

Risk Assessment tool for fire safety in Existing Buildings

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2. What are the obstacles?
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Case for refurbishment

Building stock - large % total energy consumption

Embodied energy significant

Motivation for re-use

Heritage buildings – obvious preservation motives

Commercial buildings – case needs to be made

- Pleasant environment, fit for use
- Energy efficient
- Fire safety



Sustainable design

Typical measures

Atria and light wells for natural light

- Fire and Smoke spread, Evacuation

Plenums for natural ventilation

- Fire spread in concealed spaces

Interconnected spaces, increased use of glazing

- Compartmentation

How do we address the dichotomy

Performance based design

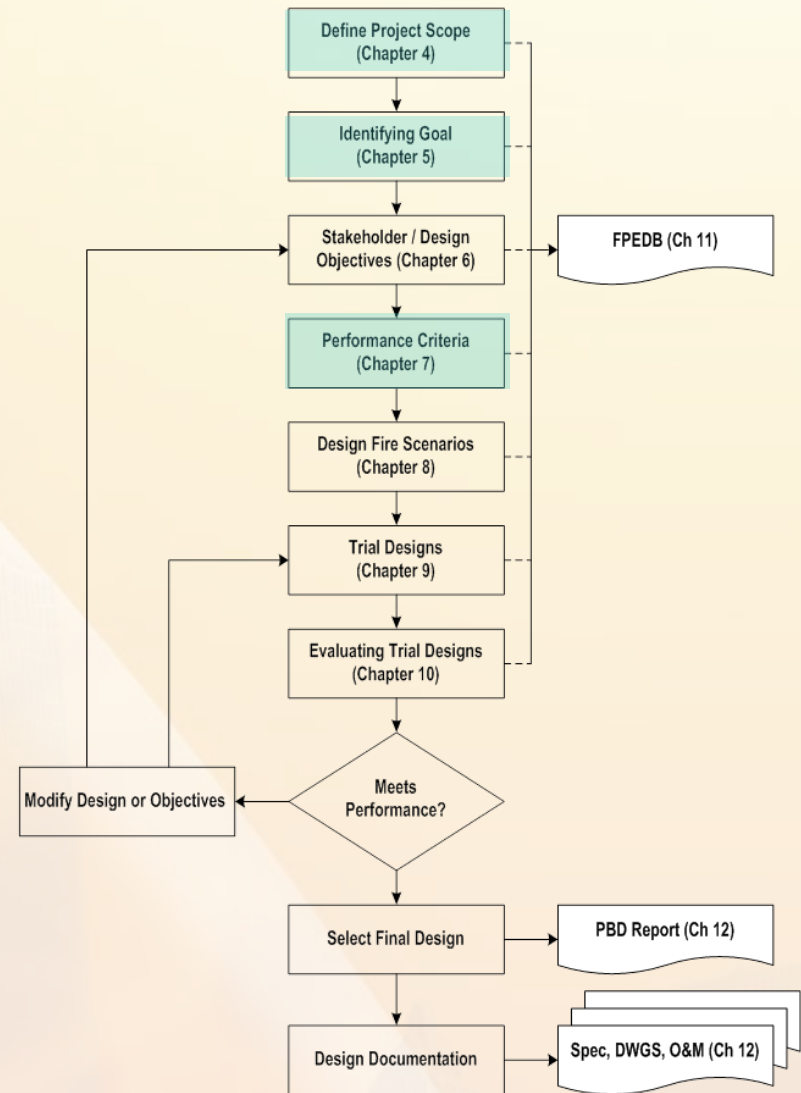
Identify objectives

- Life safety
- Property protection
- Sustainable design measures

Establish performance criteria

Find and evaluate sustainable design measures

Balance sustainability and fire safety



Examples



Existing 8 storey office building
Floors opened up for natural lighting of interior spaces

Design strategy consisted of

- Active compartmentation
- Vertical and horizontal fire curtains
- 2-storey compartments upon activation of alarm

