

Thursday - 22nd September 2011

ASFP Ireland Fire Seminar & Workshop - Dublin



Buncefield Oil Storage Depot

Sunday, 11 December 2005

A Gentle Whisper in Your Ear ...

Sustainable Fire Engineering IS THE FUTURE !

... a Safe & Sustainable Built Environment in the 21st Century





Human Injury - Business Interruption - Service Failure - Brand Damage - Waste of Resources

Direct/Indirect Fire Losses Not Yet Fully Identified ... Data & Statistics Not Reliable



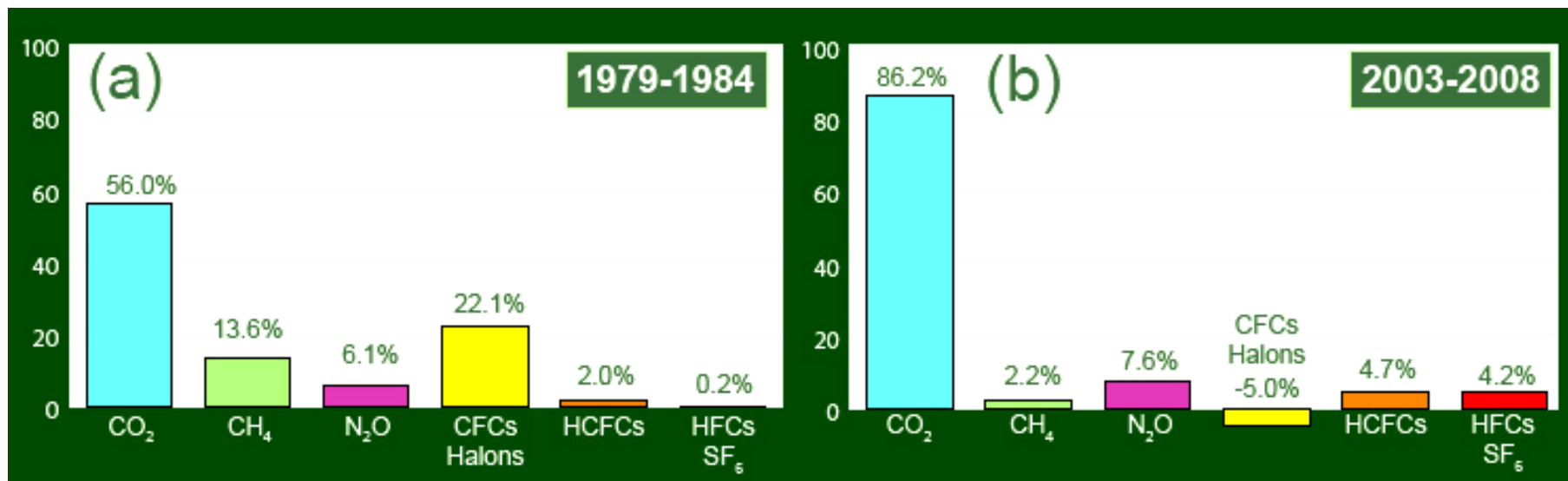
Fire at Atlantis Hotel, Dubayy, UAE - Tuesday, 2 September 2008

[A43]



Adaptation to Climate Change ?

Relative contribution of major greenhouse gases to the overall change in radiative forcing (a) between 1979 and 1984; and (b) from 2003 to 2008. The importance of **CO₂** has increased substantially. Whereas the contribution from CFC's and Halons has turned around and is now negative, the contributions from **HCFC's** and **HFC's** are increasing rapidly. From 2003 to 2008 they were, together with **SF₆**, responsible for 8.9% of the increase in the radiative forcing caused by long-lived greenhouse gases.



UN World Meteorological Organization, Greenhouse Gas Bulletin No. 5, Published 23 November 2009



A Safe 'Social' Environment ?



Madrid Train Bombings - Thursday, 11 March 2004



Mumbai 'Hive' Attacks - Wednesday to Friday, 26-28 November 2008

[A42]



'Redundancy' of Structure & Systems ?

Sustainable Design: Redundancy Necessary for Building Adaptability & Structural Reliability

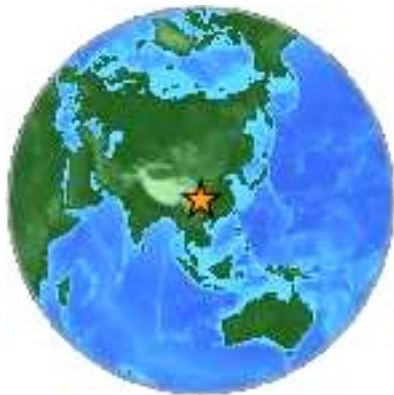
[Minimum Life Cycle for a Sustainable Building is 100 Years]

Green Concept of 'Lean Construction' is a serious error ... and anti-sustainable !



