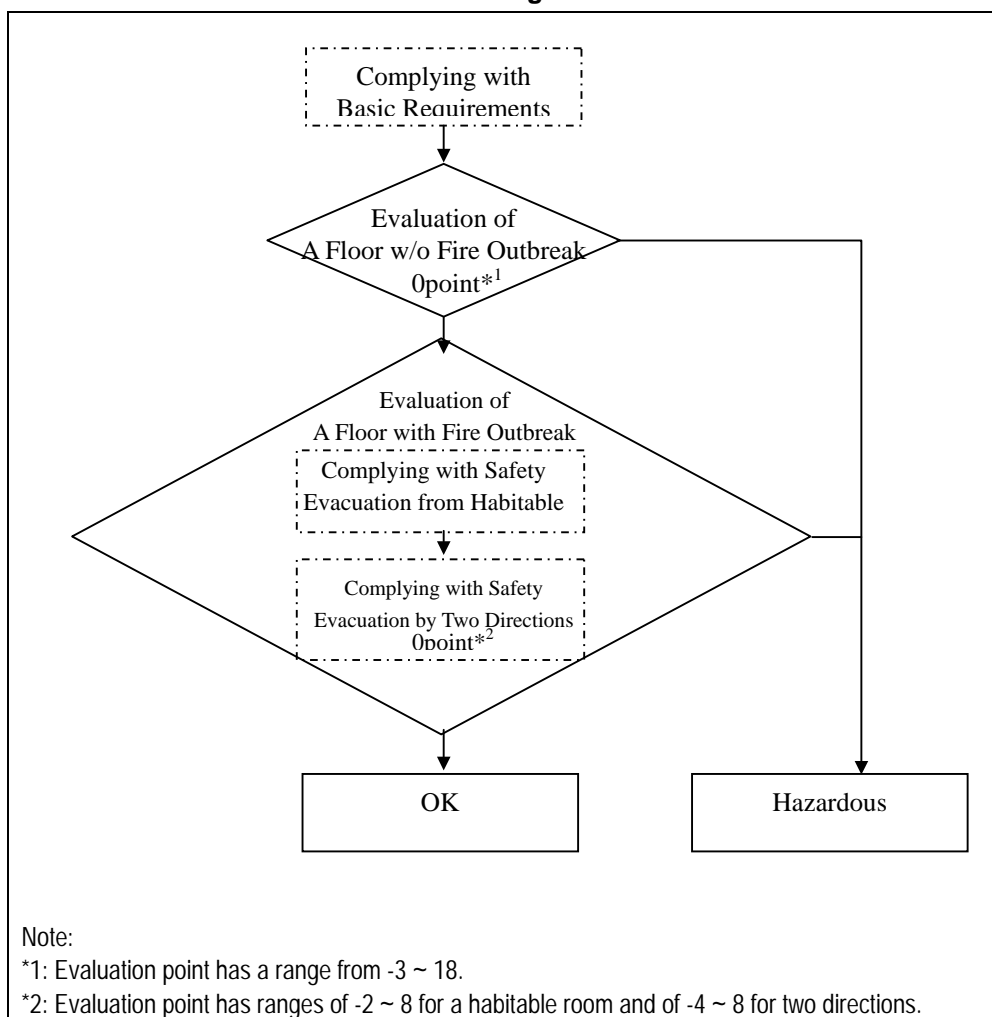
Items	Multi-story housing	Factory	Shop house
No. Of Floor (floor)	5 Floors	3 floors	4 floors
Floor Area (m <sup>2</sup> )	1,700	1 <sup>st</sup> –3 <sup>rd</sup> 1,400	1shop 250
Total Floor Area (m <sup>2</sup> )	20,000	43,000	2,000
	1 <sup>st</sup> floor Restaurant, housing 2 <sup>nd</sup> –12 <sup>th</sup> housing	1 <sup>st</sup> -3 <sup>rd</sup> Factory	1 <sup>st</sup> floor use for restaurant, karaoke, tailor. Electric shop, gas cylinder
Fire outbreak condition	8:00PM 2 <sup>nd</sup> floor habitable room Outbreak at 8:00PM from unit in the vicinity of the stairs of the second floor	7:00PM 1 <sup>st</sup> floor steam iron room Outbreak at 7:00PM from the vicinity of ironing board for the first floor shipment	11:18Pm 1 <sup>st</sup> floor restaurant Outbreak at 11:18PM from wall of the first floor restaurant
Finding and report	8:04PM	7:12PM	11:39PM
Initial extinction	8:19PM	7:23PM	11:46PM
Extinction	10:14PM	9:12PM	O: 49AM

### C.2.2 Methodology

Evaluation of the fire safety level of the buildings has examined by “Guideline of Fire Preventive Improvement on Existing Buildings” in Japan. The guideline has been developed to evaluate the fire safety level of existing buildings more than the total floor area of 1,500m<sup>2</sup>. The guideline is also aimed to evaluate various kinds of improvement in order to correspond various conditions of existing buildings.

Particular characteristic of this guideline is to focus on safety evacuation to the outside of the building in case of fire through two evaluation steps for a floor without fire outbreak, and a floor with fire outbreak. 2<sup>nd</sup> component survey of fire prevention system is consist of three phases.

#### Evaluation Flow of “Guideline of Fire Preventive Improvement on Existing Buildings”



**(1) Phase 1**

In Phase 1, 36 buildings were selected from the target buildings of 1<sup>st</sup> component survey, to make the general standard plans. In addition, three evaluation sheets, Sheet A: Evaluation Safety Capability on the floor of non-fire breakout, Sheet B: Evaluation Safety Capability on the floor of fire breakout, and Sheet C: Evaluation Safety Capability for two direction, were prepared.

**(2) Phase 2**

In Phase 2, safety capacity of the target buildings were evaluated with . In addition, modification cost for each target building was calculated.

Phase 2 is evaluation and multiply the modification cost by these buildings with making the fire evaluation of safety capability and making the modification drawings.

1) Applied Safety Standards

At this stage, the modification planning was made for a general floor in an existing building by the following three kinds of safety standards.

- Type A applied to the existing MRs.
- Type B applied to both the existing MRs and standards issued by E.I.T.stds.
- Type C applied to technical standards proposed by JICA Study team.

2) Evaluation Method

The following sheets concern the score of safety evaluation of non-outbreak floor, evaluates the installation of the detector & the emergency communication, the interior finishing materials, the installation of the smoke extraction apparatus, the safety fire separation, the necessary time for evacuation, the performance of staircase, and the installation of the sprinkler

Sheet A

Sheet A concerns the score of safety evaluation of non-outbreak floor, evaluates the installation of the detector & the emergency communication, the interior finishing materials, the installation of the smoke extraction apparatus, the fire separation, the necessary time for evacuation, the performance of staircase, and the installation of the sprinkler.

**Sheet A: EVALIATION OF SAFETY CAPABILITY ON THE FLOOR OF  
NON-FIRE BREKOUT**

Evaluation Items	Score of Evaluation		
S1: Detection & communication	Score (2 points) 1.Installed of detector and Alarming System 2.Installed of Emergency Broadcasting 3.Building Administrator 24 hrs	Score (1 point) 1.Installed of detector and Alarming Equipment 2.Existence of Building	Score (0 point) 1.Installed of detector and Alarming Equipment
S2:Interior Finishing Materials	Score (1 point) Mostly well grade of non-combustible Materials	Score (0.5 point) Partially includes combustibile Materials, fire utilizing room should be required quasi non-combustible materials or more well conditions	Score (0 point) Without left said
S3: Smoke extraction Apparatus	Score (1 point) Exist	Score (0 point) Non-exist	
S4: Safety fire separation	Score (1 point) Exist	Score (0 point) Non-exist	
S5: Necessary Time for Evacuation	Score (0 point) Within the range of required standards	Score (-1 point) Within 2 times of required time of standards	Score (-2 points) More than 2 times of required time of standards
S6: Performance of fire staircase	Score (point0 point-1 point-2) refer to attachment		
S7: Sprinkler	Score (3 point) Satisfied with Ministerial Regulation or install all rooms of building	Score (1 point) Install apart of building	Score (0 point) Not installed

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**Sheet B**

Sheet B concerns the score of safety on the floor of fire outbreak floor, and evaluates the evacuation time, the interior finishing materials, the installation of the sprinkler, and the evacuation equipment.

**Sheet B: ASSESSMENT OF SAFETY CAPABILITY ON THE FLOOR OF FIRE  
BREKOUT**

Evaluation items	Score of Evaluation		
S1 Evacuation time or a number of exit for evacuation	Score (0 point) Within standards times	Score (-1 point) Within 2 times of standards time or only one exit for the room, which area exceeded 200 s.q.m	Score (-2 points) More than 2 times of standards time or only one exit for the rooms, which area exceeded 400s.q.m
S2 Interior finishing materials	Score (1 point) More than quasi non-combustible materials	Score (0.5 point) Partially include combustible materials, ire utilizing room should be required quasi non-combustible materials or more will conditions	Score (0 point) Without left said
S3 sprinkler	Score (3 point) Satisfied with Ministerial Regulation or install all rooms of building	Score (1 point) Installed a part of building	Score (0 point) Not installed
S4 Evacuation equipment	Score (1 point) Exist	Score (0 point) Non exist	

### Sheet C

Sheet C focuses on two direction evacuation, and it evaluates the two direction of evacuation, necessary time for evacuation, interior finishing materials, installation of smoke control system, and installation of the sprinkler

#### **Sheet C: EVALUATION OF SAFETY CAPABILITY FOR TWO DIRECTION**

Evaluation items	Score of Evaluation		
	Score (0 point) There are two more directions	Score (-2 point) There is no two direction but add the escape instrument in fire safety separation area	Score (-5 points) There isn't two direction more over a lack of direct staircase
S1 Two direction of evacuation	Score (0 point) More to require Standards	Score (-1 point) Within 2 times of required Standards	Score (-2 point) More than 2 times of required Standards
S2 Evacuation Time	Score (1 point) More than quasi non-combustible materials	Score (0.5 point) Include combustible Materials except kitchen	Score (0 point) Without left said
S3 Interior Finishing Materials	Score (2 point) Yes fully	Score (1 point) No Partially	Score (0 point) Non exist
S4 Smoke control system	Score (3 point) Satisfied with Ministerial Regulation or install all rooms of building	Score (1 point) Installed a part of building	Score (0 point) Not installed
S5 Sprinkler			

### **(3) Phase 3**

Phase 3 is cost-effectiveness study that made two kinds (the modification plan along the existing MR and the modification plan to satisfy the safety level which the study team proposed) for each three building for each existing and newly buildings. Drawings for these buildings are also shown in C.2.6.

#### 1) Applied Safety Standards

##### Newly Constructed Buildings

- First, improvement from existing conditions complying with all MRs.
- Second, improvement from the existing level to the requirements proposed by JICA study team.

### Existing Buildings

- First, modification from existing conditions to the level complying with MR 47. This modification has been enforced as mandatory requirements.
- Second, improvements from the level of the MRs to the EIT stds level.
- Third, improvements from the second level to the safety level proposed by JICA study team.

### 2) Conditions

General conditions of the three buildings for the case study are presented in the following.

### Newly Constructed Buildings

<b>Building use</b>	<b>List of technical requirement</b>
Hotel	-Separation: Area separation, Vertical separation, Different use separation, Smoke barrier, -Staircase: Special escape stairs, Two or more through stairs, - Width of corridor. -Restriction of Interior finish, -Smoke exhaust system, -Automatic fire alarm system, -Lighting apparatus for emergency use, -Gas leakage detector in fire use room, -Entrance to big scale as long as possible at evacuation floor.
Hospital	-Area separation, Vertical separation, Different use separation, Smoke barrier, -Escape stairs, Two or more through stairs - Width of corridor. -Restriction of Interior finish, - Automatic fire alarm system, -Lighting apparatus for emergency use, -Smoke exhaust system, - Evacuation balcony, -Entrance to big scale as long as possible at evacuation floor.
Multi complex	-Area separation, Vertical separation, Different use separation, Smoke barrier, -Restriction of Interior finish, -Smoke exhaust system, -Width of staircase depends on floor area.



### Existing Buildings

Building use	List of technical requirement
Multi stories housing	-Area separation, Vertical separation, Different use separation, High rise separation -Special escape stairs, escape stairs, Two or more through stairs. -Restriction of Interior and exterior finish, -Smoke exhaust system, partition wall, -Appropriate detector, Automatic fire alarm system, -Lighting apparatus for emergency use,
Factory	-Area separation, Vertical separation, -Restriction of Interior finish, -Smoke barrier, -Appropriate detector.
Shop house	-Vertical separation, -Gas leakage detector -Restriction of Interior Finish in the fire room, -Escape equipment or stairs.

## **C.2.4 Evaluation of Case Study for Phase 2**

### **(1) Evaluation Score and Modification Cost**

The following table shows evaluation score and modification cost obtained in Case Study.

**Evaluation Score and Modification Cost**

Code number	Modification Type	Sheet A	Sheet B	Sheet C	Cost
2-1B-2	Existing	5	5	4	
	Type A	4	5	4	104,000
	Type B	6	5	4.5	222,000
	Type C	15	6	8	652,671
7-1B-1	Existing	5.5	3.5	3.5	
	Type A	6	4	4.5	1,050,500
	Type B	8	4	5.5	1,302,500
	Type C	15	7	8	3,620,250
5-1B-2	Existing	-1.5	0.0	-4.0	
	Type A	2	2	3	1,665,800
	Type B	7	4	5.5	1,675,250
	Type C	15	7	8	2,247,650
4-1B-2	Existing	-1.5	0.5	-4.5	
	Type A	2	2	-0.5	233,740
	Type B	7	4	5.5	2,489,740
	Type C	15	7	8	2,467,393
3-3A-1	Existing	0.0	1.0	-1.0	
	Type A	-1	2	0.5	1,391,600
	Type B	5	5	4	320,800
	Type C	10	8	6	5,837,855

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9-1B-3	Existing	6	4	4	
	Type A	6	4	3.5	628,000
	Type B	6	4	4	660,000
	Type C	15	7	8	31,173,295
2-2B-2	Existing	5.5	3.5	3.5	
	Type A	7	4	3.5	638,000
	Type B	8	4	5.5	775,500
	Type C	15	7	8	5,741,230
10-1B-2	Existing	7	4	4	
	Type A	7	4	4	475,200
	Type B	8	4	4	979,600
	Type C	15	7	8	18,159,730
3-3B-1	Existing	-1	1	0.5	
	Type A	-1	1	0.5	218,660
	Type B	6	5	4	272,950
	Type C	12	8	6	912,790
10-1A-3	Existing	7	4	4	
	Type A	7	4	4	826,000
	Type B	8	4	4	1,032,500
	Type C	15	7	8	11,995,259
6-1A-1	Existing	-0.5	0.5	0.5	
	Type A	2	2	1.5	468,500
	Type B	5	4	4.5	5,425,000
	Type C	12	7	6	9,055,000
1-1A-3	Existing	5.5	3.5	3.5	
	Type A	6	4	5.5	1,283,260
	Type B	7	4	6	1,604,075
	Type C	15	7	8	4,139,167
10-1A-2	Existing	6	4	4	
	Type A	6	4	3.5	334,000
	Type B	7	4	4.5	417,500
	Type C	12	7	6	926,790
9-1A-2	Existing	6	3.5	4	
	Type A	6	4	4.5	177,792
	Type B	7	4	5	222,240
	Type C	13	7	7	8,211,569
2-2A-2	Existing	5.5	3	3.5	
	Type A	6	4	4.5	400,480
	Type B	7	4	4.5	500,600
	Type C	15	6	8	3,847,738
2-1A-1	Existing	4	4.5	4	
	Type A	6	5	5	216,000
	Type B	6	5	5	2,070,000
	Type C	15	7	8	1,446,459
2-2A-3	Existing	3	4	3.5	
	Type A	5	5	4.5	151,000
	Type B	6	5	6	188,000