Economic and energy efficient

- Minor increase in costs
- Enhanced rental demand

Practical case

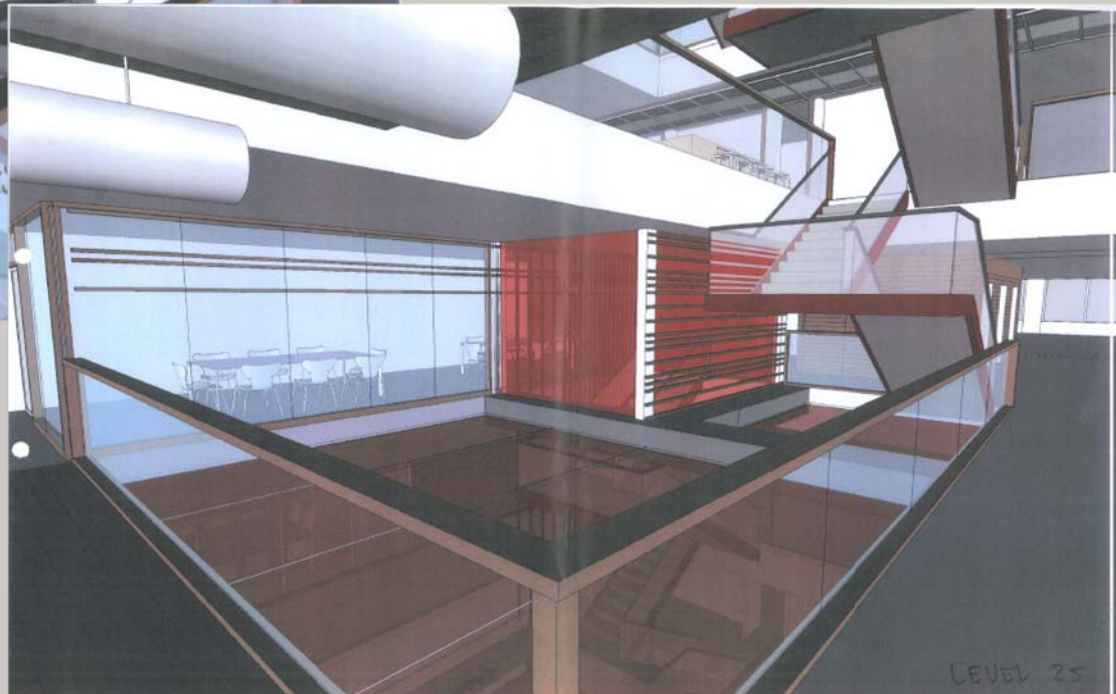


Commercial buildings

- Deteriorating before refurbishment
- New lease of life

Performance based design for

- Energy efficient measures
- Fire safety

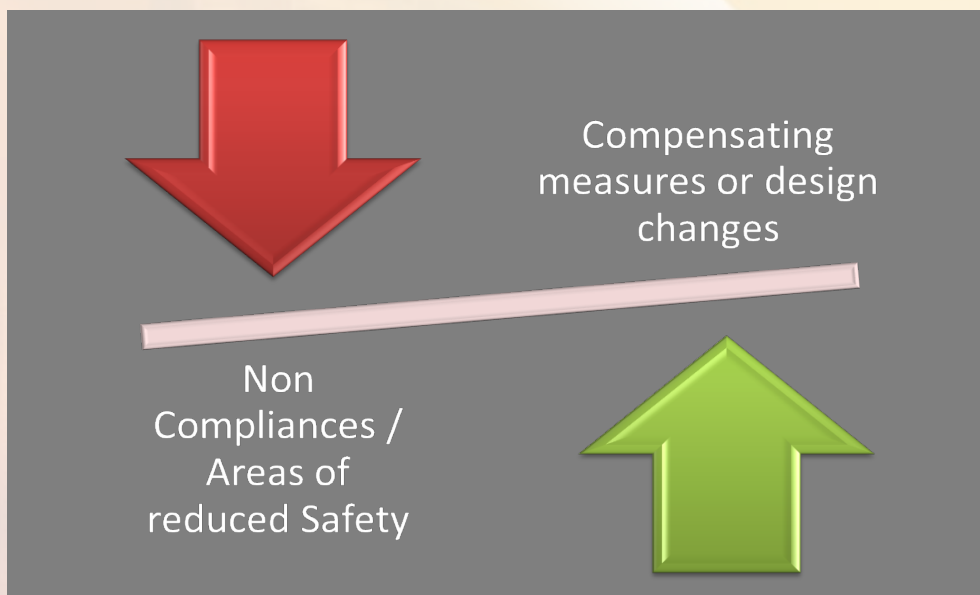


Decision to upgrade or not

Developers need to be able to evaluate alternatives

Sometimes the performance requirements just can't be met

What then ?