79th Floor, Empire State Building (NY) - Following a B-25 Bomber Direct Impact at 09.40 hrs on Saturday, 28 July 1945





Collapse of Recently Constructed Buildings in Eastern Sichuan, China - Following the Earthquakes of 12 May 2008

Independent Technical Control ?

NIST urges state and local agencies **to rigorously enforce** building codes and standards since such enforcement is critical to ensure the expected level of safety. Unless they are complied with, the best codes and standards cannot protect occupants, emergency responders, or buildings.

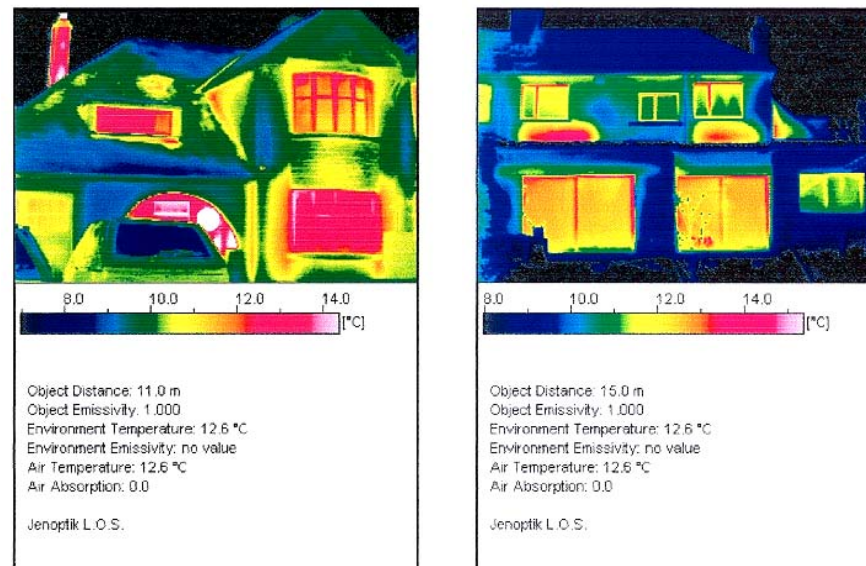
Executive Summary, 2005 NIST(USA) Final Report on 9-11 WTC 1 & 2 Collapses



Monitoring 'Real' Construction Performance ?

- Quantitative & Qualitative Performance Indicators
 - Built-In & Portable Monitoring Equipment

e.g. Energy Efficiency & Conservation (1998) ...



Long Wave Infra-Red Thermography (8-12 microns)



Iconic & Innovative Buildings ?