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	Type C	15	6	8	611,794
2-1B-2	Existing	-0.5	0.5	0.5	
	Type A	2	2	1.5	820,120
	Type B	6	4	5.5	1,484,120
	Type C	13	7	8	2,985,561
5-4A-1	Existing	-1.5	0.5	0.5	
	Type A	2	2	1.5	2,046,000
	Type B	6	4	4.5	2,145,000
	Type C	12	7	6	2,224,945
4-1B-2	Existing	-1	1	1	
	Type A	-1	1	-1.5	1,863,300
	Type B	5	4	4.5	2,428,250
	Type C	10	7	5	2,707,930
8-2B-3	Existing	-1	1	1	
	Type A	-1	1	0.5	2,218,200
	Type B	5	4	4.5	2,644,000
	Type C	10	6	5	2,203,240
4-1B-2	Existing	-1.5	0.5	-2	
	Type A	-0.5	2	-1	569,520
	Type B	6	5	5	2,208,400
	Type C	15	8	8	4,464,417
2-3B-2	Existing	3.5	4.5	1.5	
	Type A	5	5	5	330,300
	Type B	6	5	5	412,500
	Type C	11	7	8	664,398
1-2B-2	Existing	0.5	0.5	0.5	
	Type A	3	2	2.5	3,076,400
	Type B	6	4	4.5	3,329,500
	Type C	13	7	7	5,063,925
10-1B-2	Existing	-1	1	1	
	Type A	-1	1	-1.5	2,082,480
	Type B	5	4	5	2,289,726
	Type C	13	7	8	4,854,213
10-1B-2	Existing	-1.5	0.5	0.5	
	Type A	2	2	2.5	1,826,400
	Type B	6	4	4.5	1,854,750
	Type C	13	7	8	4,365,150
3-3A-1	Existing	-1.5	0.5	0.5	
	Type A	3	2	2.5	2,580,400
	Type B	6	4	4.5	2,815,000
	Type C	13	7	8	4,859,000
10-1A-3	Existing	0.5	0.5	0.5	
	Type A	2	1	1.5	1,086,300
	Type B	6	4	4.5	1,317,500
	Type C	13	7	7	2,694,510
6-1A-1	Existing	-1	1	1	
	Type A	3	2	3	2,840,700

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	Type B	6	4	4.5	300,200
	Type C	12	7	6	4,913,750
10-1A-2	Existing	5	5	5	
	Type A	7	4	5.5	98,400
	Type B	7	4	5.5	150,000
	Type C	13	7	7	5,537,530
1-3A-3	Existing	4.5	4.5	3.5	
	Type A	5	5	4.5	527,000
	Type B	7	5	5	655,000
	Type C	12	8	6	1,127,070
2-3A-2	Existing				
	Type A	4	5	5	208,000
	Type B	6	5	5	260,000
	Type C	13	8	8	2,492,900
8-1B-2	Existing	1.5	3.5	3	
	Type A	3	5	4.5	313,500
	Type B	6	5	5	389,500
	Type C	12	8	6	609,380
8-1B-2	Existing	-1	1	-4	
	Type A	1	1	0	2,183,000
	Type B	6	4	5	2,438,500
	Type C	12	7	6	2,024,500
3-4B-2	Existing	-2	0	0	
	Type A	-1	0	1	1,793,000
	Type B	6	4	4.5	1,822,000
	Type C	12	7	6	1,788,750
5-1B-1	Existing	-1	1	1	
	Type A	1	1	2	1,810,200
	Type B	5	4	4.5	1,834,500
	Type C	12	7	6	3,195,015

In the above table, code numbers are defined as follows;

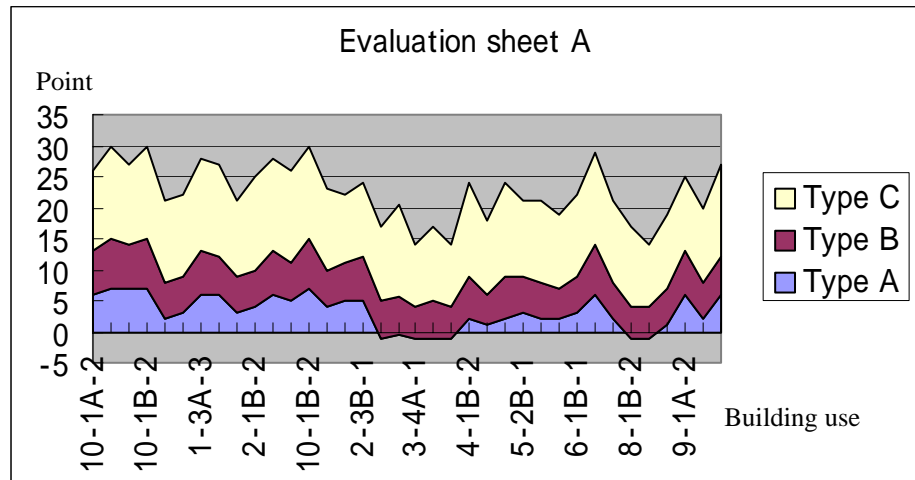
<p><b>X-XX-X</b></p> <p>(1) (2) (3) (4)</p>
<p>(1) Type of Building Use 1: Hotel, 2: Office, 3: Theater, 4: Hospital, 5: Education, 6: Factory, 7: Multi stories Housing, 8: Shophouse, 9: Department Store, and 10: Complex</p> <p>(2) Scale or detailed use of Building (Refer to Table below)</p> <p>(3) Year of Completion A: Target buildings constructed after enforcement of MR33 B: Target buildings constructed before enforcement of MR33</p> <p>(4) Order</p> <p>For example, 4-1B-2 stands for "Hospital which is less than 7 stories, was constructed before enforcement MR 33, and was identified second in the survey."</p>

**Scale or Detailed Use of Building**

Building Use	Number in (2)	Description
Hotel	1	Less than 7 stories
	2	More than 7 - 20 stories
	3	More than 21 stories
Office	1	More than 7 - 20 stories (Mixed Occupancy)
	2	More than 21 stories (Mixed Occupancy)
	3	More than 7 - 20 stories (One Occupancy)
	4	More than 21 stories (One Occupancy)
Theater	1	One theater
	2	Cinema complex
	3	Assembly hall
	4	Entertainment
Hospital	1	Less than 7 stories
	2	More than 7 - 11 stories
	3	More than 11 stories
Education	1	Primary school
	2	Secondary school
	3	College
	4	University
Factory	1	More than 10,000 - 35,000 m <sup>2</sup> .
Multi-stories Housing	1	National housing (more than 7 stories)
	2	Owned type (more than 7 stories)
	3	Rental type (more than 7 stories)
Shophouse	1	High hazard materials (more than 2 stories)
	2	Commercial or modification (more than 2 stories)
Department Store	1	More than 10,000 - 35,000 m <sup>2</sup> .
Complex	1	More than 10,000 - 35,000 m <sup>2</sup> .

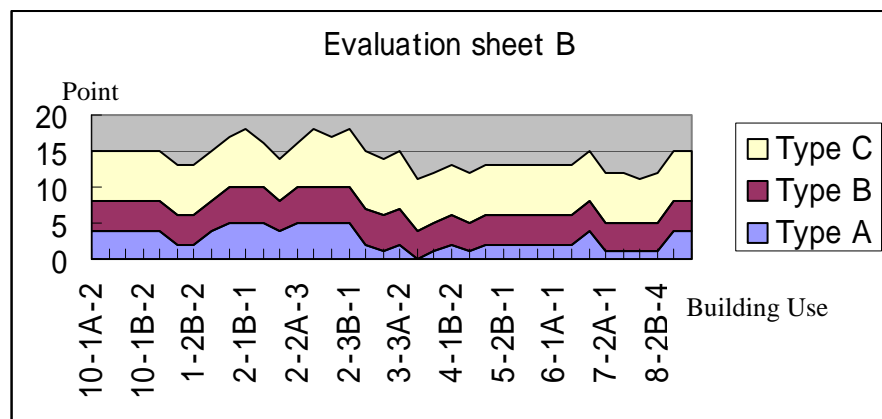
**(2) Analysis of Sheet A**

- 1) High score is obtained in complex buildings and office buildings, which are high rise and large scale buildings.
- 2) On other hand, theater, shop house got lower score than other building uses. It is because recommendable standards are not suitable to small scale buildings such as the theater and the shop house.



### (3) Analysis of Sheet B

- 1) On the floor of fire outbreak, the capability of safety evacuation scored high points in hotel, office, department store, and complex buildings. It is because installation of most equipment for unspecified visitors or customers is required.
- 2) Theater buildings and Factory buildings obtained lower score than other building uses, due to reconsideration of the criteria in evaluation items.

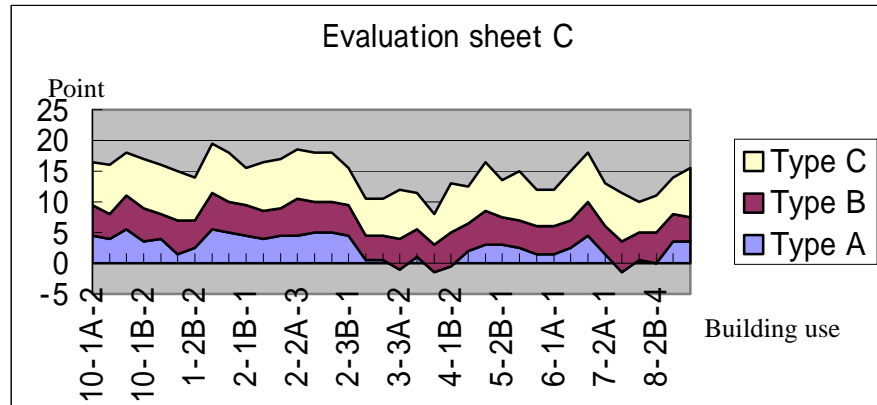


### (4) Analysis of Sheet C

- 1) Evaluation sheet C expresses the capability of safety in two direction evacuation on the floor fire outbreak. High rise and extra large scale Department store, Complex, Hotel, and Office building obtain high score, because many stairs, smoke exhaust system, and the sprinkler

system are well provided in those buildings.

- 2) The sheet will be advantageous for an extra large-scale building, which has many evacuation stairs and smoke control system, in the future.



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##### (5) Consideration

- Large scale and high-rise building on the complex, hotel, office, and department store obtain high score in every sheet, due to the consistency between the reality and the requirement in those building.
- On the other hand, small and low story buildings like as theaters, factories, and shop houses got fairly low score, due to insufficient provision of sprinkler and evacuation equipment.

## C.2.5 Evaluation of Case Study for Phase 3

### (1) Newly Constructed Buildings

Modification cost, total construction cost, additional cost, assessment safety capability for newly constructed buildings are shown in the table below.

	Const. Cost s.q.m. (Bath)	Modification Cost per s.q.m. (Bath)		Fire Loss per s.q.m. (Bath)			Increase ratio of const. cost per s.q.m.	Increase ratio of const. cost per s.q.m.	Decrease ratio of fire loss per s.q.m.	Decrease ratio of fire loss per s.q.m.
	a	b	c	d	e	f	g=b/a	h=c/b	i=e/d	j=f/e
		Case-1 to 2	Case-2 to 3	Case-1	Case-2	Case-3	(%)	(%)	(%)	(%)
<b>Newly</b>										
Hotel			Non			Non				
P	32,500	580					1.8%			
A	17,500	368					2.1%			
T	50,000	948		166	32		1.9%		19.3%	0.0%
Hospital			Non			Non				
P	21,000	211					1.0%			
A	14,000	419					3.0%			
T	35,000	630		2,641	950		1.8%		36.0%	0.0%
M.C.building			Non			Non				
P	22,750	564					2.5%			
A	12,250	707					5.8%			
T	35,000	1,271		949	53		3.6%		5.6%	0.0%

Note: P: Passive System, A: Active System, T: Total of Passive and Active Systems



## (2) Improvements on Existing Buildings

Modification cost, total construction cost, additional cost, assessment safety capability for existing buildings are shown as below.

	Const. Cost s.q.m. (Bath)	Modification Cost per s.q.m. (Bath)		Fire Loss per s.q.m. (Bath)			Increase ratio of const. cost per s.q.m.	Increase ratio of const. cost per s.q.m.	Decrease ratio of fire loss per s.q.m.	Decrease ratio of fire loss per s.q.m.
		b	C	D	e	f				
		Case-1 to 2	Case-2 to 3	Case-1	Case-2	Case-3				
	a						g=b/a	h=c/b	i=e/d	j=f/e
							(%)	(%)	(%)	(%)
<b>Existing</b>										
Apartment										
P	17,500	32	53	442			0.2%	165.6%		
A	7,500	148	247	111			2.0%	166.9%		
T	25,000	180	300	553	307	60	0.7%	166.7%	55.5%	19.5%
Factory										
P	12,500	14	23	1,149			0.1%	164.3%		
A	7,500	146	244	287			1.9%	167.1%		
T	20,000	160	267	1,436	798	288	0.8%	166.9%	55.6%	36.1%
Shop house										
P	14,000	138	230	8,859			1.0%	166.7%		
A	6,000	152	254	2,215			2.5%	167.1%		
T	20,000	290	484	11,074	6,152	349	1.5%	166.9%	55.6%	5.7%

Note: P: Passive System, A: Active System, T: Total of Passive and Active Systems

## (3) Consideration

Through the examination, major findings can be summarized below.

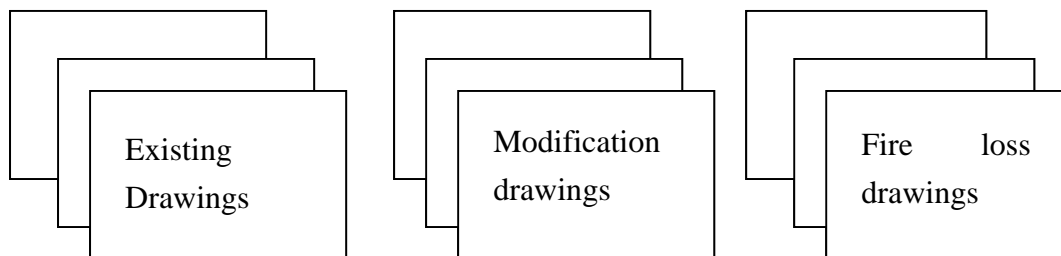
- Improvements on passive fire prevention system, including fire separation and interior finishing, increase construction cost of 1-3% for newly constructed buildings, though 5-8% increment for existing buildings. Improvements on the passive system can be arranged by planning to mitigate initial cost for newly constructed buildings, though the improvements directly cause increase in construction cost for the existing buildings.
- In contrast to the passive system, improvements on active fire prevention system, such as sprinkler and fire alarms, obviously cause increase in construction cost at 6-10% for newly constructed buildings, and 2-6% for existing buildings.
- The composition of the cost for passive and active planning should be

well balanced

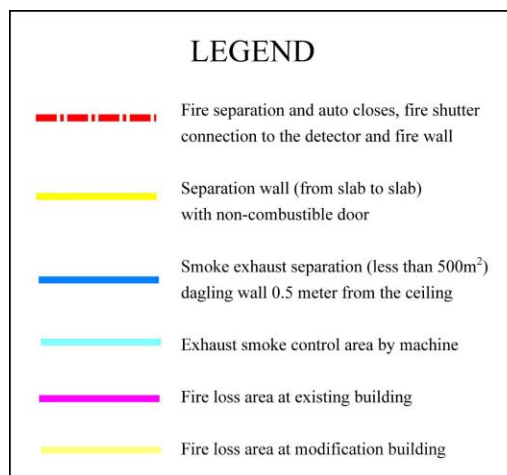
- Effectiveness of the cost and fire loss per s.q.m. by use and size (total floor area and stories) should be examined more deeply.

### C.2.6 Drawings

Existing drawings, modification drawings, and fire loss drawings, which explained the main points of improvement for complex, multi-story housings, and shop houses are shown in this subsection.