Let's not fool ourselves into thinking that with PBD we'll always find a fully compliant solution

Need method to balance fire safety with other considerations

Alternative to 'do nothing'



Can case be made for improvement, without full compliance ?

Do nothing → energy consumer, low level of fire safety

Refurbish → energy efficient, improved fire safety, but maybe not full compliance

Use Risk Assessment tools to measure fire safety performance against a quantified acceptance threshold

Risk assessment example

Risk ranking tool developed, based on an internationally recognised methodology for quantifying risk

- (NFPA 101A: Guide on Alternative Approaches to Life Safety)

Tool can be applied to building as a whole or by zone

Methodology:

- Identify key performance indicators for fire safety
- Performance score is calculated against each KPI
- Mandatory values calculated for each of the KPIs
- Performance compared with Mandatory values for each KPI
- Scorecard for each KPI to assess adequacy of the proposed package of measures

KPI's and Safety Parameters

7 KPI's to assess risk against life safety or property protection

- General Life Safety KPI
- Fire containment KPI
- Extinguishment KPI
- People movement KPI
- General property protection KPI
- Fire propagation KPI
- Smoke spread KPI

Safety Parameters	Life Safety KPIs			
	General	Containment	Extinguishment	Egress
1. Construction / Level of BCA Compliance and Combustibility	✓	✓	✓	×
2. Level of Compartmentation	✓	✓	✓	✓
3. Unprotected Voids/Vertical Openings	✓	✓	✓	✓
4. Segregation of Hazardous Areas	✓	✓	✓	×
5. Smoke Control	✓	×	×	✓
6. Emergency Movement Routes	✓	×	×	✓
7. Occupant Warning	✓	×	✓	✓
8. Smoke Detection	✓	×	✓	✓
9. Automatic Sprinklers	✓	✓	✓	✓
10. Emergency Lighting and Illumination	✓	×	×	✓
11. Emergency Procedure and Staff Training	✓	×	✓	✓
12. Fire Hose Reels	✓	✓	✓	×
13. Fire Hydrants	✓	✓	✓	×
14. Fire Extinguishers	✓	✓	✓	×

14 Safety Parameters are used to assess zone performance

S3 (People Movement)

= Sum of (Safety Parameter Scores 2*,3,5,6,7,8,9*,10,11)

(Safety Parameter Scores 1 – Construction /Level of BCA Compliance, 4 – Segregation of Hazardous Areas, 12 – Fire Hose Reels, 13 – Fire Hydrants, 14 – Fire Extinguishers are omitted)