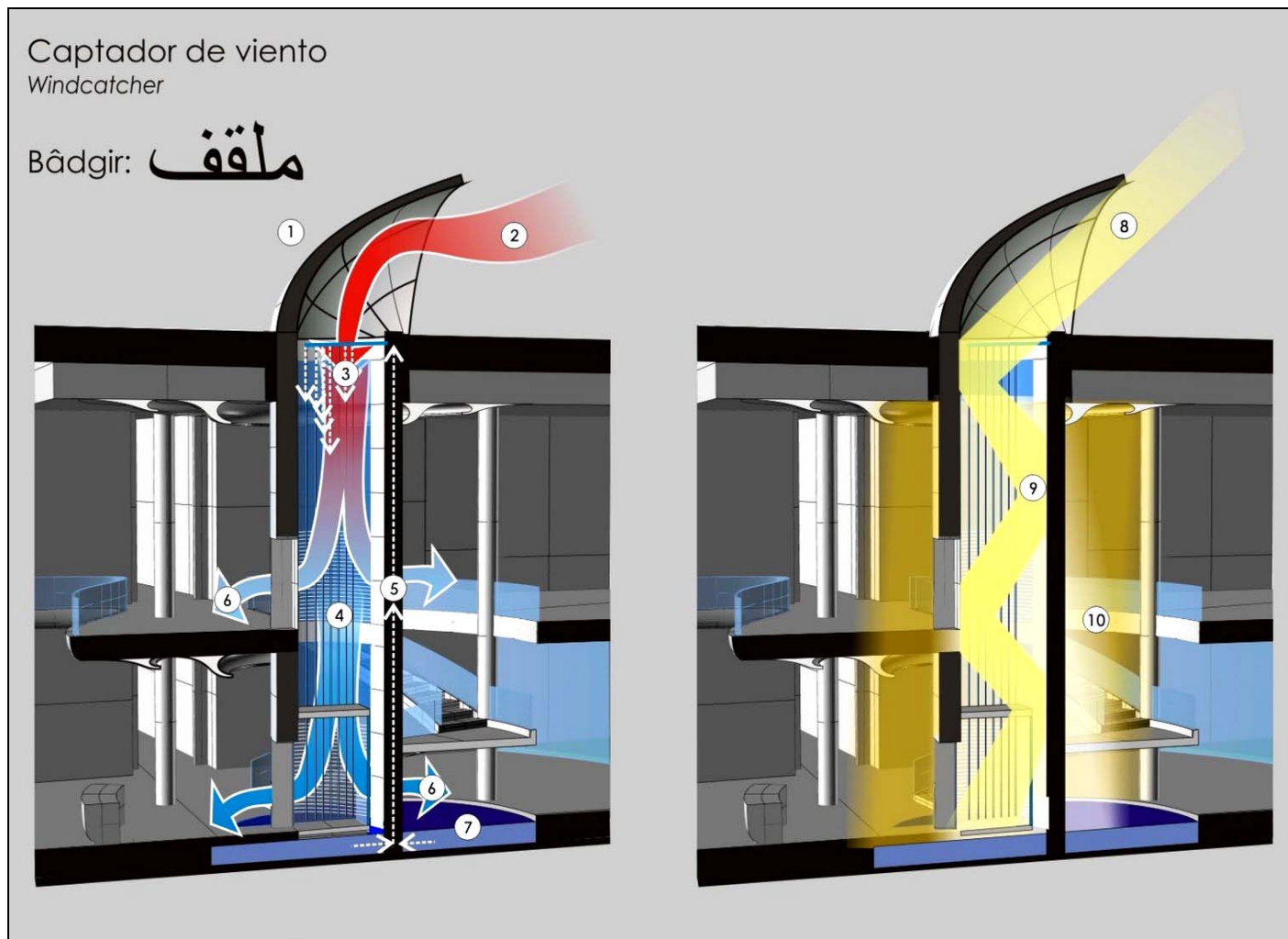


Structural Articulation

Open Space

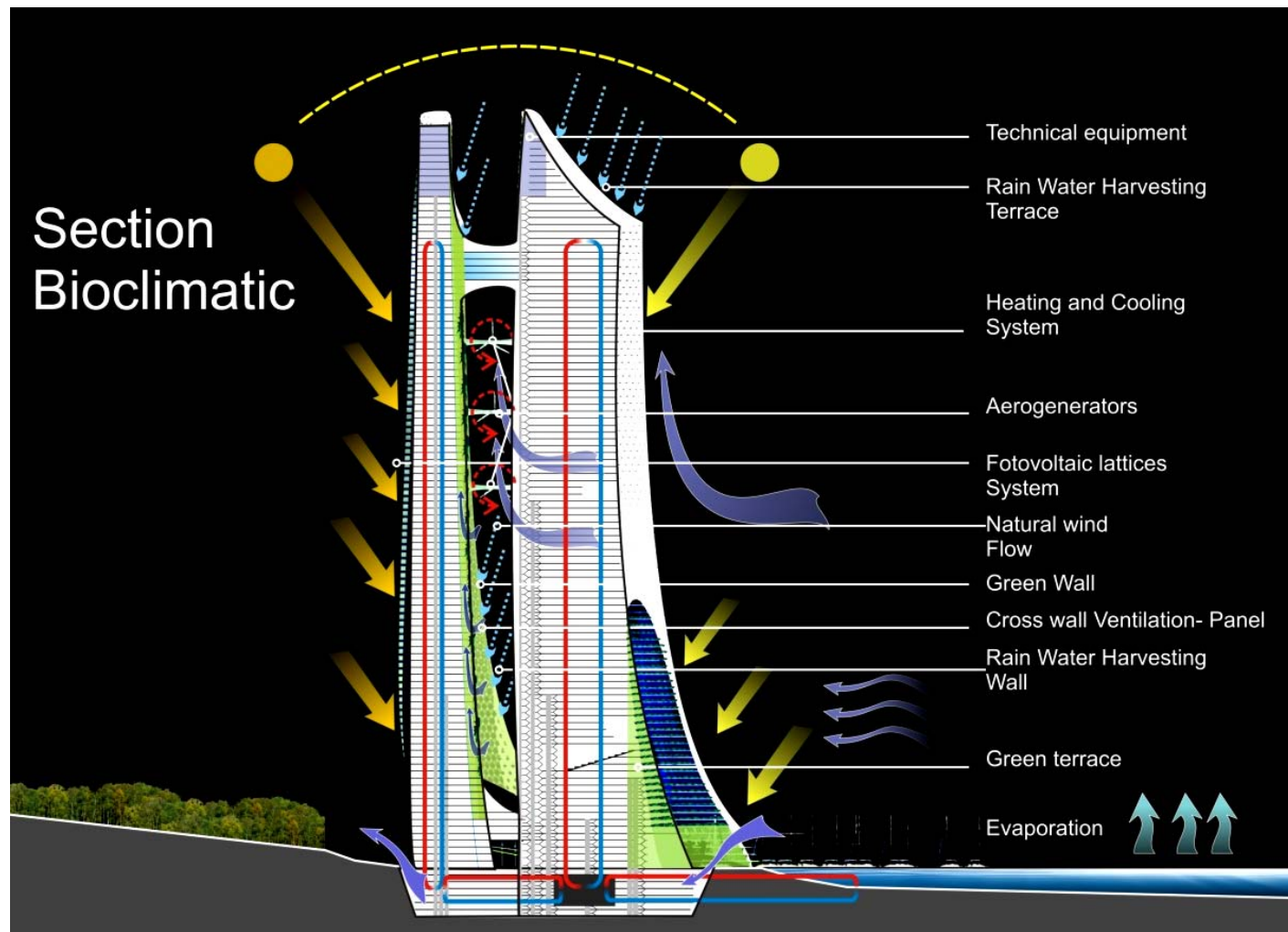
Barcelona Pavilion - Mies van der Rohe (1929)