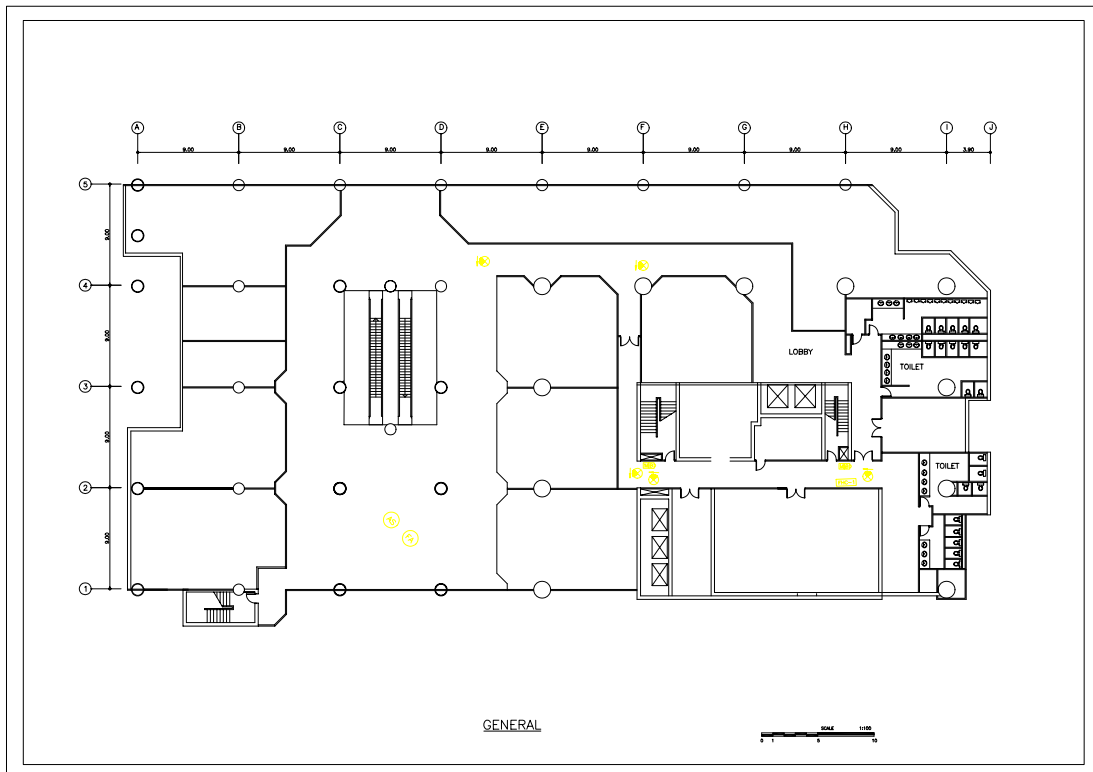
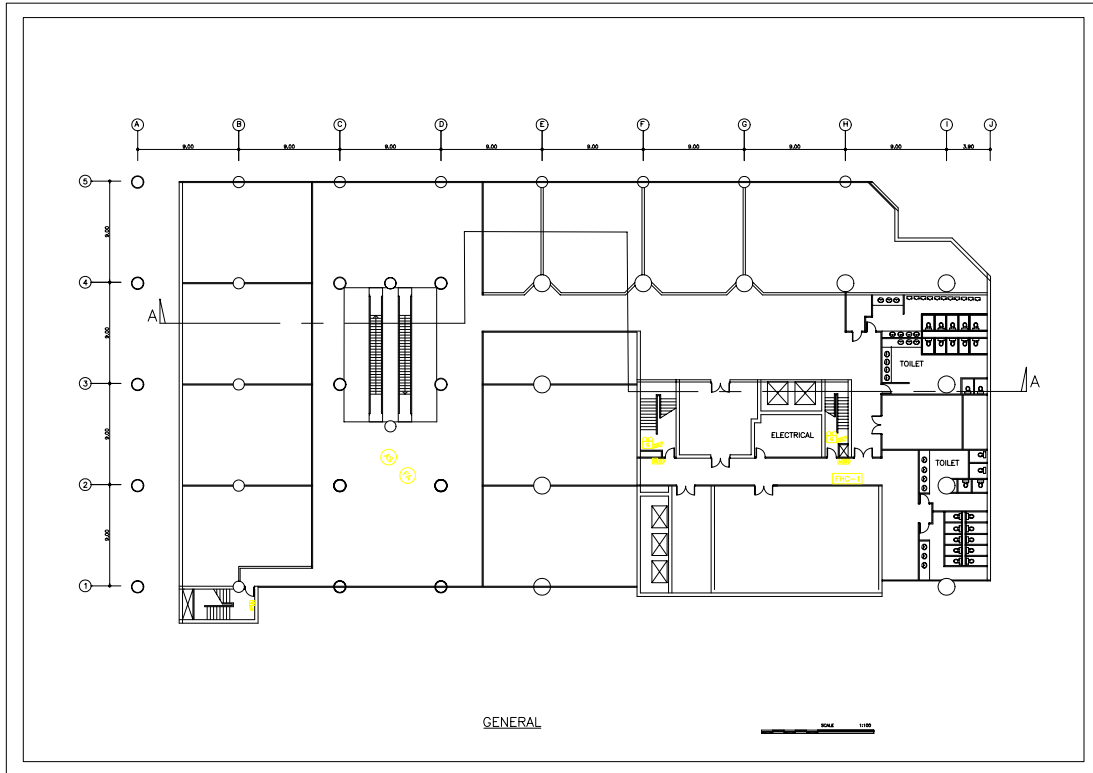


The following legend should be referred in all drawings.

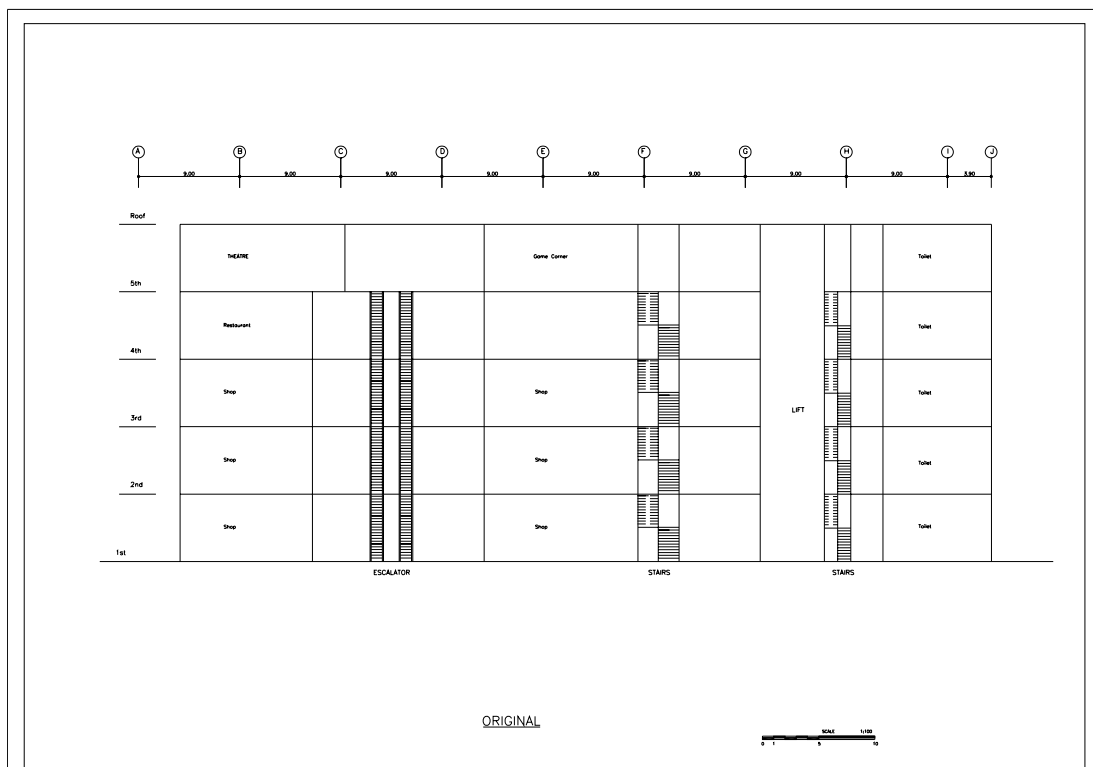
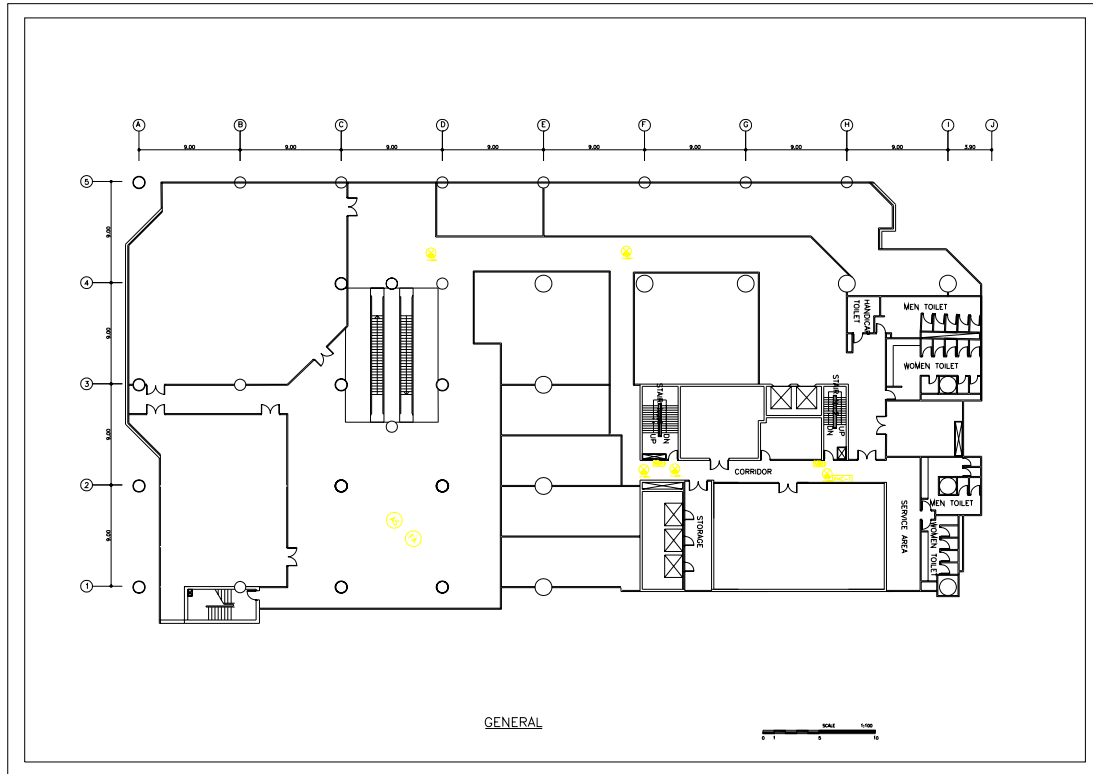


## 1) Complex

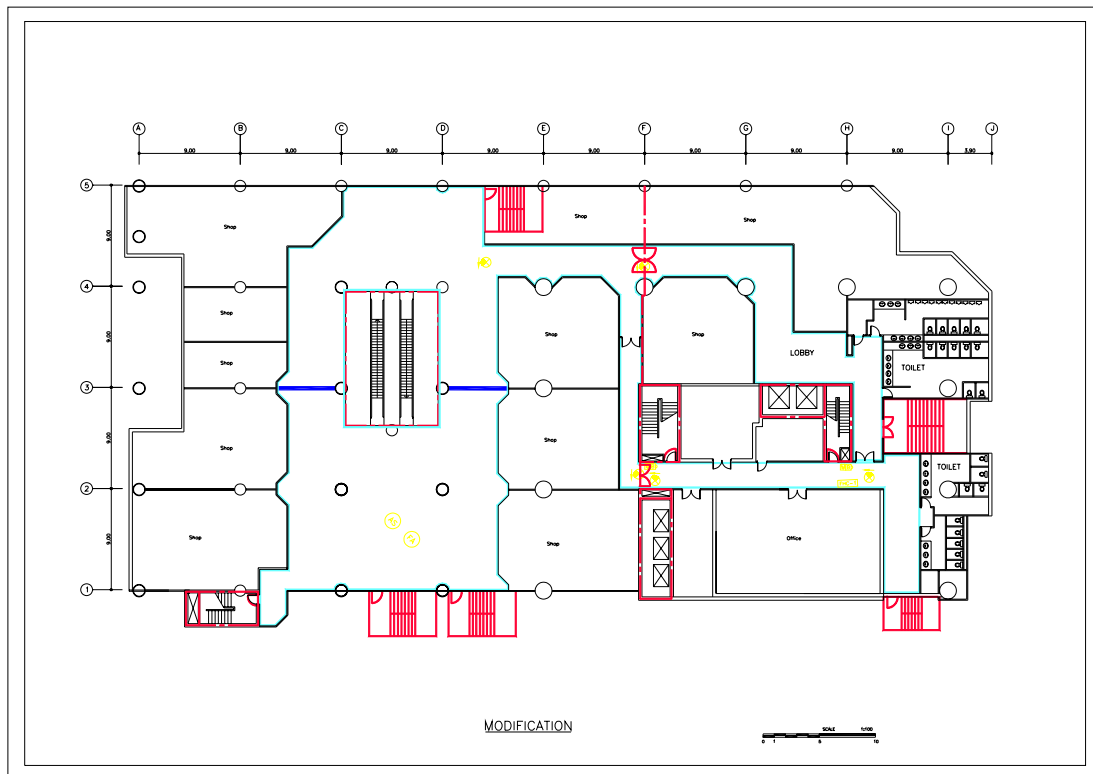
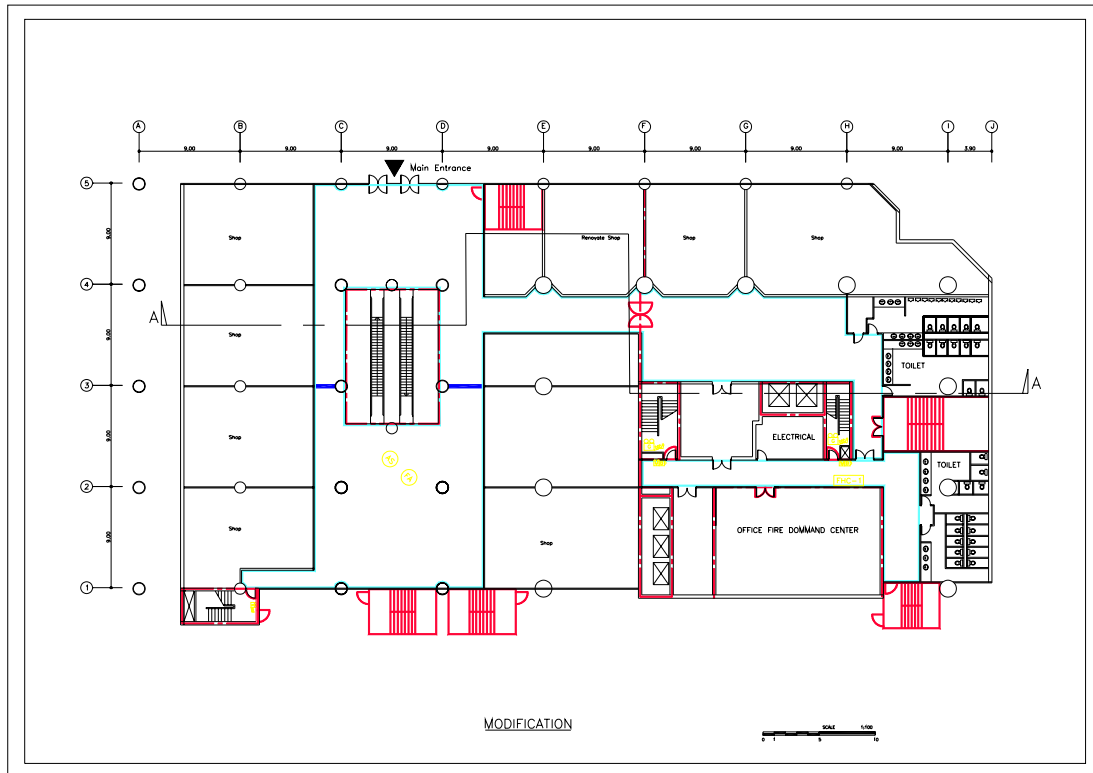
### Complex (Existing Condition) (1/2)