Safety parameter weighting

1. Type of Construction / Level of BCA Compliance	BCA Deficient -2	Complies with BCA 1	Higher Level Than BCA 2	Combustible -4		
2. Level of Compartmentation *	No fire compartmentation -3	Floor by floor compartmentation 1	Compartmentation within the Floor			
			Different use areas compartmented	Individual floors compartmented + different use areas		
			2	3		
3. Vertical Openings (a) (Stairs, shafts)	Unprotected Opening 4 Floors (without sprinklers), BCA non-compliant -4	Unprotected Openings 3 (without sprinklers) or 4 (with sprinklers) Floors, BCA non-compliant -2	Openings 2 (without sprinklers) or 3 (with sprinklers) floors to BCA requirement, or no vertical openings 1	Enclosed with Indicated Fire Resistance		
				Smoke Isolated (e)	1 hr or less (f)	> 1 hr
				1	2	3
4. Hazardous Areas	Double Deficiency		Single Deficiency		No Deficiency	
	In Zone -4	In Adjacent Zone -3	In Zone -3	In Adjacent Zone -2	1	
5. Smoke Control *	No Control/ BCA Requirement -2	No or Partial Control/ No BCA Requirement 1	Passive/Natural and BCA does not require smoke control (h) 2	Mech. Assisted Systems by Zone 4		
6. Emergency Movement Routes	Single Exit		Multiple Exits			
	Extended Travel (i) or non-compliant width -5	Extended Travel (d), or non compliant width -2	BCA DTS Compliant 1	Horizontal Exits 1	Direct Exits 3	
7. Occupant warning *	No Warning System Installed & required by BCA -4	No Warning System, Not Required by BCA 0	Bell Only -0.5	EWS 2	EWIS (c) 4	
8. Smoke Detection * (n) (o)	None (j), required by -3	Manual call Points 1	Thermals Only 3	Smoke Detection 5	Incomplete System 2	
9. Automatic Suppression (l) *	None, not required by BCA 1	None, required by BCA -3	Partial and (if sprinklers are provided) compliant separation 5	Partial and (if sprinklers are provided) non-compliant separation 3	Entire Building 10	
10. Emergency Lighting and Illumination *	No Emerg. Lighting or Exit Signage -3	Exit signage only -1	Emergency Lighting only -2	Emergency Lighting and Exit Signage 2		
11. Emergency Procedure and Staff Training *	No Procedures or Training (b) -3	Procedures and no training 1	Training and no procedures 3	Comprehensive Plan and Training 5		
12. Fire Hose Reels *	Not Installed -4	Installed, Not compliant (m) -2	BCA Compliant (m) 1			
13. Fire Hydrants * (p)	Not Installed -5	Installed, Not compliant -2	coverage from external hydrants 2			
14. Fire Extinguishers *	Not Installed -4	Installed, Not compliant(m) -1	BCA Compliant (m) 1	Installed within each smoke/fire compartment (m) 2	Installed adjacent each exit. (m) 4	

Mandatory values for KPI's

Risk factor values used to calculate Mandatory values for Life Safety and Property Protection KPI's

Ignition Sources (A)	
No Sources	1
One Source not naked flame	1.6
Multiple sources of same type or different type	2
Single Naked flame source	2.5
Multiple flame sources	3
Electrical Protection (B)	
Residual Current Device	1
Circuit Breakers	1.2
Wired Fuses	1.5
Occupant Density (C), number of people / m ² floor area	
<1	1
1-3	1.2
3-5	1.5
>5	2
Zone Location (D), Floor	
Ground floor	1
1st or 2nd	1.2
Roof	1.4
Basement	1.6

Annual inspection finding a Priority 1 fault (>100oC)	1.0
Annual inspection finding a Priority 2 fault (75 to 100oC)	0.8
Annual inspection finding only Priority 3 or 4 faults (<75oC)	0.6
No fault found or fault rectified	0.5

Number of Floors in whole building	Mandatory Values for Key Performance Indicator		
	Containment (Sa)	Extinguishment (Sb)	People Movement (Sc)
One Storey	2	5	5
2 or 3 Stories	4	8	8
4 Stories or more	5	8	10

Public to staff member ratio

1

Open to public

doors/Security

controls

V, Roving

V, Roving

ing of switchboards and distribution

overloading and faults (G)

Annually

1.2

1.0

0.8

0.6

0.5

Heritage Value of Building and Contents

Mandatory Values for Key Performance Indicator

Fire Spread (Sd)

Smoke Spread (Se)

Low or medium heritage value of contents or building fabric within Zone

0

0

High heritage value of contents or building fabric within Zone

6

6

Exceptional heritage value of contents or building fabric within Zone

8

8

Measurement of performance

Performance measures against Mandatory values for each KPI for zone or building

KPI	Zone Performance	Mandatory Value	Risk Level Result Z(L)
Fire Containment	S1	Sa	S1-Sa
Fire Extinguishment	S2	Sb	S2-Sb
People Movement	S3	Sc	S3-Sc
General Safety	S4	R(L)	S4-R(L)