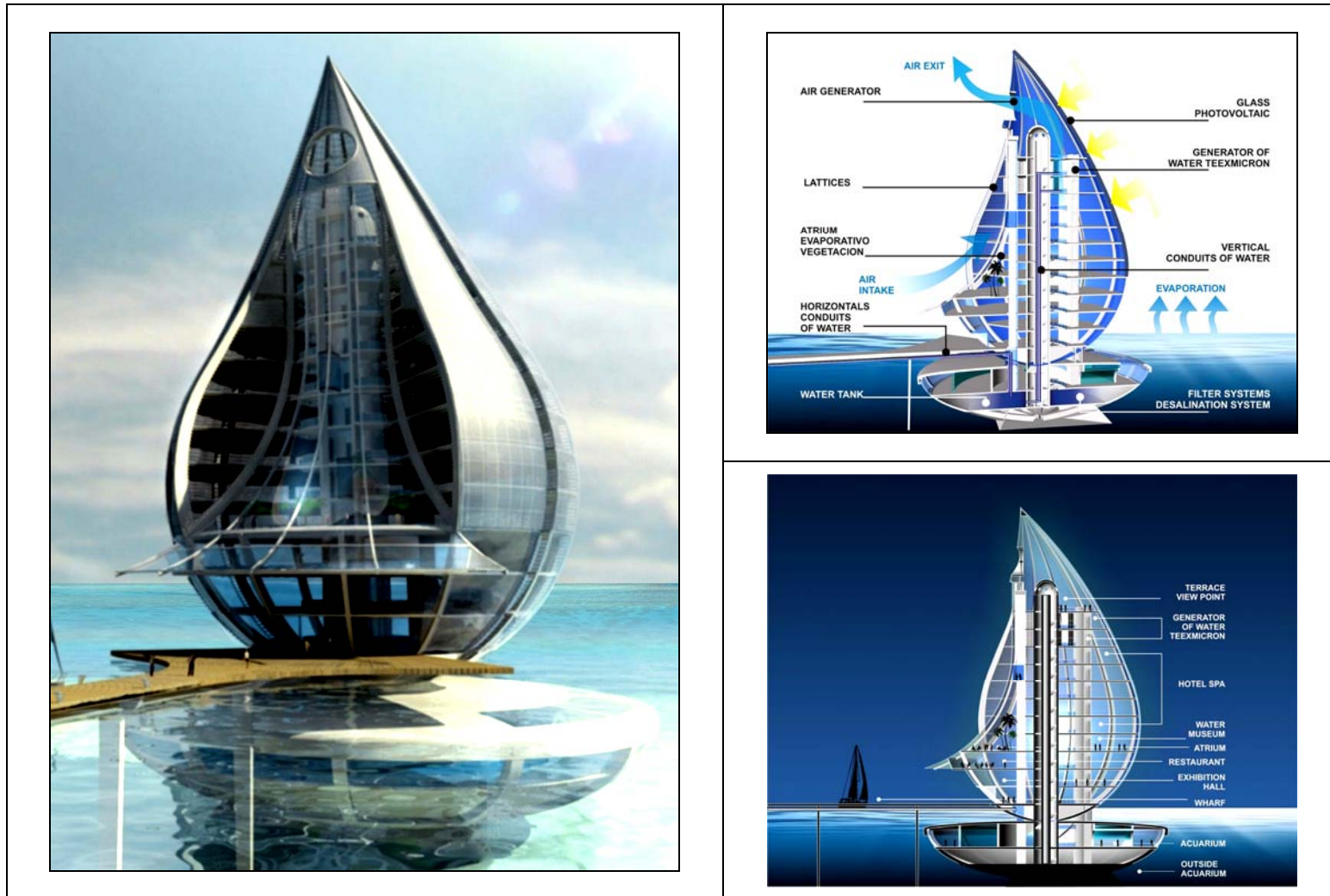
Current Project by Orlando De Urrutia, Architect - Spain





Current Project by Orlando De Urrutia, Architect - Spain





Current Project by Orlando De Urrutia, Architect - Spain



Sustainable Fire Engineering

- ◆ Must be 'Reliability-Based'
- ◆ Must be 'Person-Centred'

That design process which places 'real' people at the centre of creative endeavours and gives due consideration to their responsible needs, and their health, safety, welfare and security in the **Human Environment**.