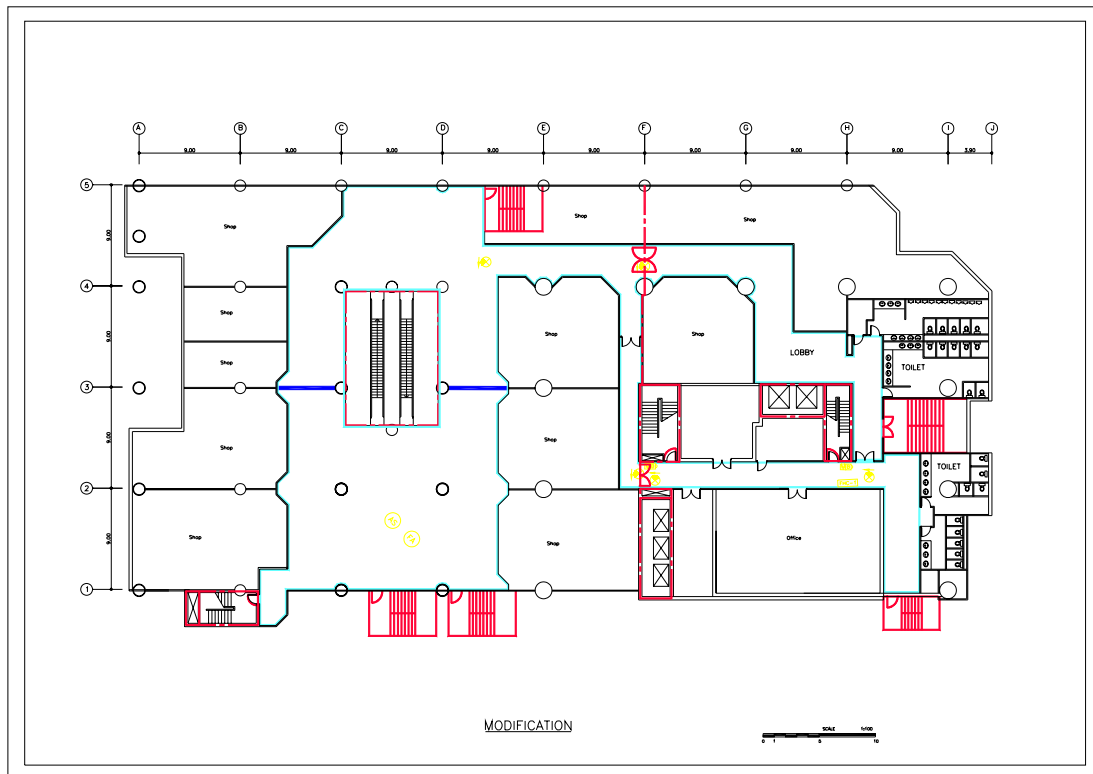
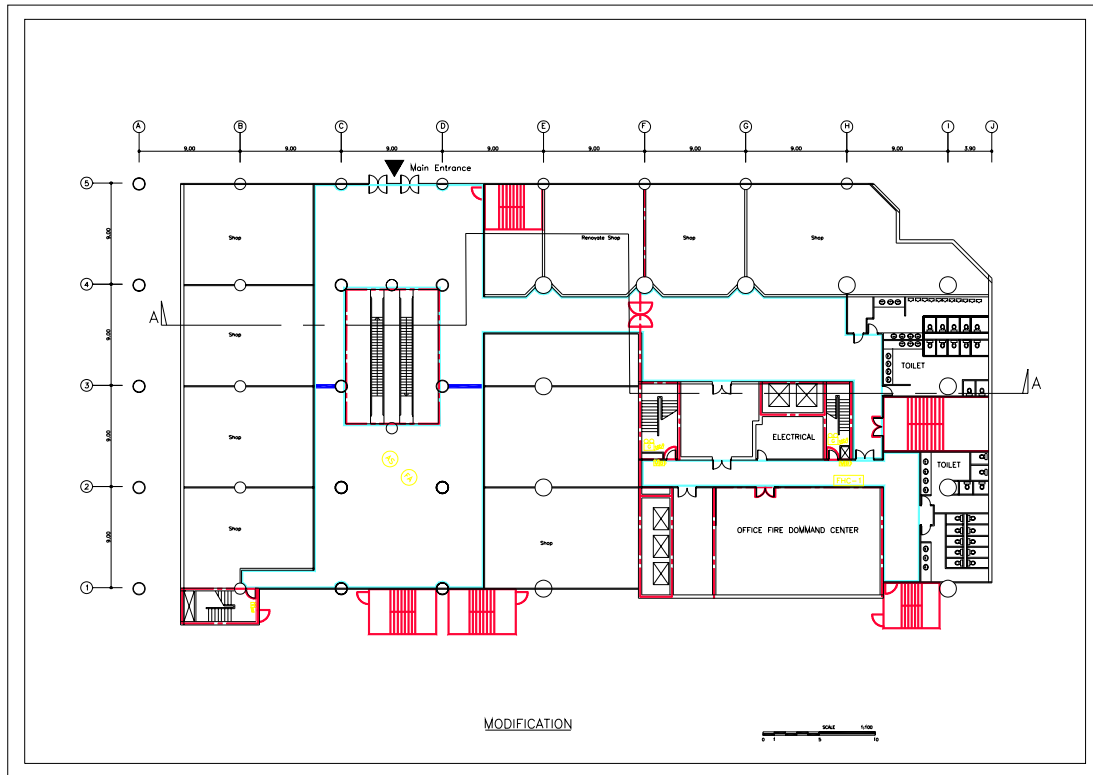
Complex (Existing Condition) (2/2)



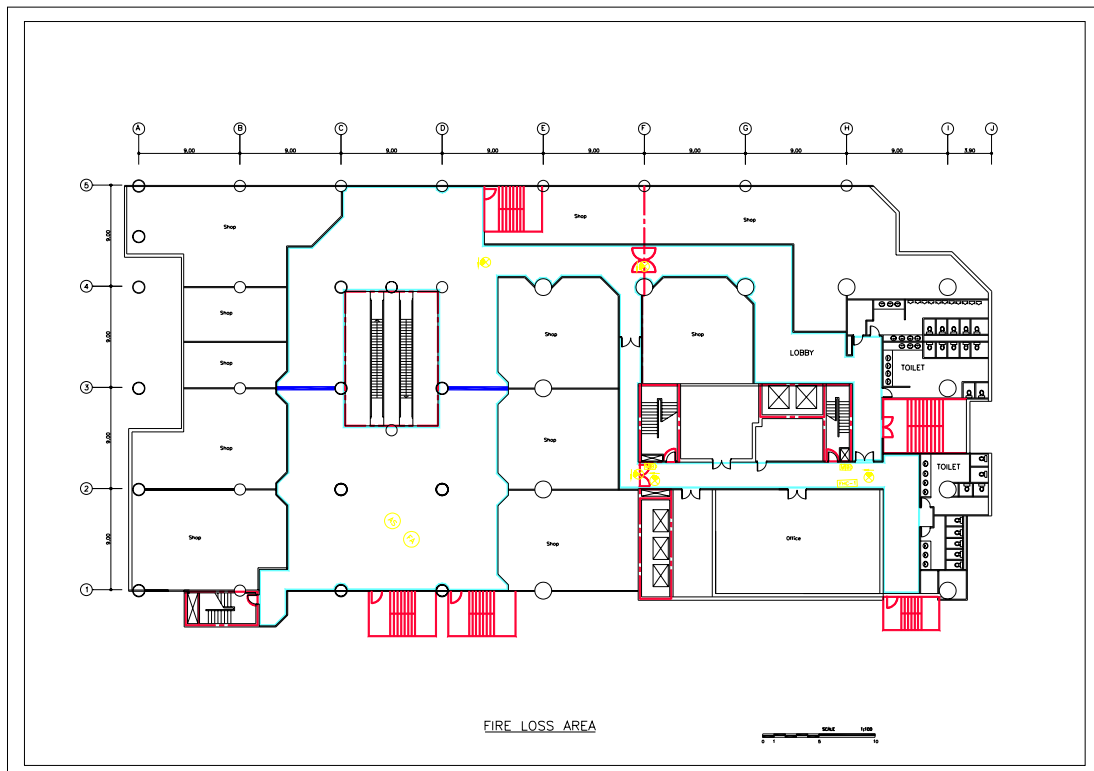
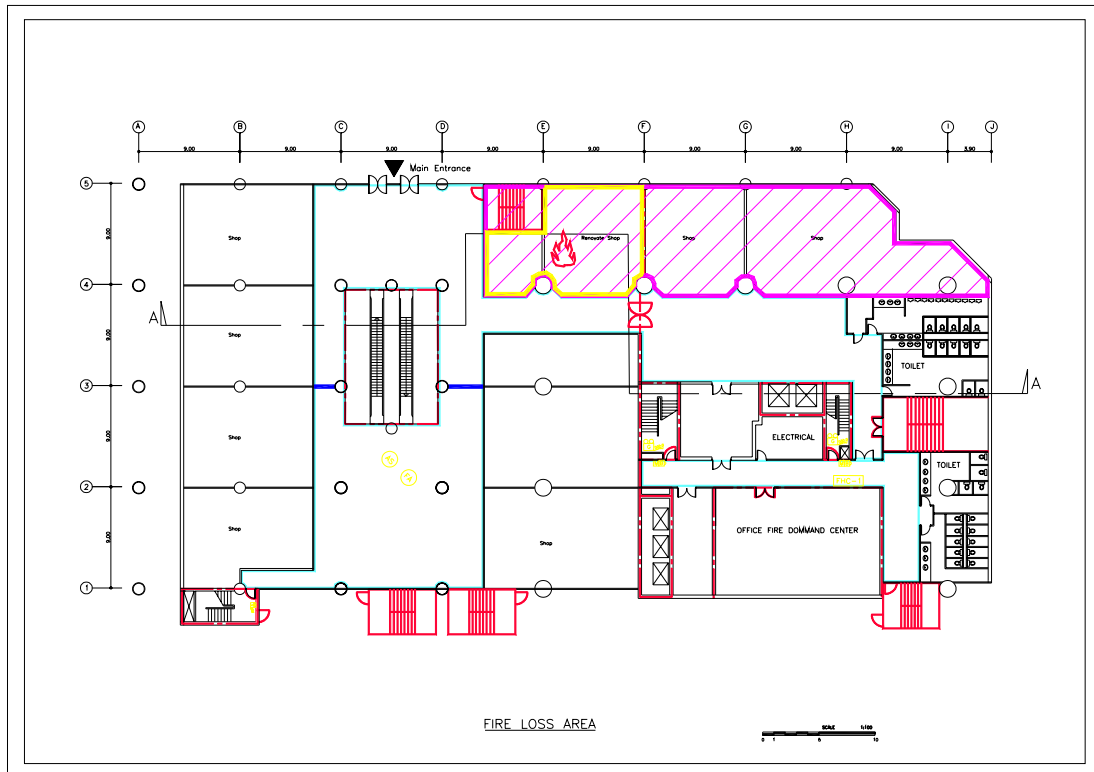
Complex (Modification) (1/2)



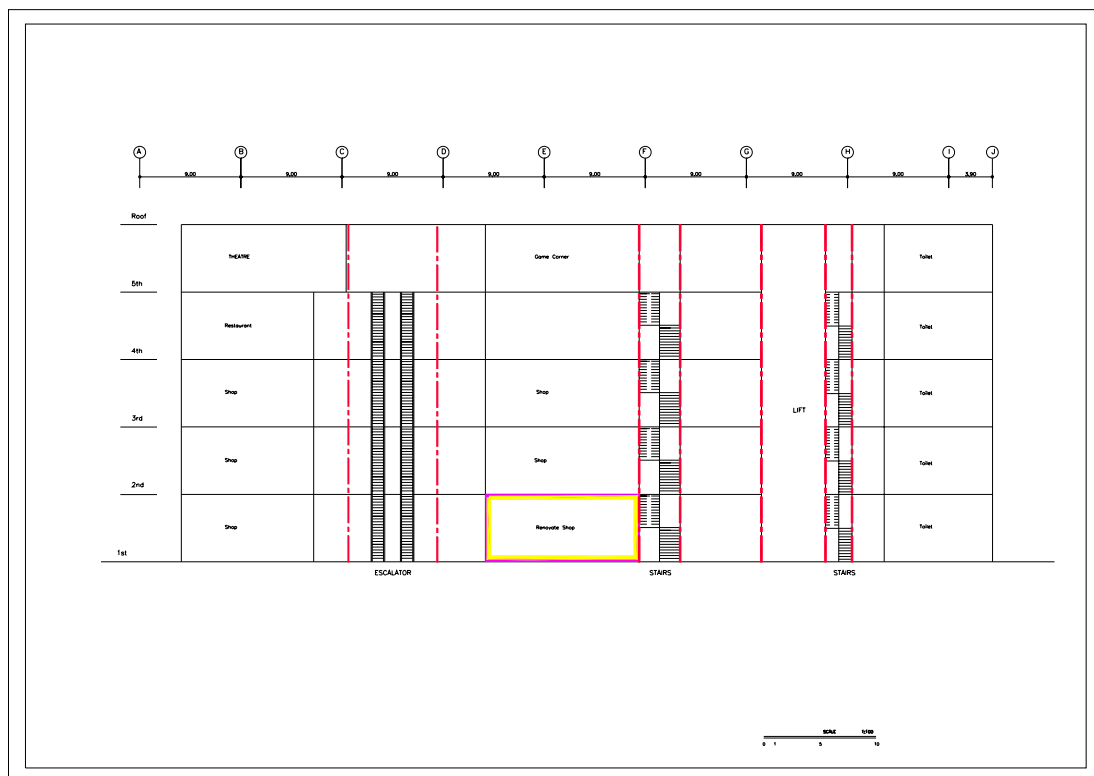
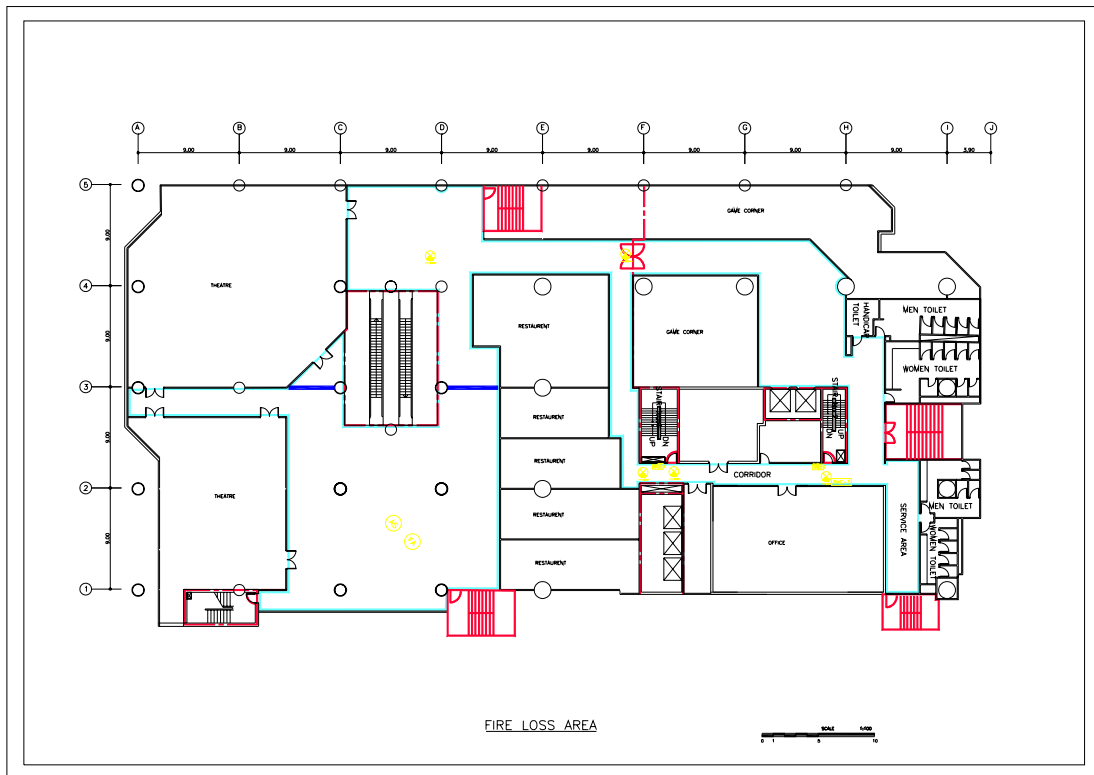
Complex (Modification) (2/2)



Complex (Fire Loss Area) (1/2)



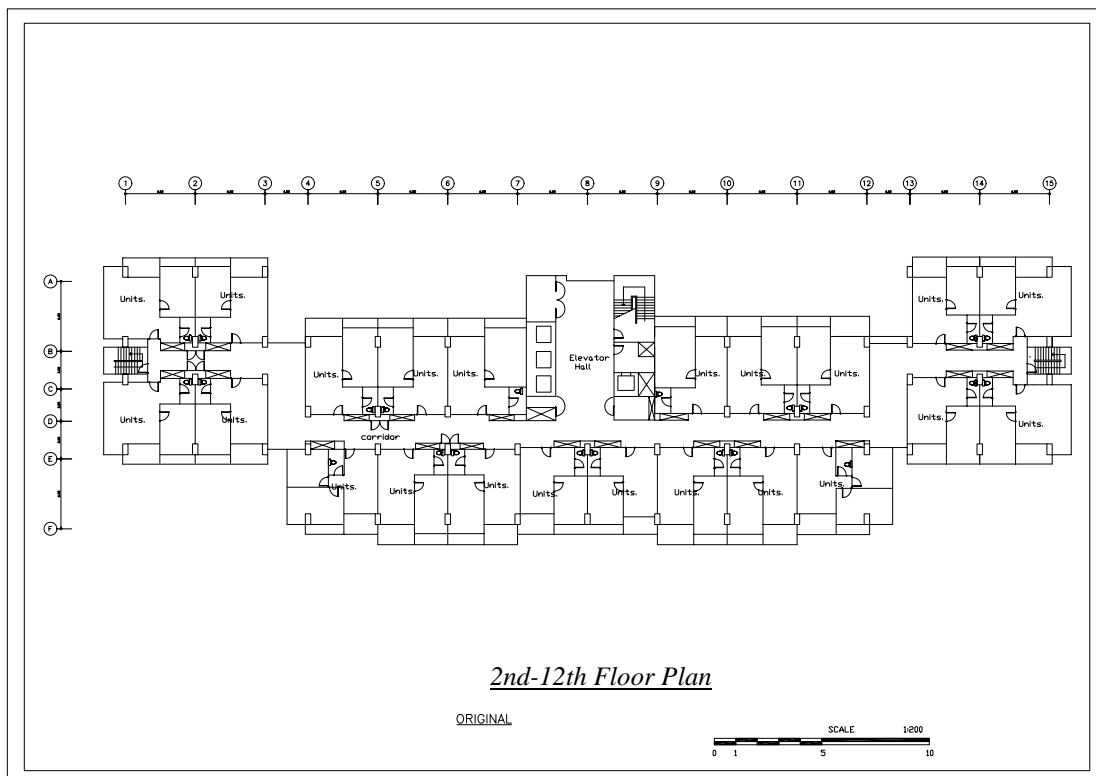
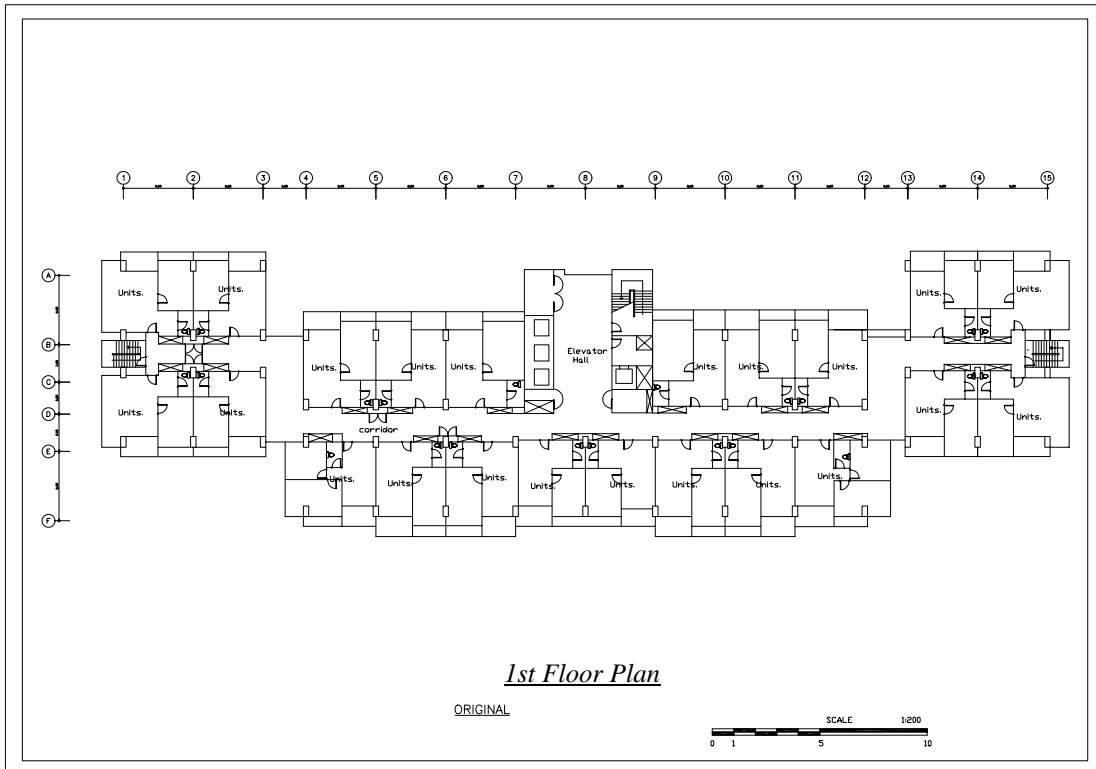
Complex (Fire Loss Area) (2/2)