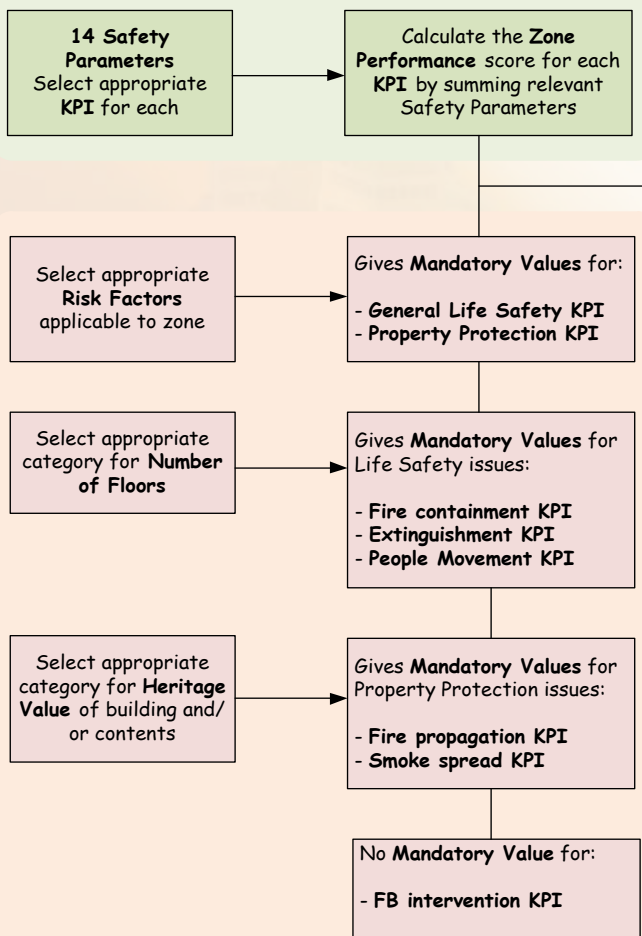
KPI	Building / Zone Performance	Mandatory Value	Risk Level Result Z(L)
Fire Spread	S5	Sd	S5-Sd
Smoke Spread	S6	Se	S6-Se
General Property Protection	S7	R(P)	S7-R(L)

KPI	Level of Fire Risk			
Fire Containment	$Z(L) < -5$	$-5 \leq Z(L) < 0$	$0 \leq Z(L) < 5$	$5 \leq Z(L)$
Fire Extinguishment	$Z(L) < -5$	$-5 \leq Z(L) < 0$	$0 \leq Z(L) < 5$	$5 \leq Z(L)$
People Movement	$Z(L) < -5$	$-5 \leq Z(L) < 0$	$0 \leq Z(L) < 5$	$5 \leq Z(L)$
General Safety	$Z(L) < -5$	$-5 \leq Z(L) < 0$	$0 \leq Z(L) < 5$	$5 \leq Z(L)$

Red, Orange, Yellow and Green scoring for convenience

Overview - Risk Assessment methodology

Performance -existing state and for options considered



Assessment of Performance vs Mandatory measures

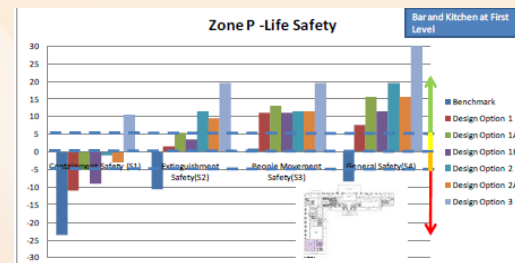
Calculate difference between Zone Performance and Mandatory Value for each KPI