Sustainable Design Solutions are appropriate to **Local** Geography, Culture, Climate (& Climate Change), Economy, Social Need, Language/Dialect ...

'Sustainability'... fundamentally transforms everyday
Fire Engineering Design & Practice !

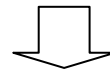


What is Sustainable Development ?

World Commission on Environment & Development
1987 Report: 'Our Common Future' - Chapter 2, Paragraph #1

#1. Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

- the **concept of 'needs'**, in particular the essential needs of the world's poor, to which overriding priority should be given ; and
- the **idea of limitations** imposed by the state of technology and social organization on the environment's ability to meet present and future needs.



1992 UN Rio Declaration on Environment & Development

[1992 United Nations Framework Convention on Climate Change + 1997 Kyoto Protocol]



1972 UN Stockholm Declaration on the Human Environment

[1985 UN Vienna Convention for the Protection of the Ozone Layer + 1987 Montreal Protocol]



What is Sustainable Development ?

World Commission on Environment & Development

1987 Report: 'Our Common Future' - Chapter 2, Paragraphs #2 & #4

#2. Thus, the goals of economic and social development must be defined in terms of sustainability in all countries - developed or developing, market-oriented or centrally planned. Interpretations will vary, but must share certain general features and must flow from a **consensus** on the basic concept of sustainable development and on a **broad strategic framework** for achieving it.

#4. ... The essential needs ... of people in developing countries - for food, clothing, shelter, jobs - are not being met, and beyond ... these people have legitimate aspirations for an improved quality of life. ... Sustainable development requires meeting the **basic needs of all** and **extending to all the opportunity** to satisfy their aspirations for a better life.



Sustainable Human & Social Development

Sustainable Design International

2004 Rio de Janeiro Declaration on Sustainable Social Development, Disability & Ageing

Development which meets the responsible needs, i.e. the Human & Social Rights*, of this generation - without stealing the life and living resources from future generations, especially our children ... and their children ... and the next five generations of children.

***As defined in the 1948 Universal Declaration of Human Rights**

Our **Ultimate Goal** must be to arrive, quickly, at a dynamic and harmonious balance between a Sustainable 'Human' Environment and a flourishing, not just a surviving, 'Natural' Environment ... with the **Overall Aim** of achieving Social Wellbeing for All.

Social Wellbeing

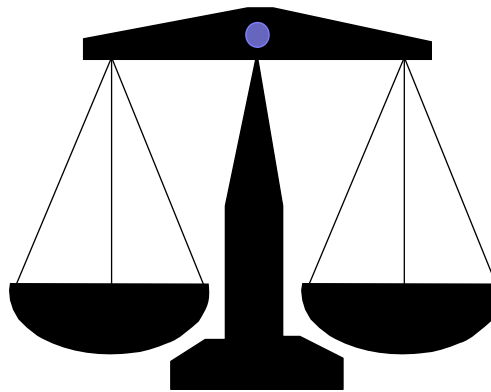
A general condition - in a community, society or culture - of health, happiness, creativity, responsible fulfilment, and sustainable development.



Many Aspects to Sustainable Development

Social + **Economic** + **Environmental** + **Institutional**
[Social Organization]
+ **Political** + **Legal** + **Judicial**

in an agreed context of International Law & Lasting Peace



Balanced & Equitable Implementation across All Aspects
is a Fundamental Value & Principle !

[2007 Leipzig Charter on Sustainable European Cities]



An Ethical Foundation Is Essential

Fire Engineering Design & Practice is concerned with more than the 'cost-effective' compliance with the minimal Fire Safety Objectives mandated in Building Legislation & Codes.

Issues such as ...

- Resistance to **Fire-Induced Progressive Collapse** & Disproportionate Damage ;
- Sufficient care and attention paid to **Vulnerable Building Users** in 'situations of risk' - Article 11 of UN Convention on the Rights of Persons with Disabilities ;
- **Safety of Firefighters & Rescue Teams** - Essential Requirement 2 of EU CPD ;
- Adaptation to **Climate Change** & Severe Weather Events ... in design, not less than a recurrence interval of 100 yrs. (min. building life cycle of 100 yrs.) ; and
- **Sustainable Human & Social Development** ...

Should be referenced in a **Fire Engineering Code of Ethics**, using as template

World Federation of Engineering Organizations (WFEO/FMOI)
2011 Updated Model Code of Ethics



Sustainable Fire Engineering Practice

In designing a building for conditions of fire, and its aftermath, **Project-Specific Fire Engineering Design Objectives** should cover the following spectrum of concerns ... in order to properly protect the interests of society and our clients ...