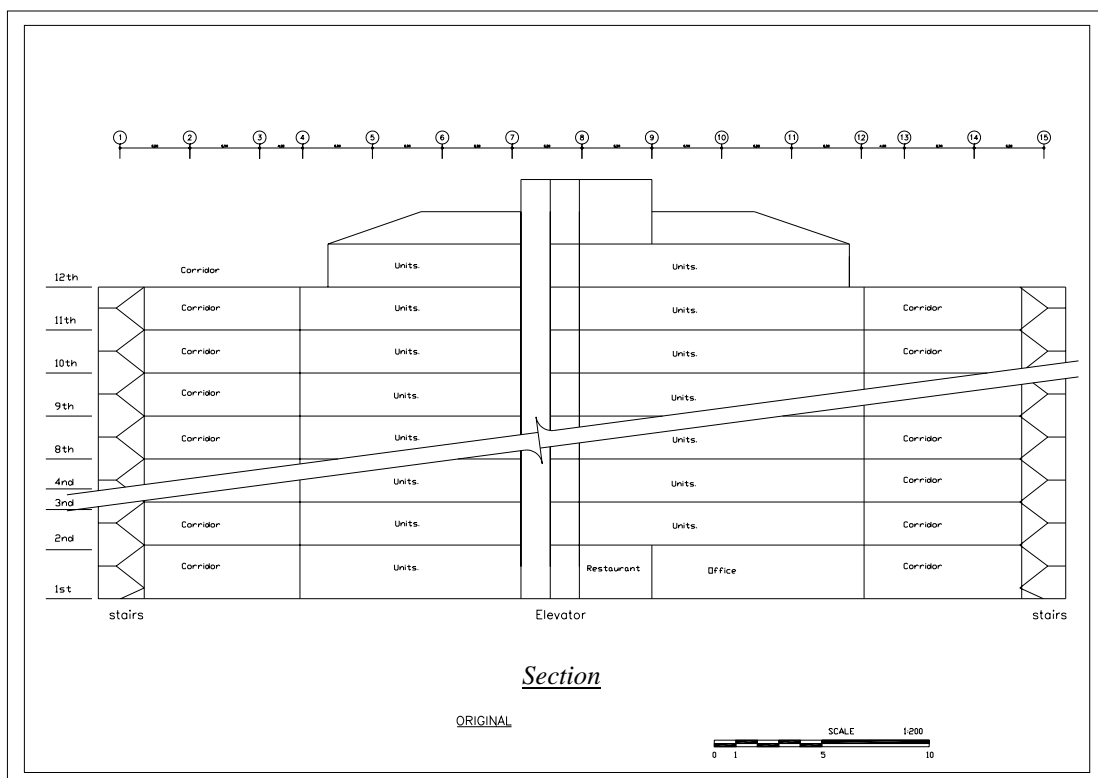
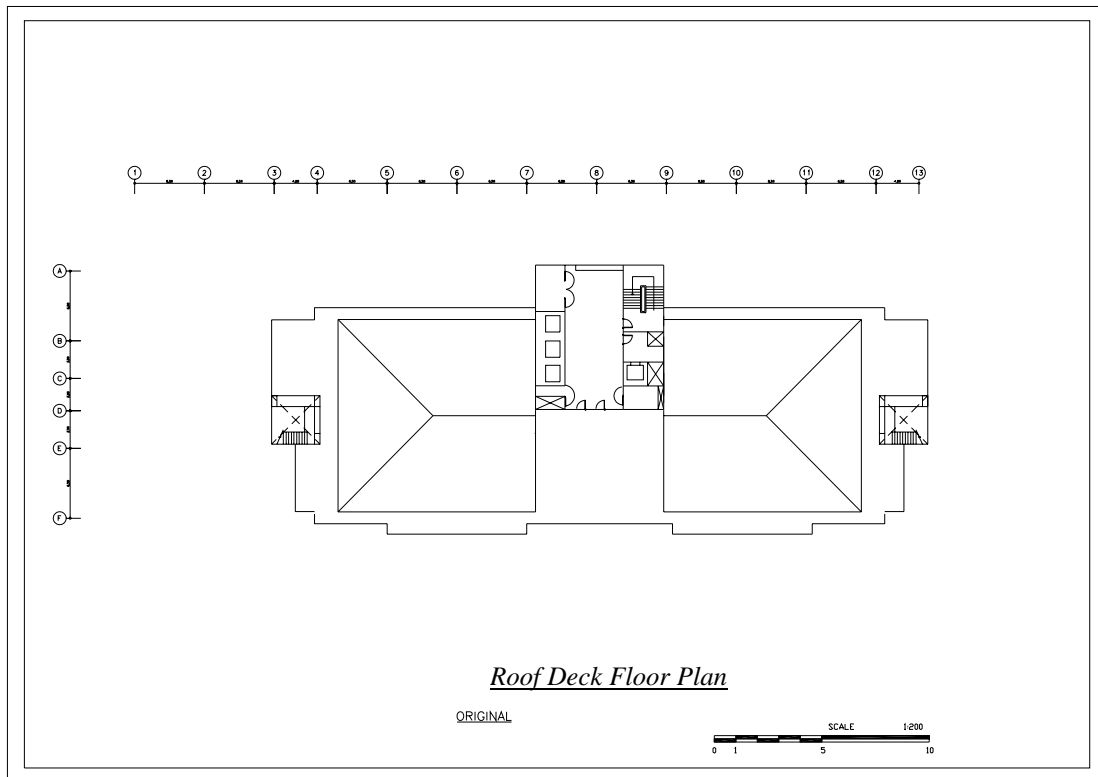


2) Multi-story Housing

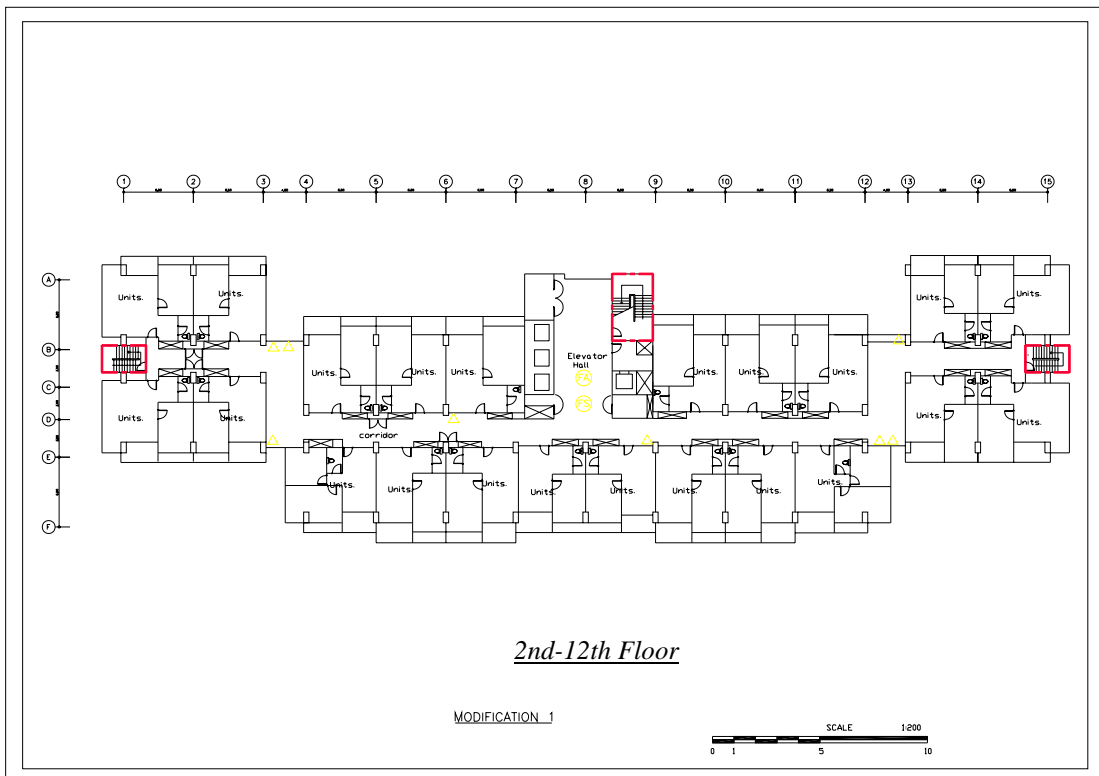
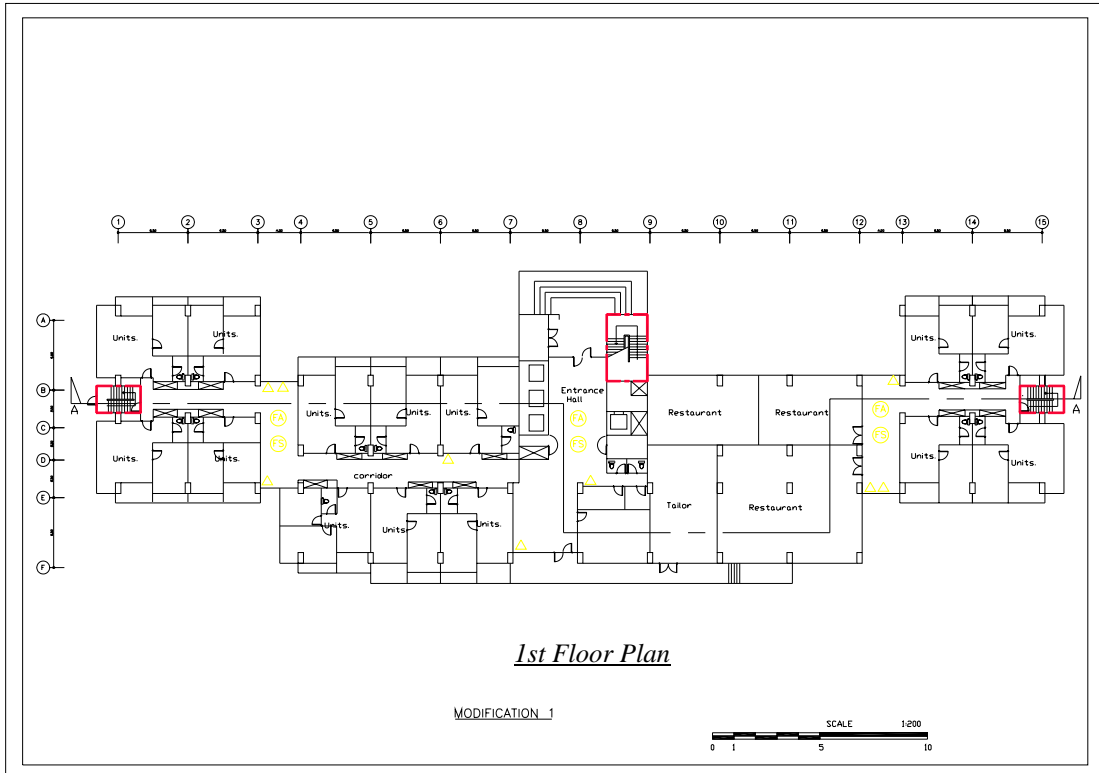
*Multi-story Housing (Existing Condition) (1/2)*



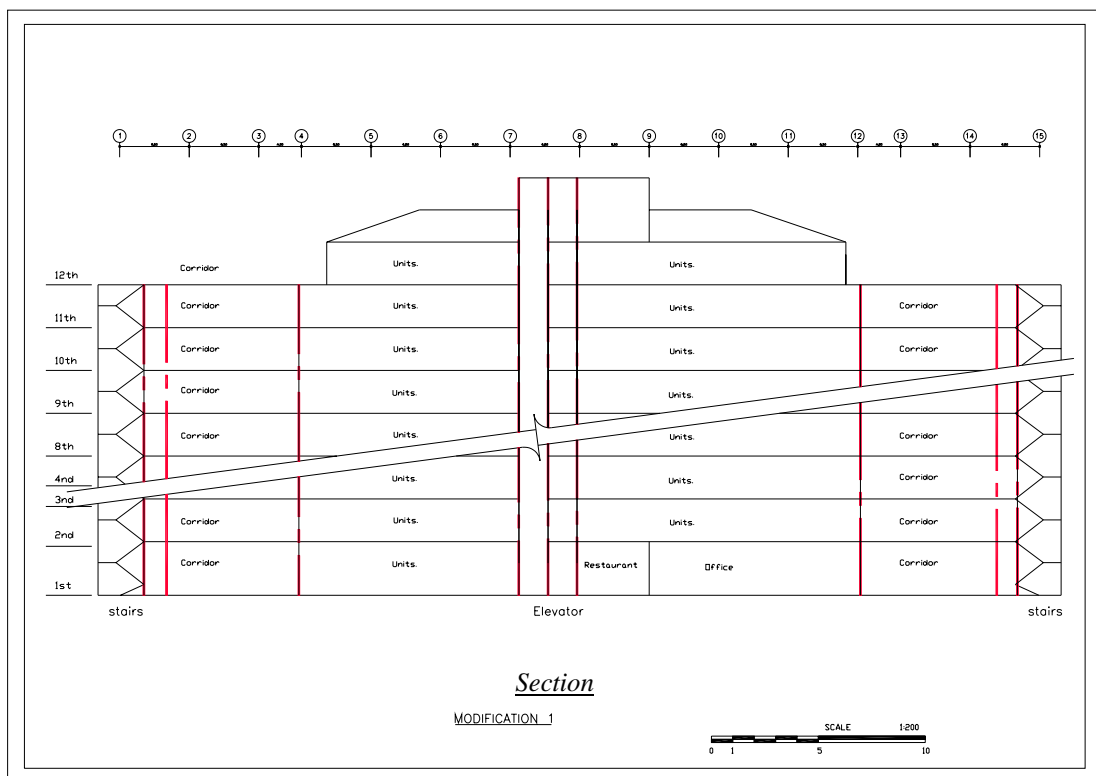
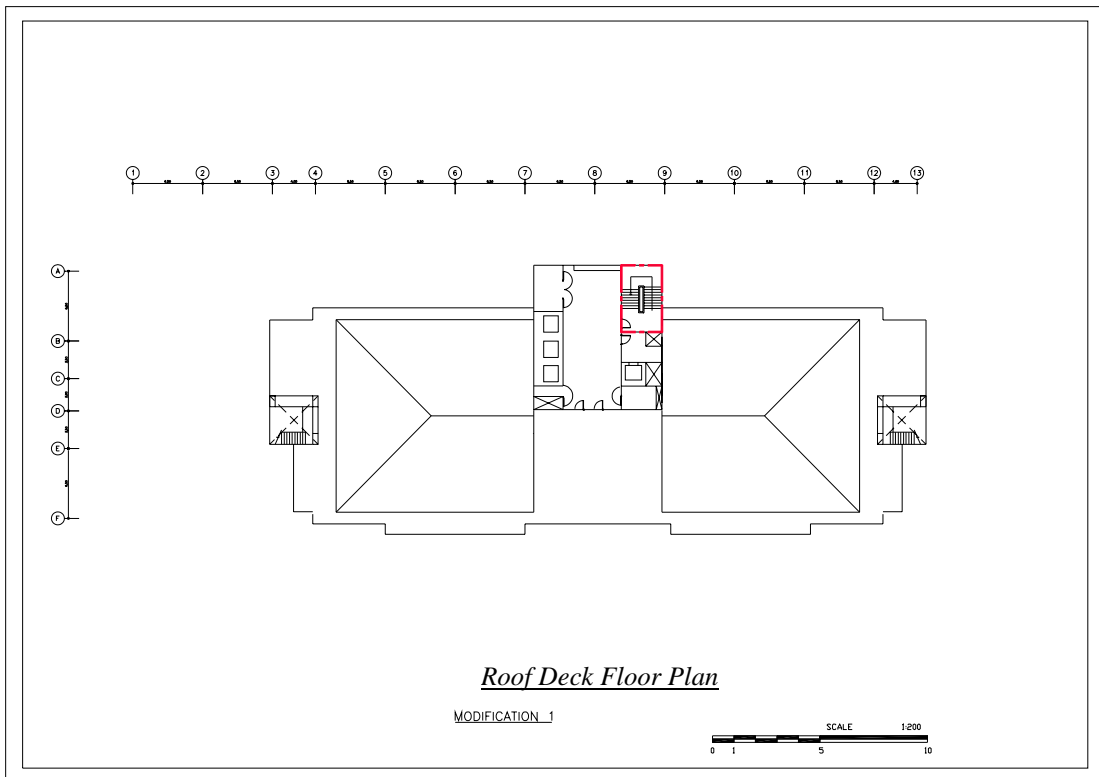
Multi-story Housing (Existing Condition) (2/2)