For each KPI tag final risk score as Red, Yellow, Orange or Green

Give graph representation of results for all KPIs by zone

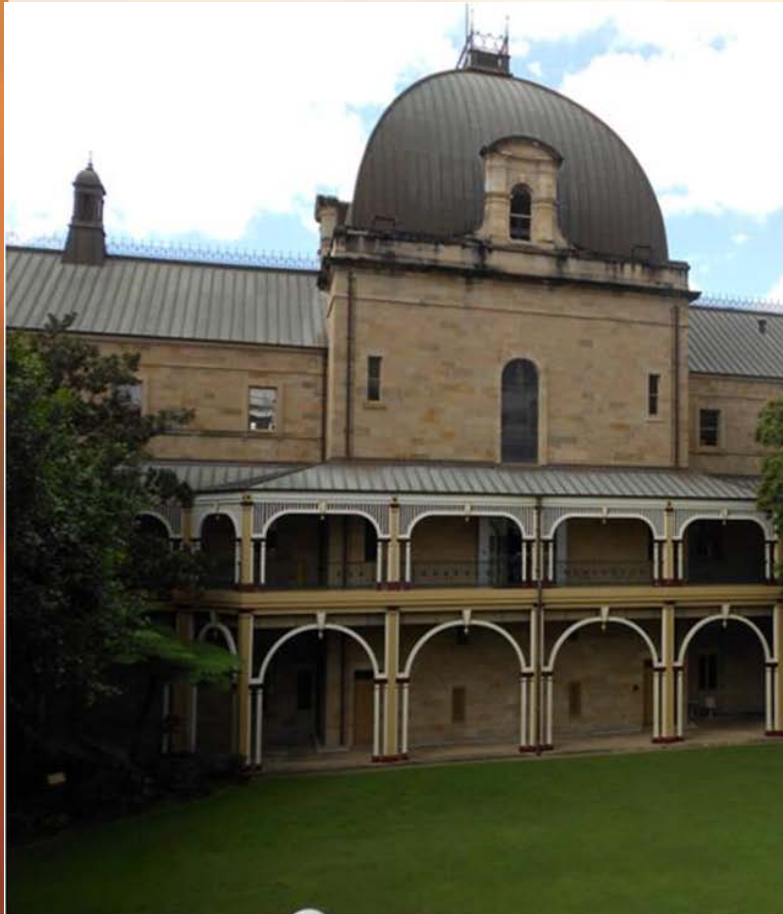
KPI	Zone Performance	Mandatory Value	Risk Level Result Z(L)
Fire Containment	S1	Sa	S1-Sa
Fire Extinguishment	S2	Sb	S2-Sb
People Movement	S3	Sc	S3-Sc
General Safety	S4	R(L)	S4-R(L)

Zone	KPI No.1	KPI No. 1 Score	KPI No.2	KPI No. 2 Score	KPI No.3	KPI No. 3 Score
Major tenancy 1	High	-9.5	Extreme	-10.65	Low	11.1
Major tenancy 2	Extreme	-14.0	Extreme	-14.35	Extreme	-17.1
Specialty 1	Medium	9.5	Medium	3.15	Low	20.9
Specialty 2	Low	11.5	Low	10.5	Low	36.1
Mall 1	Extreme	-17	High	-9.85	High	-5.6