- ◆ **Protection of the Health & Safety of All Building Users** ... including **People with Activity Limitations (2001 WHO ICF)**, visitors to the building who may be unfamiliar with its layout, and contractors or product/service suppliers temporarily engaged in work or business transactions on the premises ;
- ◆ **Protection of Property** ... including the building, its contents, and adjoining or adjacent properties ... from loss or damage ;
- ◆ **Protection of the Health & Safety of Firefighters, Rescue Teams & Other Emergency First Response Personnel** ;
- ◆ **Facility, Ease & Efficient Cost of Carrying Out Effective Reconstruction, Refurbishment or Repair Works after a Fire** ;
- ◆ **Sustainability of the Human Environment** (social, built, virtual, economic, ...) - including **Fitness for Intended Use** and **Life Cycle Costing** of fire engineering related products, components, systems, etc., fixed, installed or incorporated in the building ;
- ◆ **Protection of the Natural Environment from Harm, i.e. Adverse Impacts.**





WTC Complex, New York

11 September 2001

Catastrophic Failure in Our Practices & Procedures:

- **Architectural Design | Structural Engineering | Fire Engineering** ;
- Building Management Systems ;
- Emergency Responders / Firefighters / Rescue Teams ;
- Control Organizations Having Authority (AHJ's) or Jurisdiction ;
- Fire Safety Objectives in Building Legislation, Codes & Standards.



Fire Engineering **After** 9-11 & Mumbai

- ◆ **2005 NIST(USA) Final Report on 9-11 WTC 1 & 2 Tower Collapses**

Introduced a New Benchmark for International Fire Engineering ...

30 Important Recommendations (1-30) contained in Chapter 9

3R's - 'Reality' - 'Reliability' - 'Redundancy'

Evacuation Way Finding - 'Intuitive & Obvious'

- ◆ **2008 NIST(USA) Final Report on 9-11 WTC 7 Building Collapse**

Confirmed this New Benchmark ...

12 Recommendations (A, C-M) reinforce earlier 2005 Recommendations,
with **1 New Important Recommendation (B)**, contained in Chapter 5

Fire-Induced Progressive Collapse

- ◆ **NYC-ATSDR WTC Health Registry (established 2002)**

Long-Term Monitoring of Health Status ... Survivors directly exposed
to the WTC 9-11 Incident ... Regular Reporting ... 20 Years ...

Outside the Final Exit of a Fire Building ≠ Health or Safety





Building Evacuees Requiring Assistance / All Building Types, excluding Health Facilities

Buildings Must Remain Serviceable =

- ◆ While People with Activity Limitations wait in 'Areas of Rescue Assistance' ;
+
- ◆ Until all of these People can be rescued by Firefighters and every person can reach a 'Place of Safety', via an accessible route ;
- ◆ With an assurance of Individual Health, Safety & Welfare during the course of those tasks.



Building Users / Fire Incident / No Explosion Hazard *



Place of Safety:

Any location beyond a perimeter which is [100] metres from the fire building or a distance of [10] times the height of such building, whichever is the greater
and
where necessary and effective medical care and attention can be provided, or organized, within one hour of injury
and
where people can be identified.

* Where there is a Risk of Explosion ... multiply the numbers in square brackets by **4**