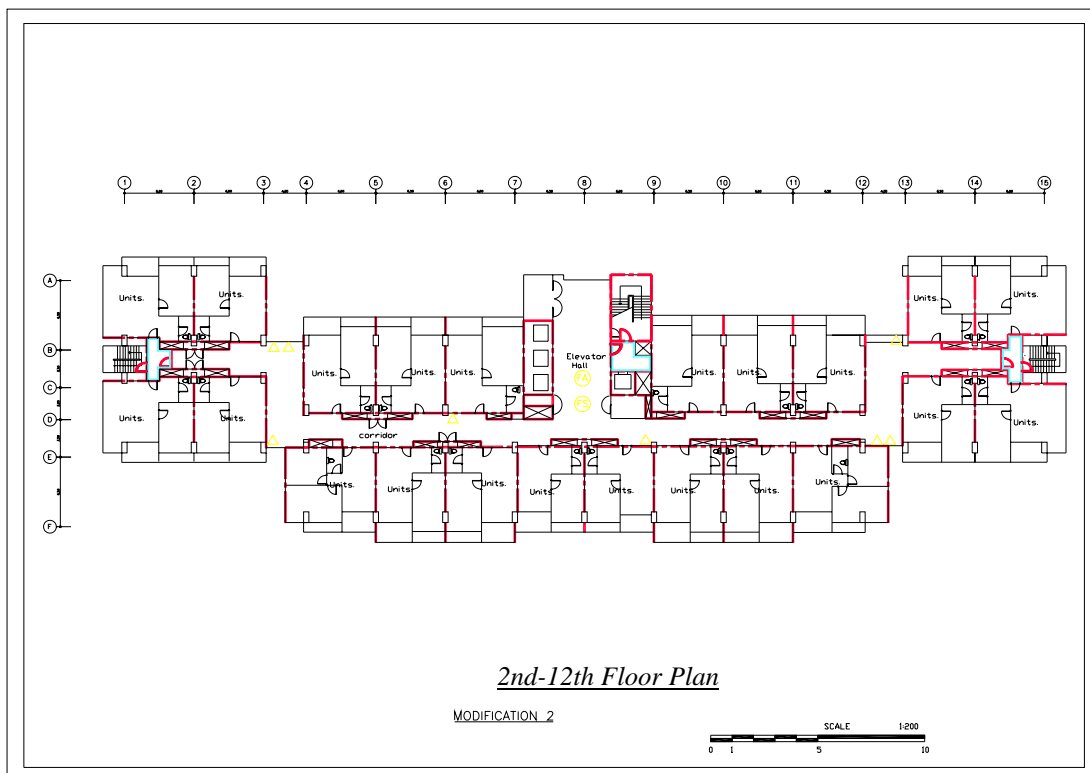
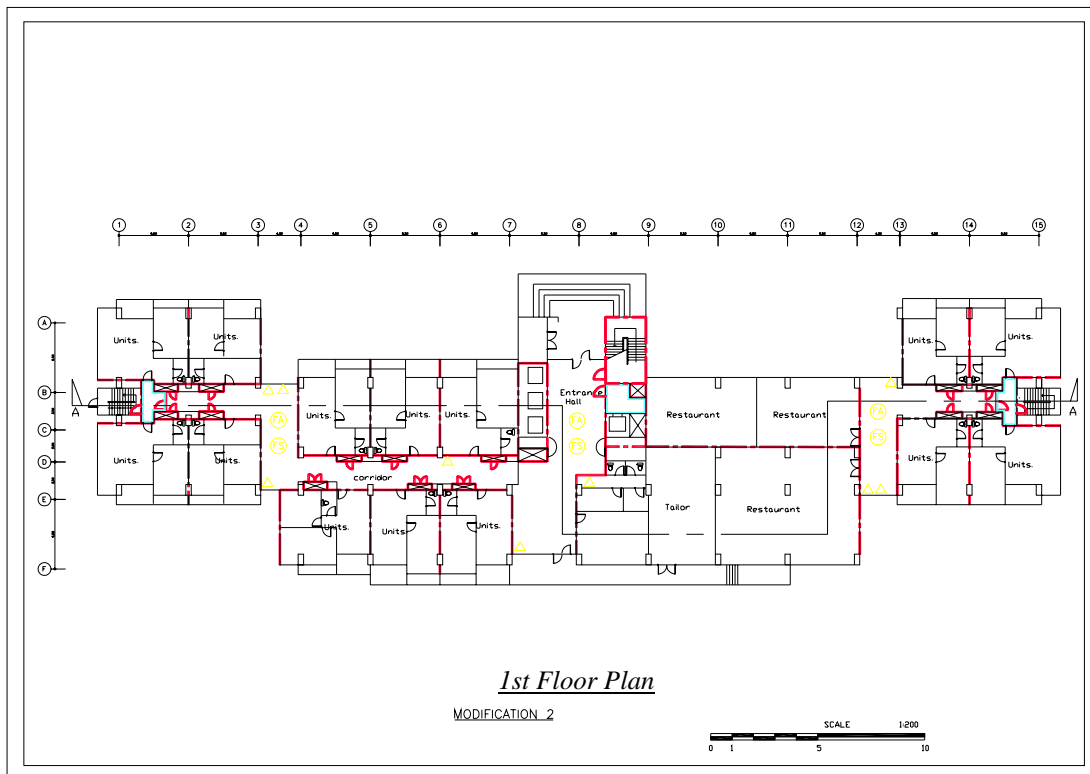
*Multi-story Housing (Modification to MR-47) (1/2)*



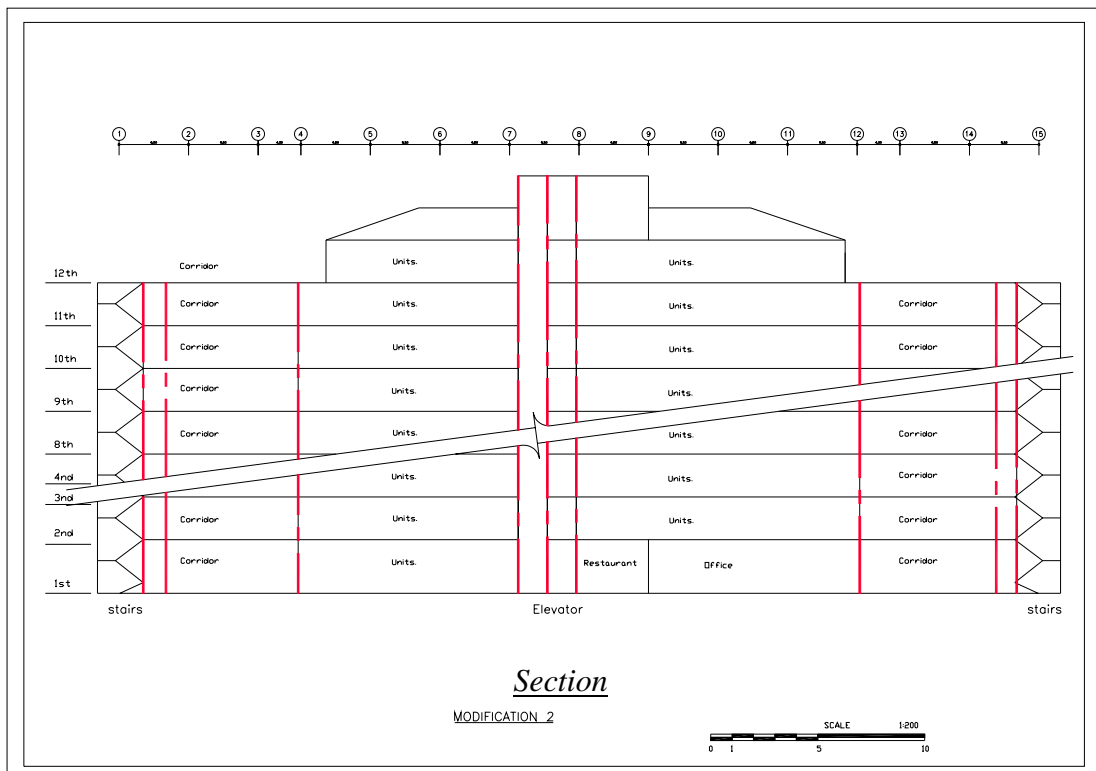
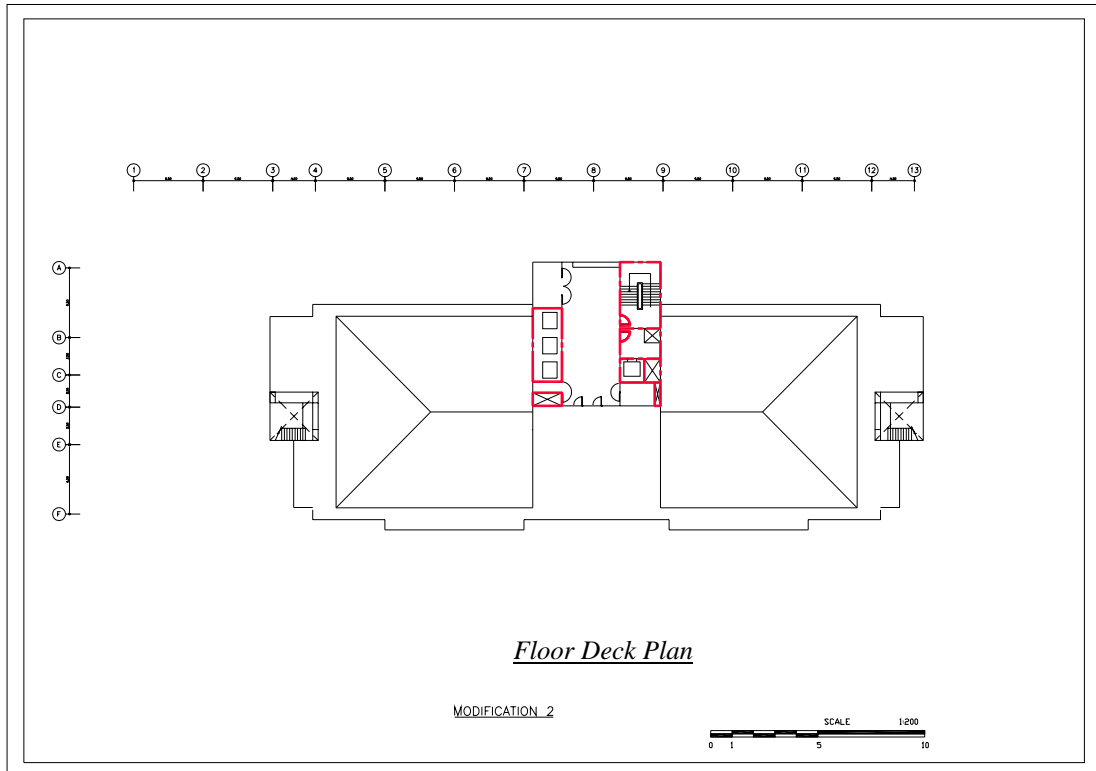
Multi-story Housing (Modification to MR-47) (2/2)



*Multi-story Housing (Modification to Standard) (1/2)*

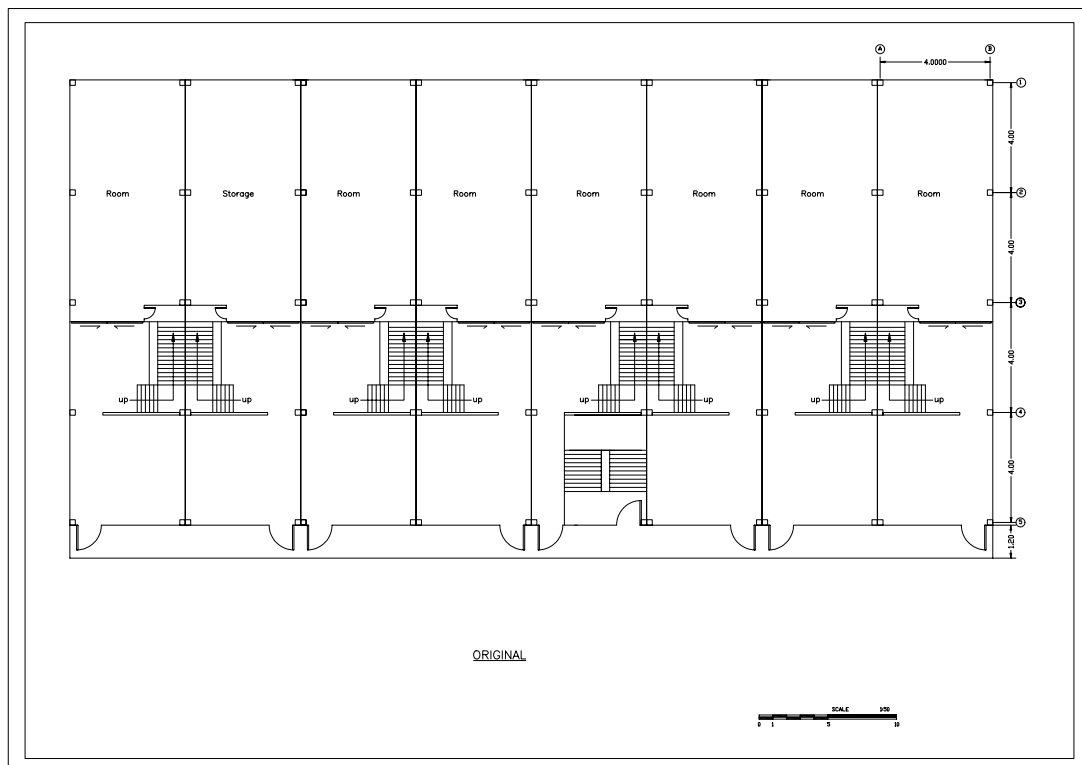
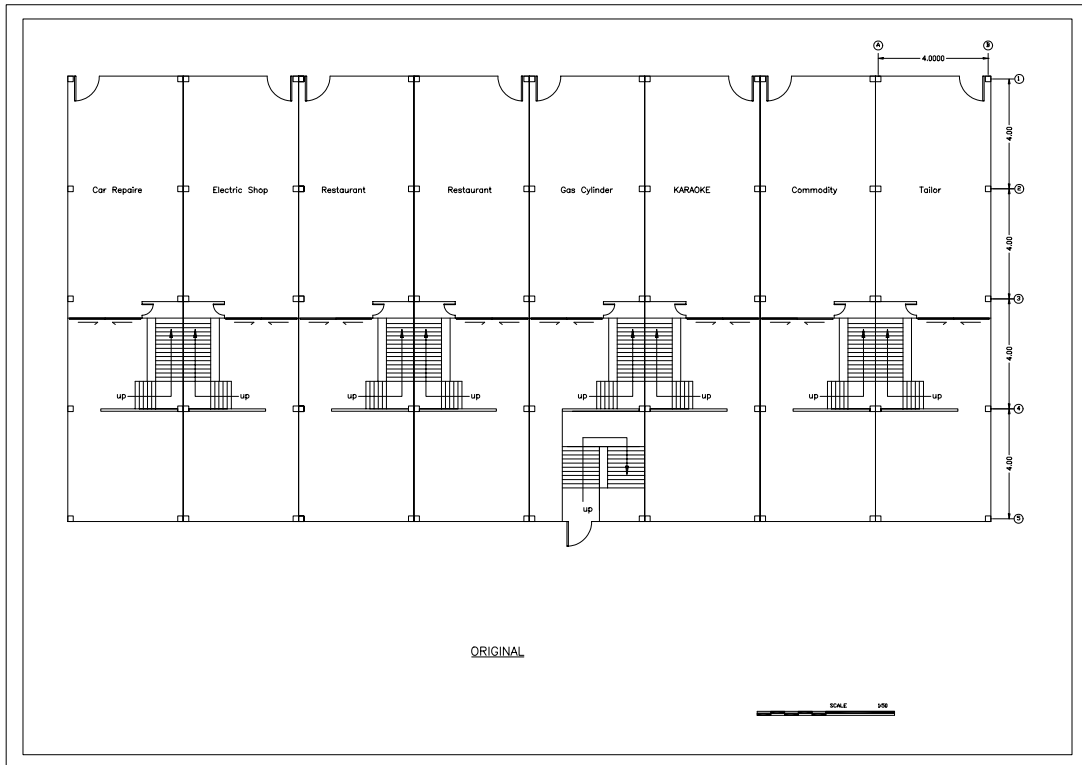