Measure of Mandatory Performance

Existing Parliament House building



Aim of the risk assessment tool

Identify fire safety hazards and risks in an existing building

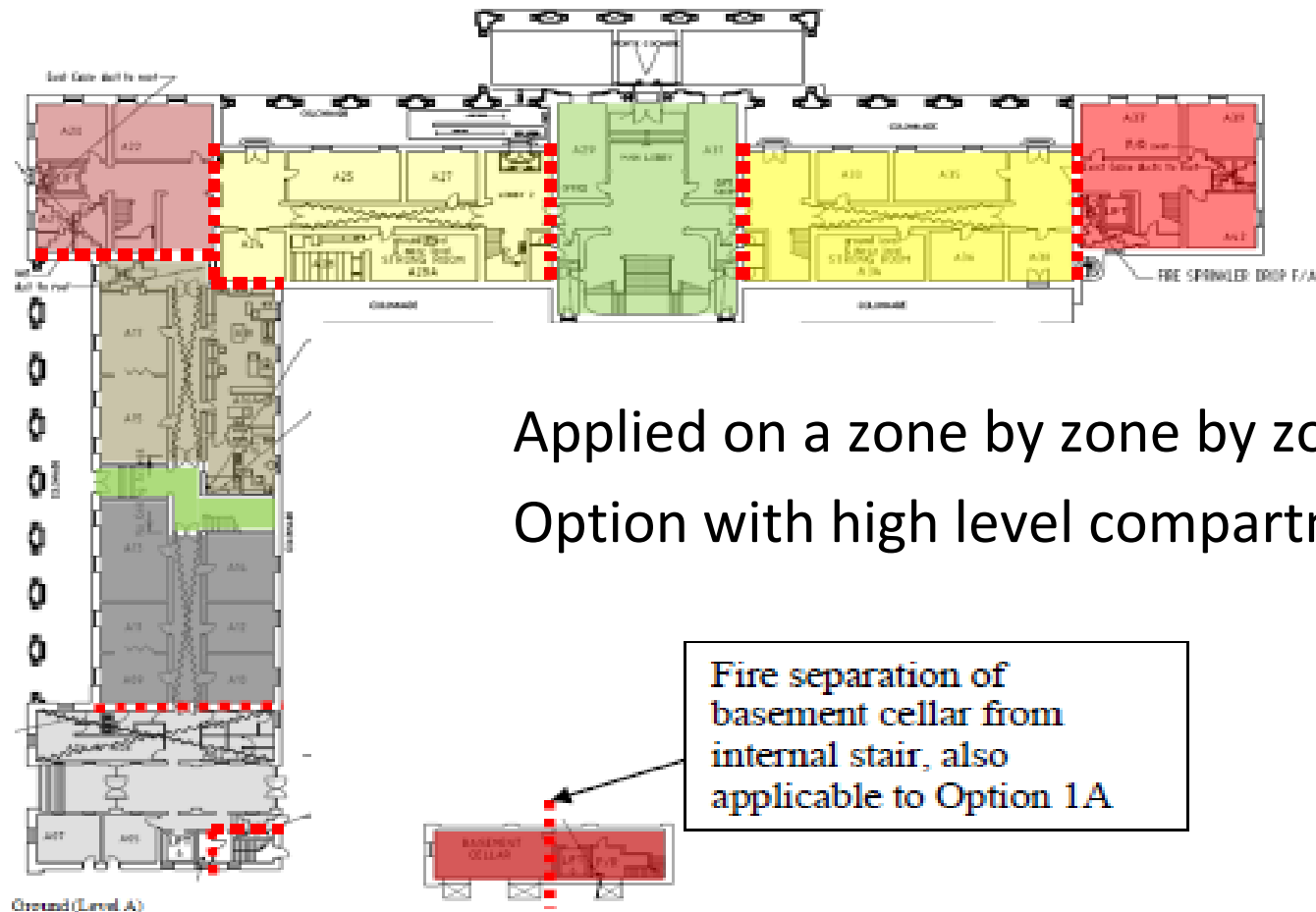
Better understand the possible risk reduction measures and their effectiveness

Quickly compare different options

In this case, some of the fire safety issues were

- Common roof void
- Timber construction and open stairs
- Generally good egress but no protected stairs
- Use of areas beneath stairs
- Hydrant performance and locations
- Potential for significant loss before brigade control