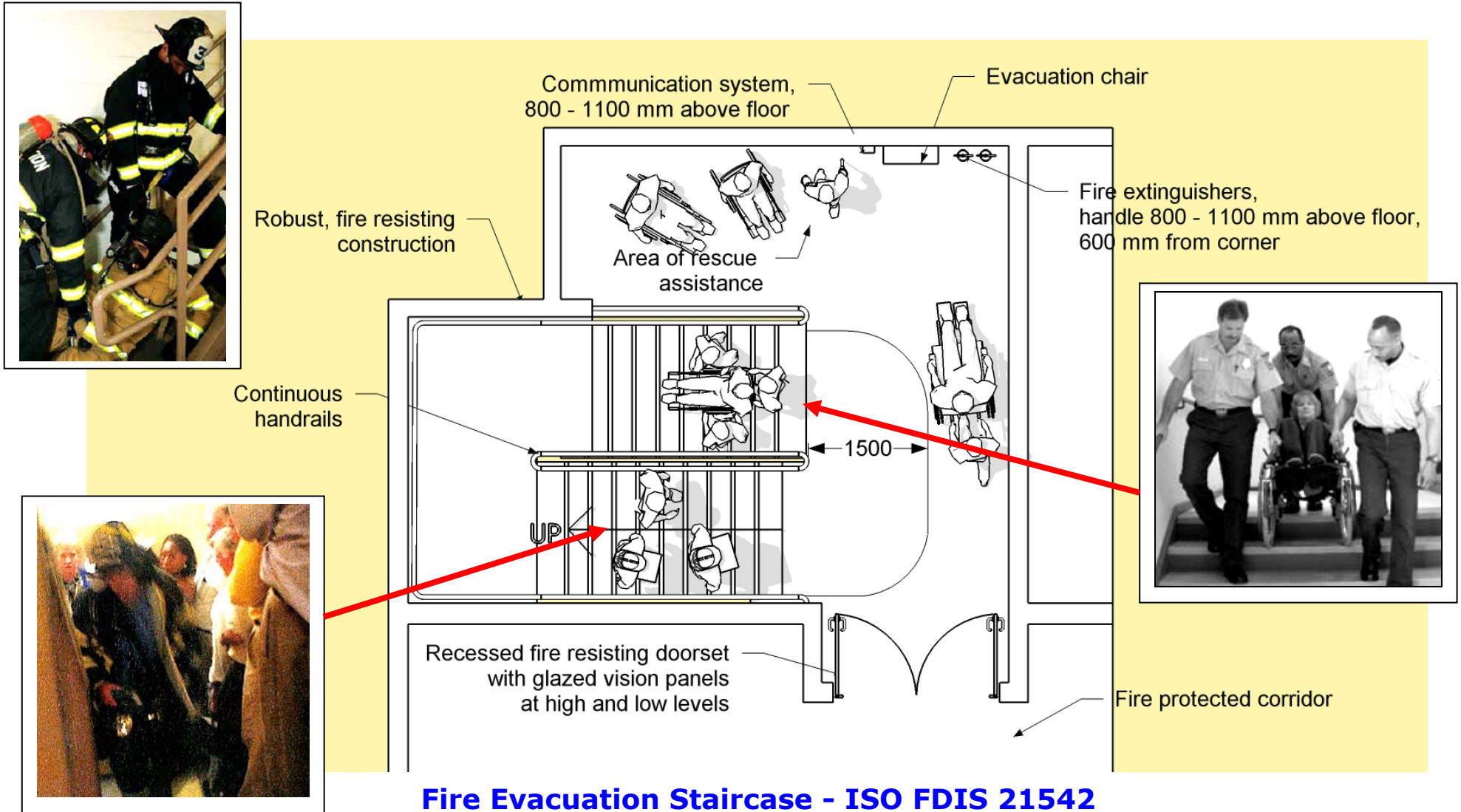


People Are Different & React Differently ...

- They must be '**Skilled**' for evacuation ... to a '**Place of Safety**'
- Warnings must be timely, informative, **and** be understandable
- **Panic Attacks** exist **Standard Movement Times** do not exist

2005 NIST(USA) Final Report on 9-11 WTC 1 & 2 Tower Collapses / Footnote 39: The average surviving occupant in the WTC Towers descended stairwells at about half the slowest speed previously measured for non-emergency evacuations.