Multi-story Housing (Modification to Standard) (2/2)

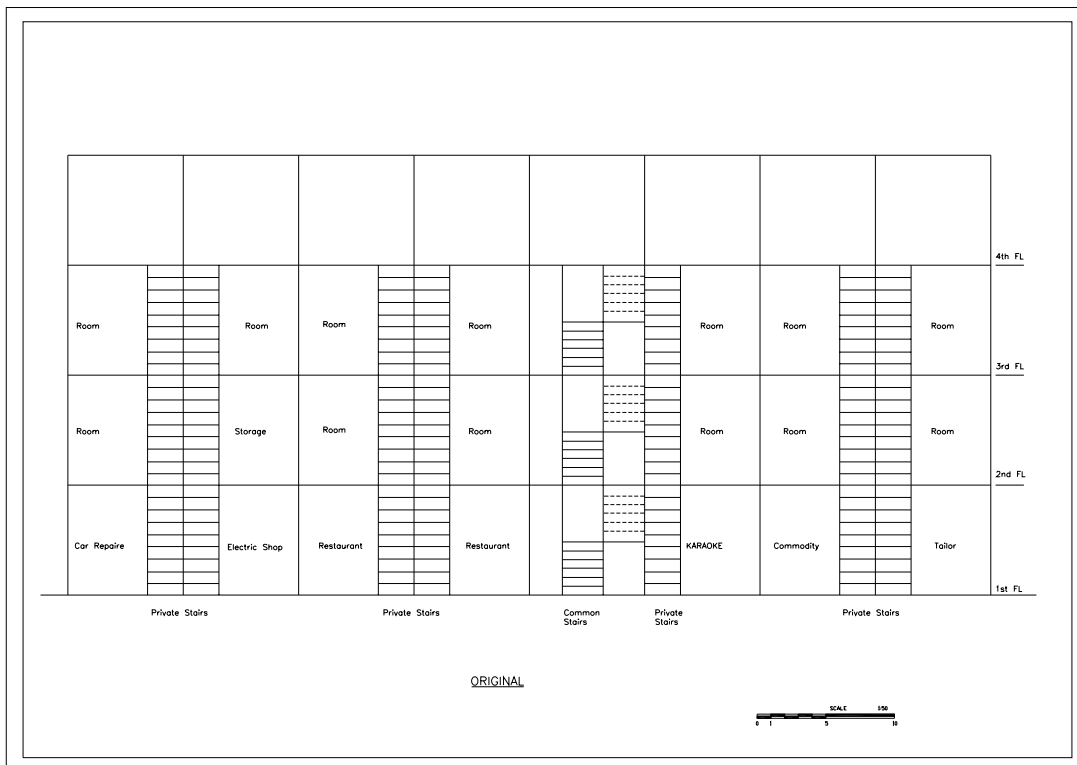
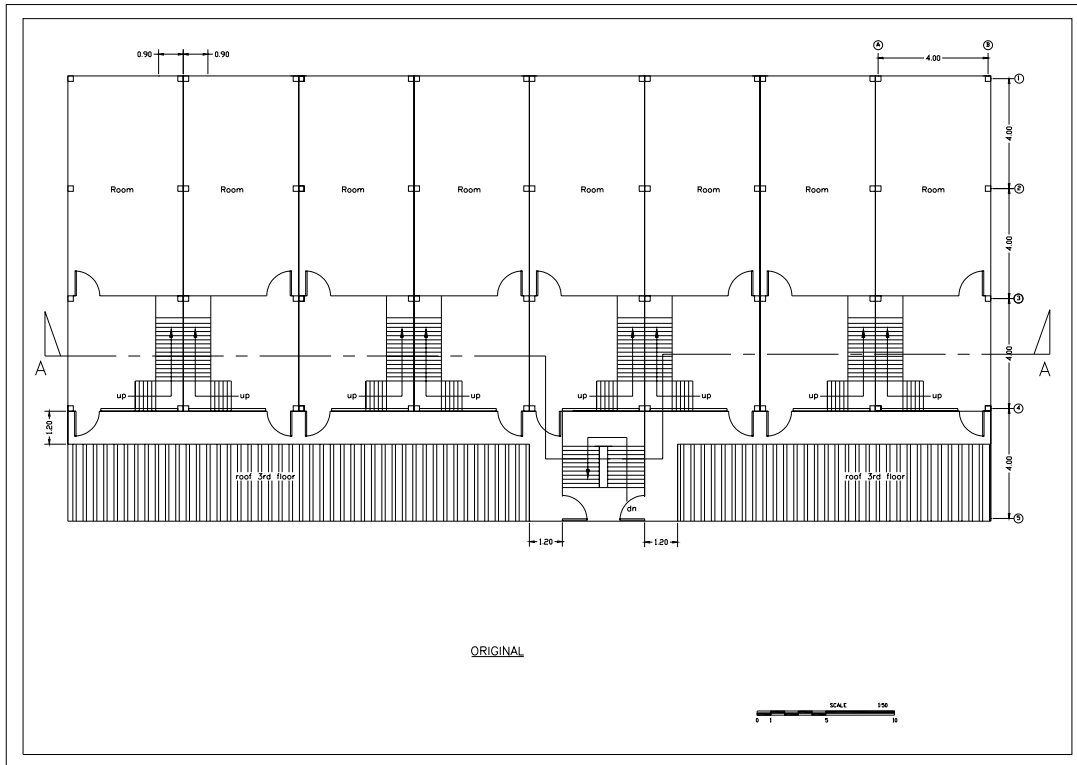


### 3) Shop House

#### Shop House (Existing Condition) (1/2)

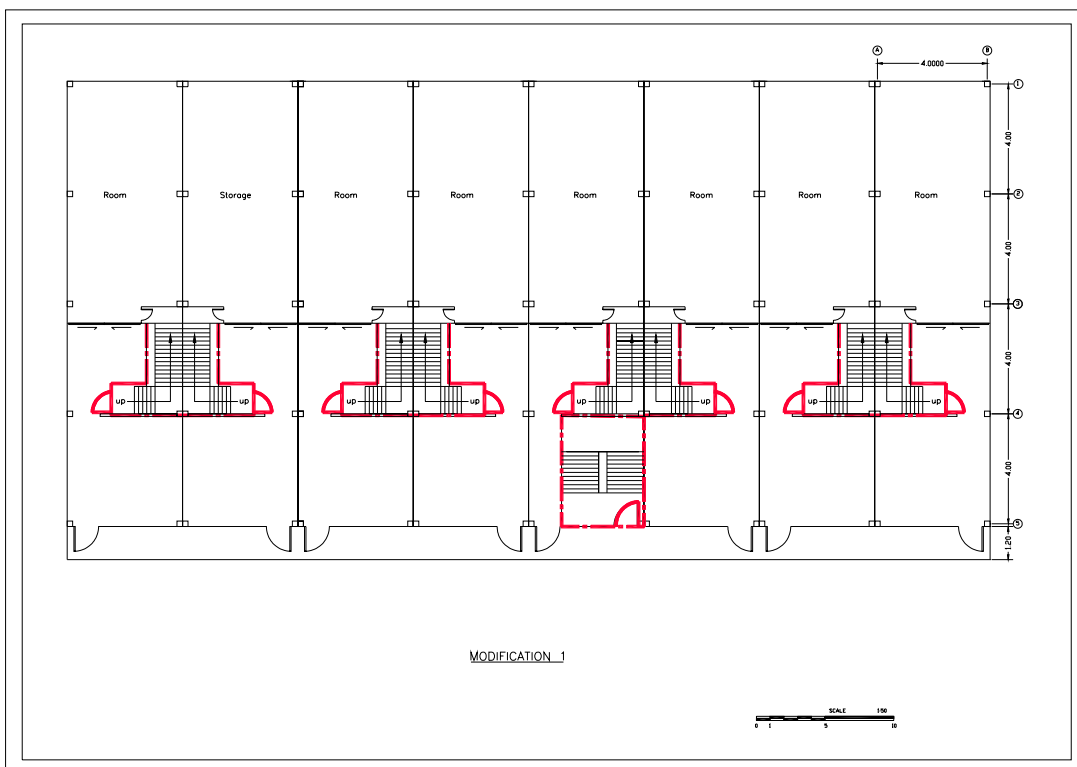
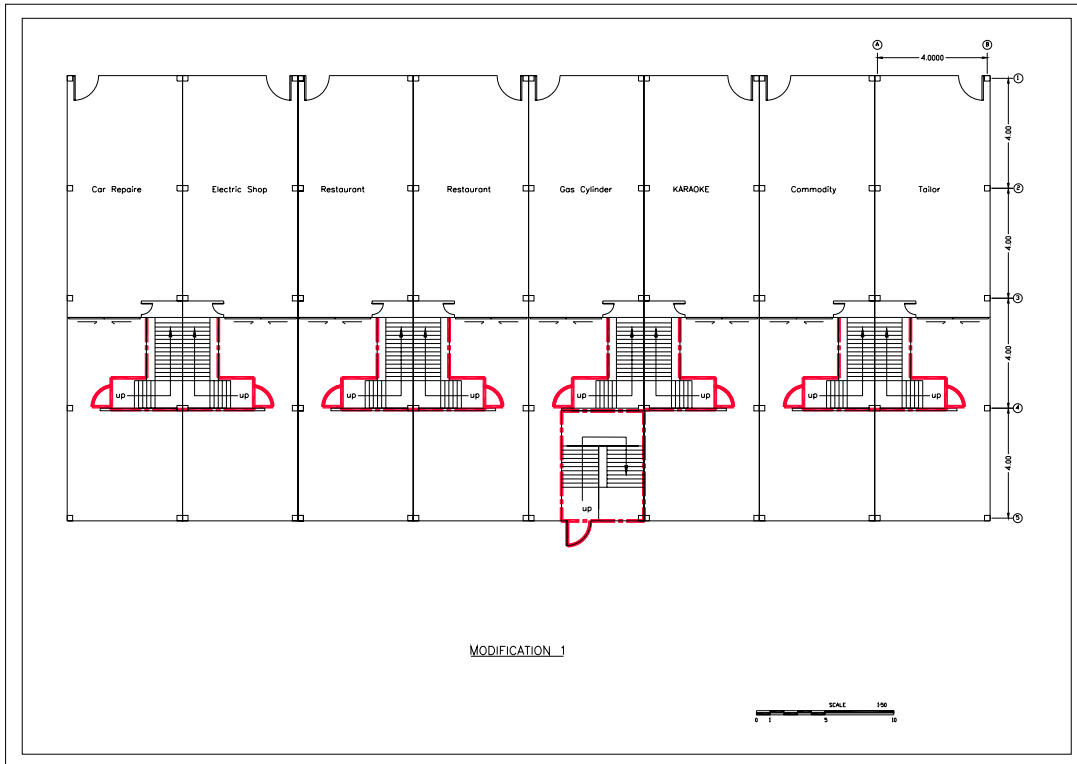


*Shop House (Existing Condition) (2/2)*

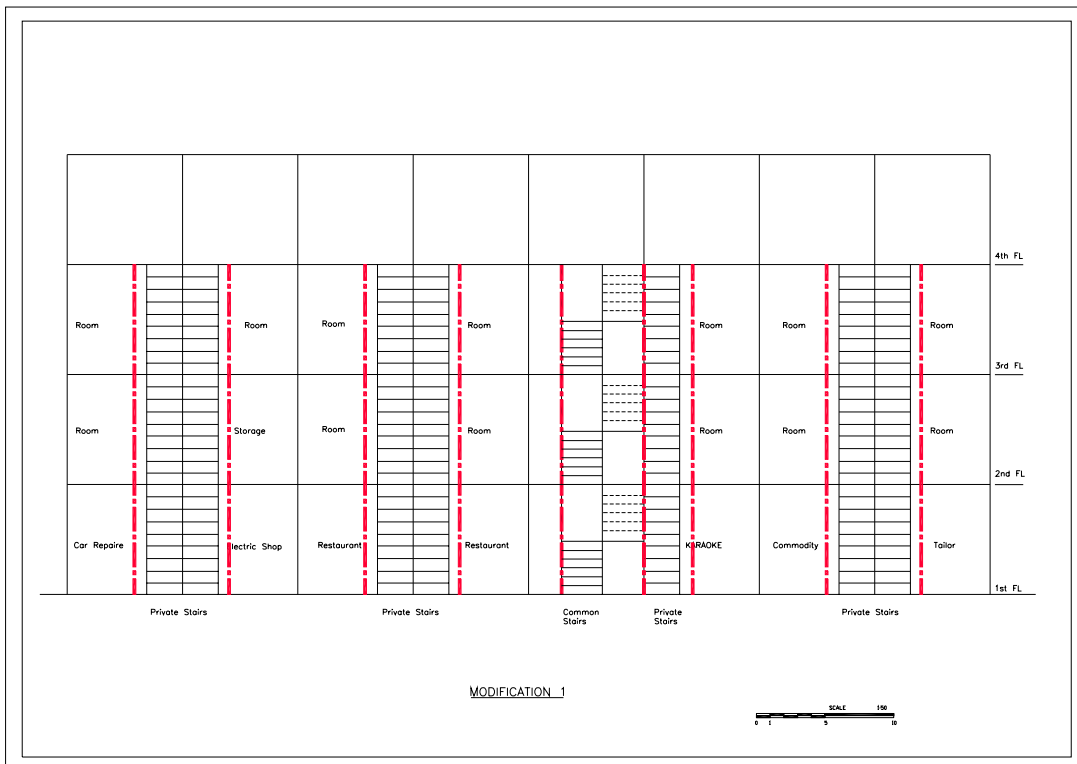
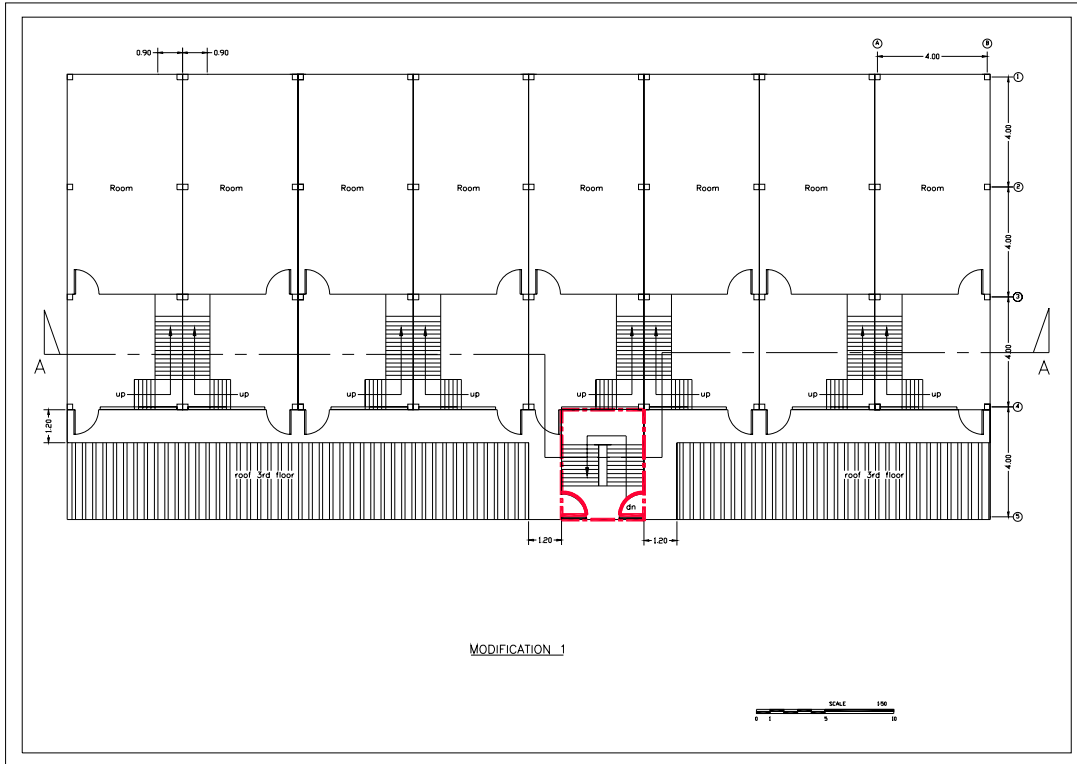