Zone by zone application



Applied on a zone by zone by zone basis
Option with high level compartmentation

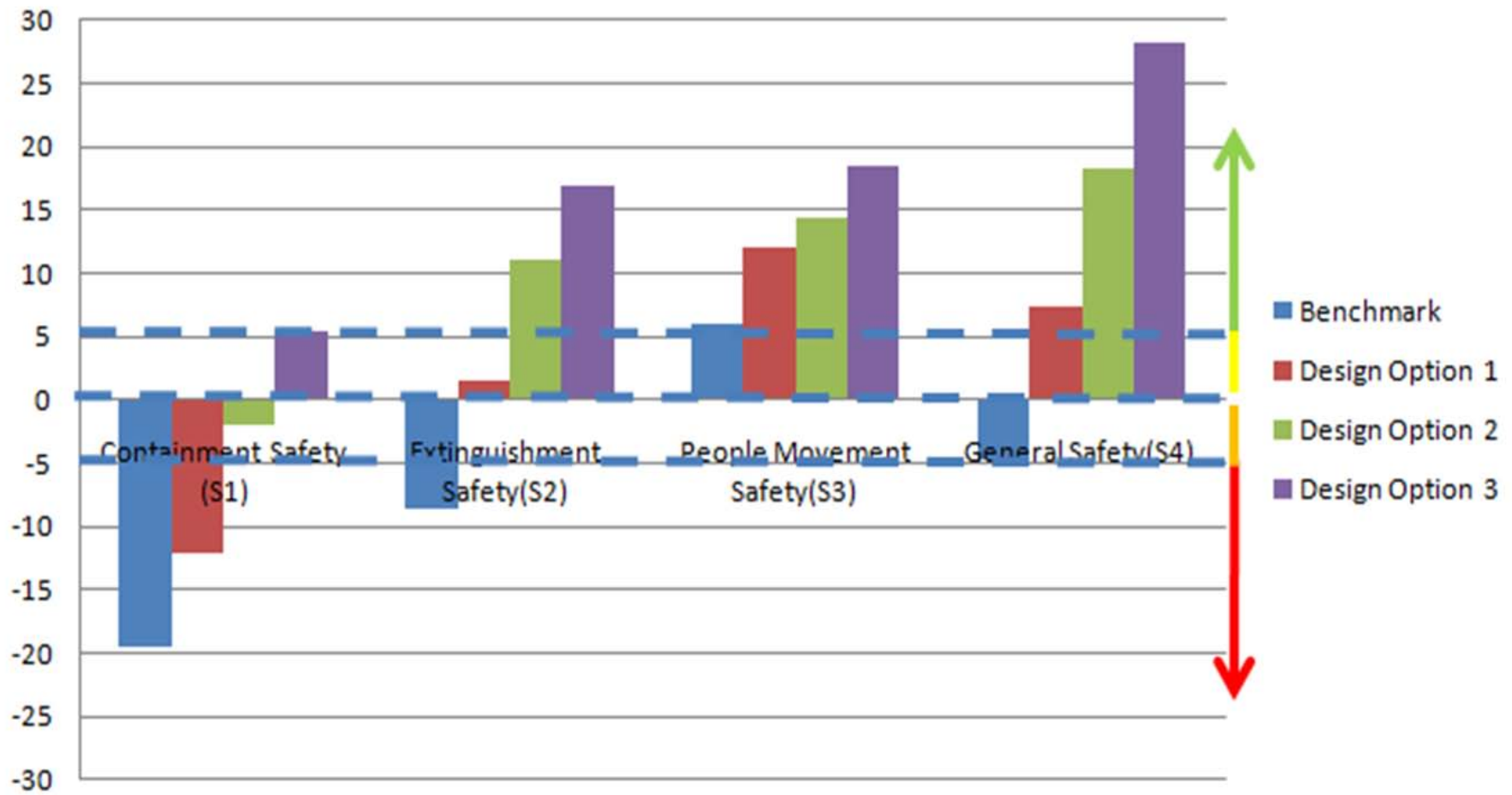
Fire separation of
basement cellar from
internal stair, also
applicable to Option 1A

Figure 5 Concept Design Strategy Option 3 – Fire compartmentation lines at ground level

Risk levels vs Benchmark

Zone T -Life Safety

O'Donovan Library at
Second Level



Summing up on RA Tool

Advantages of the use of the risk assessment tool

- Identify and rank the fire safety hazards and risks in an existing building
- Enable better decision making based the risk reduction achieved and related to cost
- Allows the Authorities to be involved in setting an appropriate level of risk for a particular building
- Provides means to balance cost, disruption to activities, heritage and sustainability considerations with fire life safety requirements

Limitations of the risk assessment tool

- A positive score in the assessment does indicate code compliance
- The assessments does not provide a measurement of absolute risk
- The method is not intended to replace a detailed fire engineering analysis (e.g. smoke analysis, egress analysis, structural fire engineering analysis) of future works

Conclusion

Identify adequate level of Fire Safety - within constraints

- Improvements over a base case (existing or code equivalent)

Performance objectives of all issues need to be considered

- Energy consumption, comfort, fire safety, ...

Quantify a base case and show how proposals affect that

Balance fire safety with other considerations

Can the project afford to proceed?

Need a Legislative environment

to support this approach !



Gracias por su atención
Thanks for your attention

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