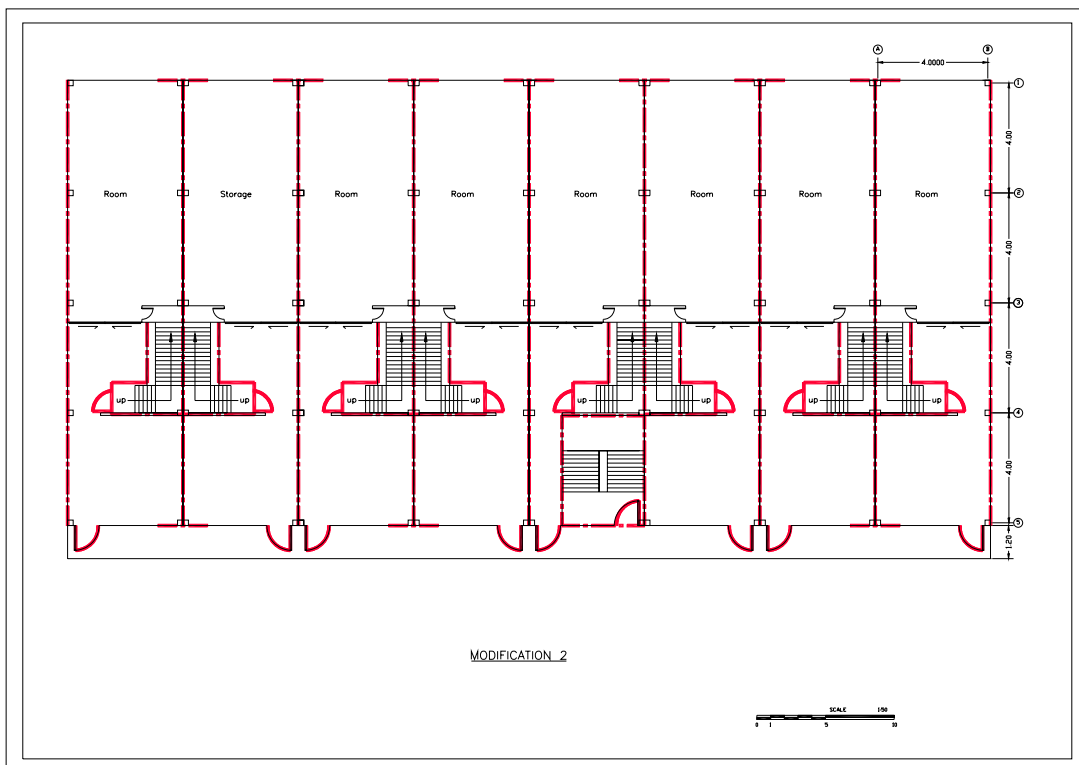
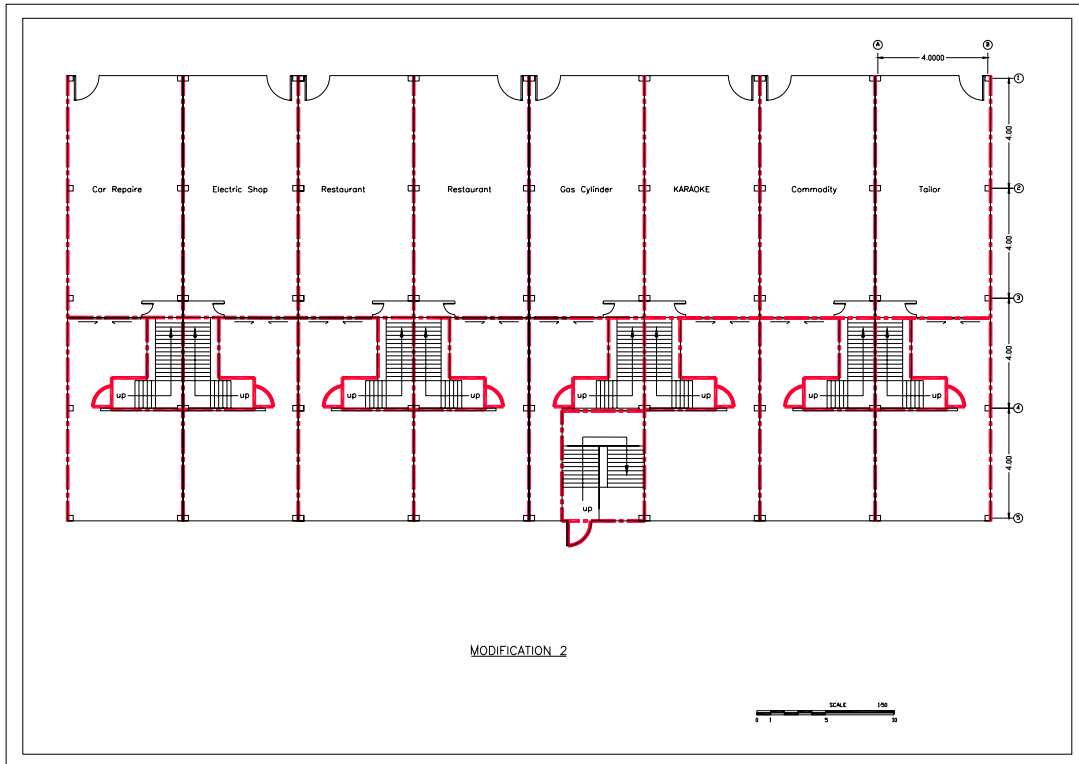
Shop House (Modification to MR-47) (1/2)



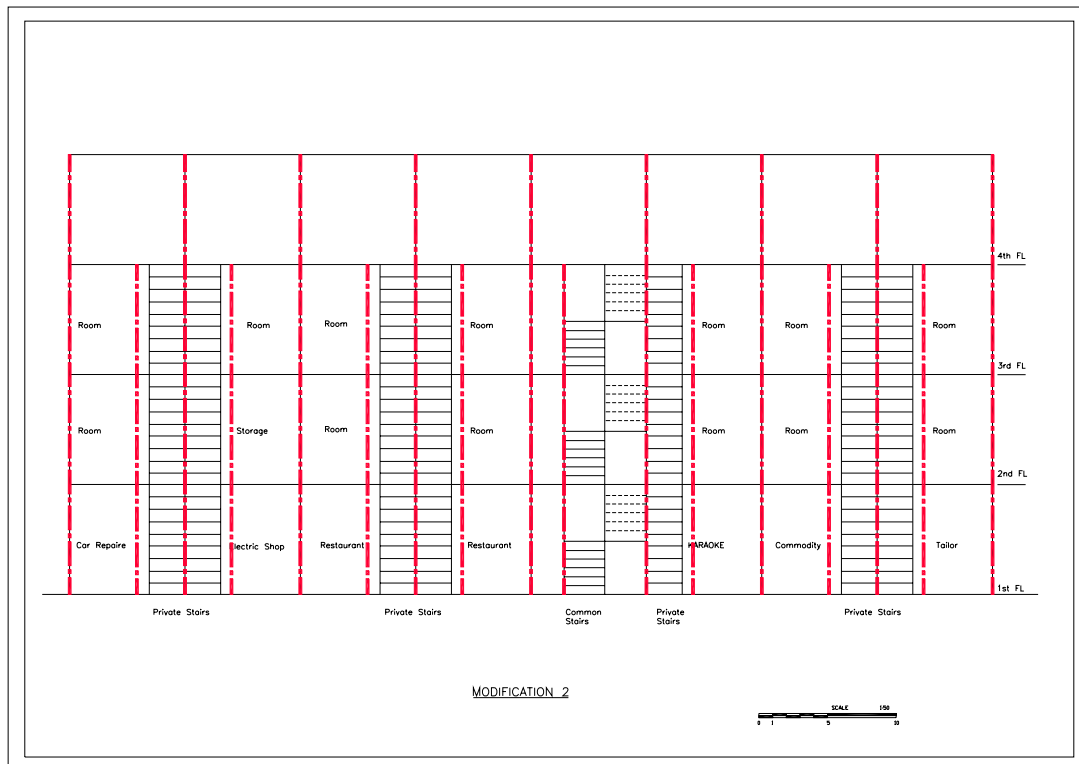
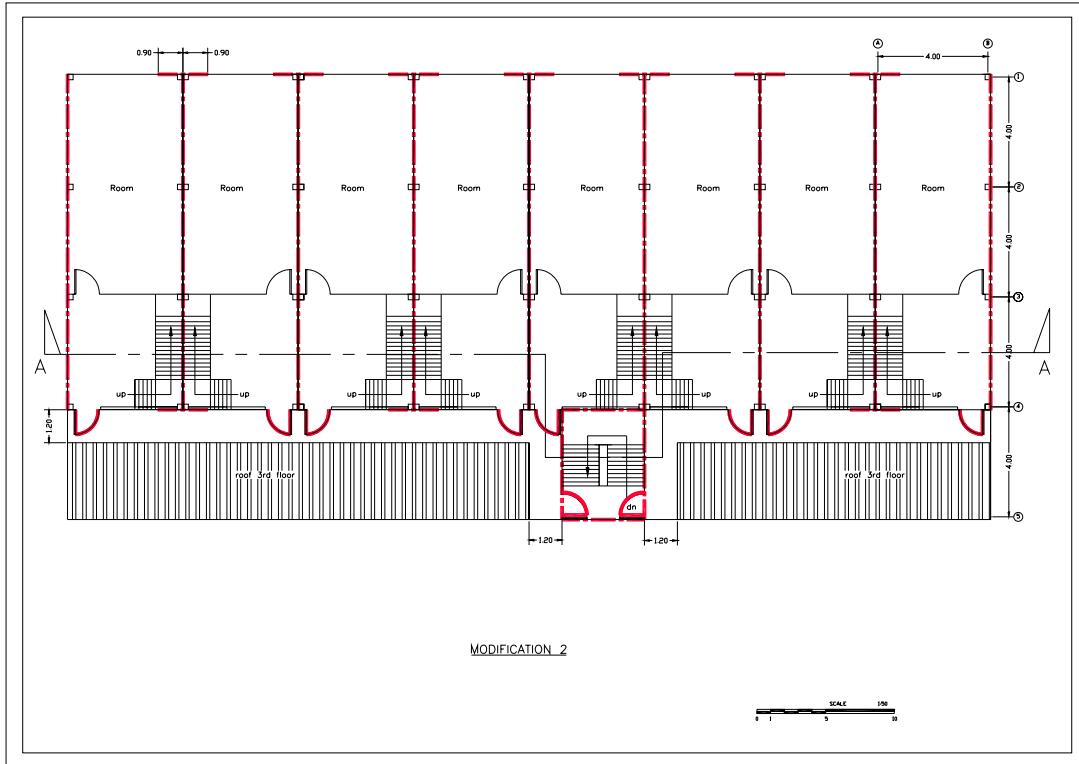
Shop House (Modification to MR-47) (2/2)



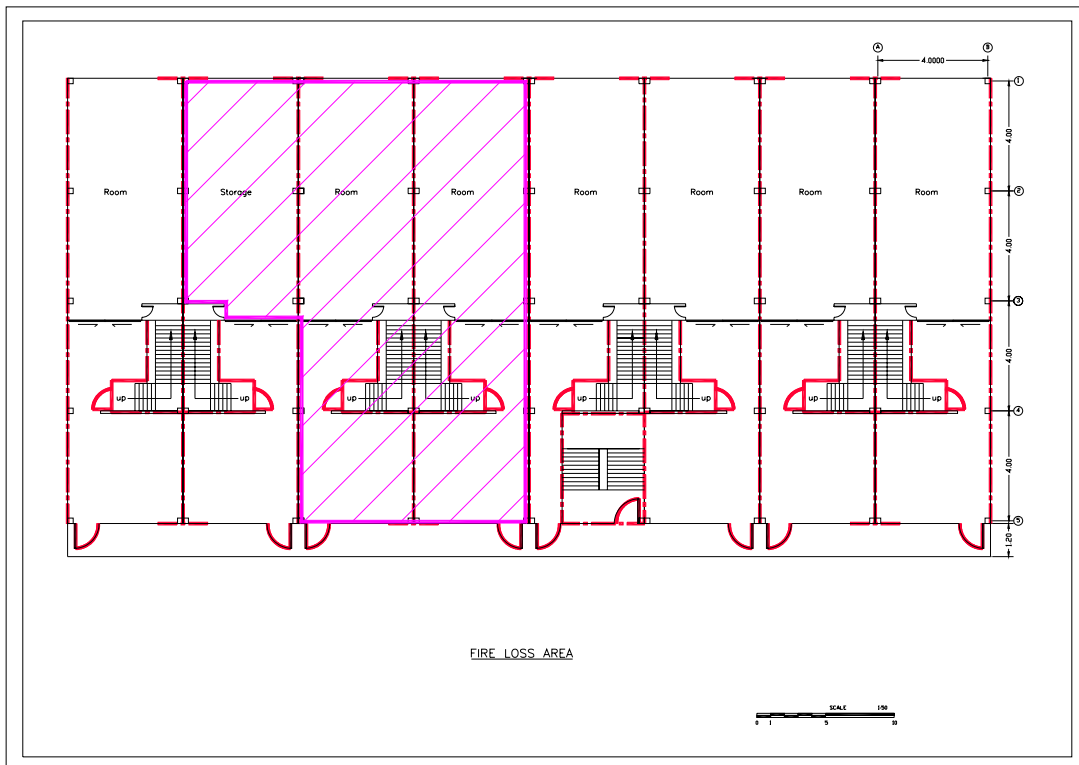
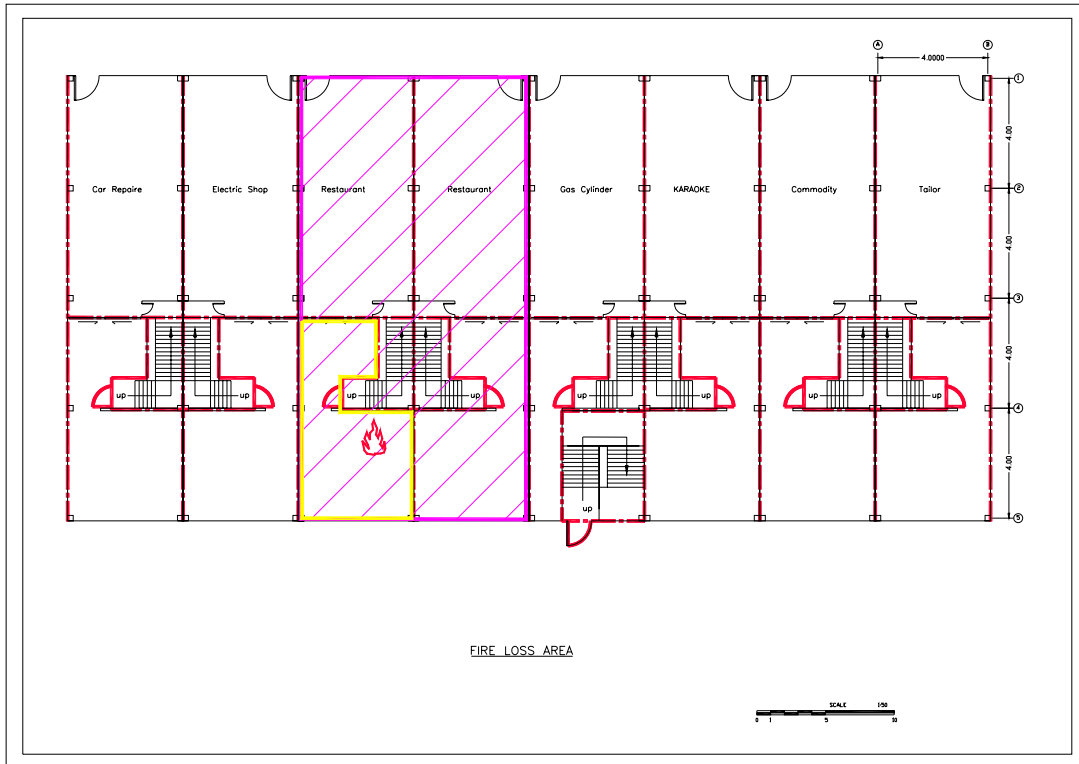
Shop House (Modification to Standard) (1/2)



Shop House (Modification to Standard) (2/2)



Shop House (Fire Loss Area) (1/2)



Shop House (Fire Loss Area) (2/2)