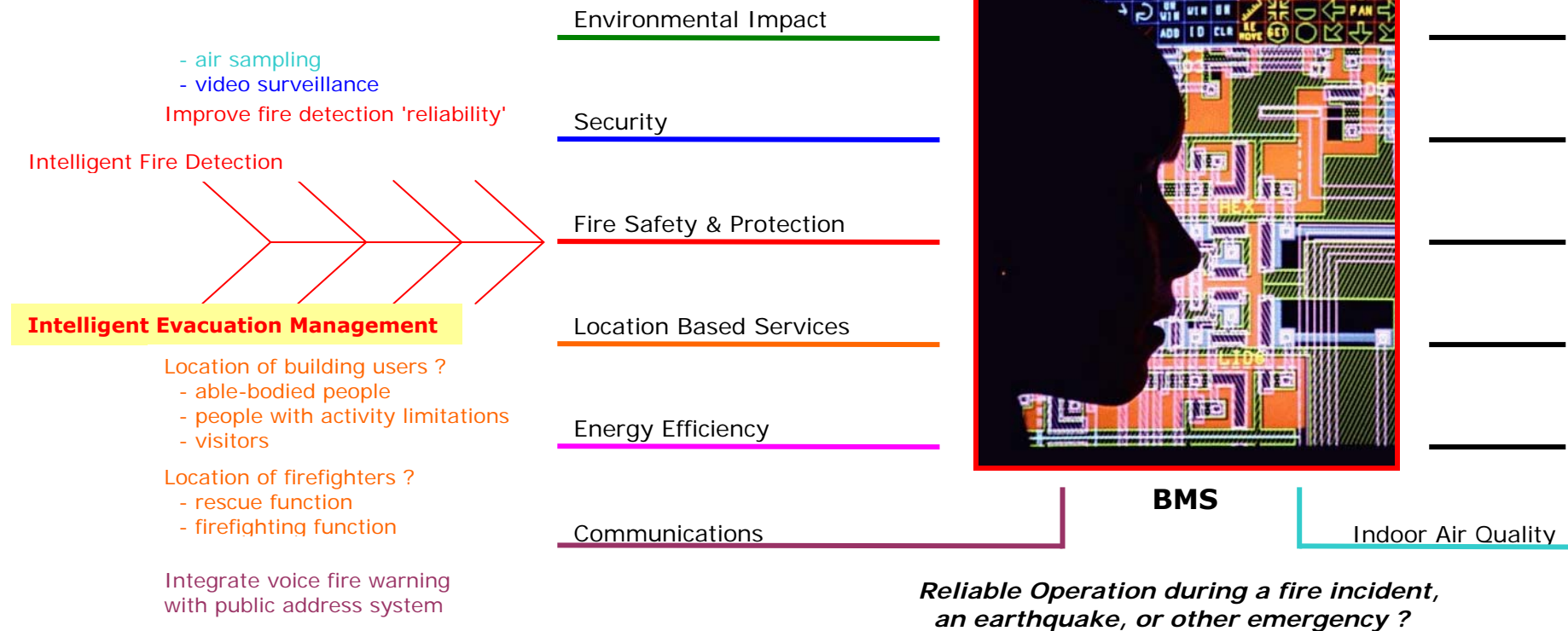




Fire Evacuation Staircase - ISO FDIS 21542
 [All lifts/elevators in a building are used for fire evacuation]



***Large Scale Application of Full BMS Integration:
(‘Building Life Cycle’ Risk Specific)***



Intelligent Evacuation Management



2005 NIST(USA) 9-11 WTC 1 & 2 Final Report - Recommendations 4 & 9

NIST recommends the development of standards and code provisions to enable the design and retrofit of structures to resist 'real' building fire conditions, including their ability to achieve the (fire engineering design) objective of burnout in a **Maximum Credible Fire Scenario**, without structural or local floor collapse ... recognizing that sprinklers could be compromised, not operational, or non-existent.

[**Footnote 26** states that a **Maximum Credible Fire Scenario** includes conditions which are severe, but reasonable to anticipate ... related to building construction, occupancy, fire loads, ignition sources, compartment geometry, fire control methods and adverse, but reasonable to anticipate, operating conditions.]

Maximum Credible User Scenario

Represents user conditions which are also severe but reasonable to anticipate ...

- ◆ **10% of People Using the Building** (occupants, visitors and other users) have an **Impairment** (visual or hearing, physical function, mental or cognitive, psychological, with some impairments not being identifiable) ;
[ISO FDIS 21542: 'Building Construction - Accessibility & Usability of the Built Environment']
- ◆ The Number of People Using a Building increases, on occasions which cannot be specified, to **120% of calculated maximum building capacity** ;



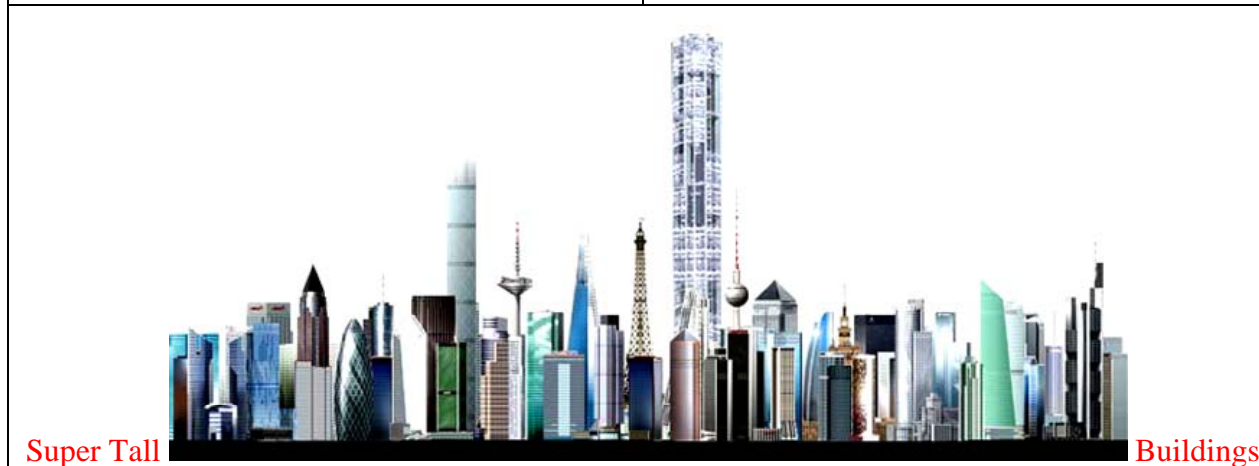
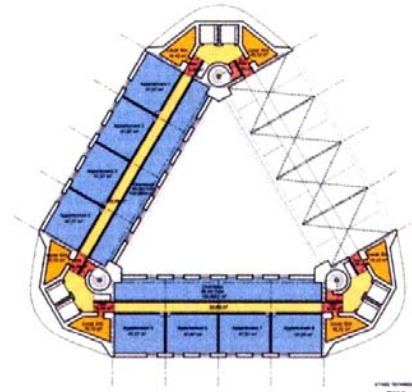
Accessible Routes to 'Places of Safety'



Design for Evacuation = Safer Structural Forms



Multi-Core Design



Super Tall

Buildings



Denis Sloan, architecte; Peter Terrell et Geoff Rooke, ingénieurs structures; et Claude Delalande, ingénieur sécurité (ex-Officier BSPP, Paris-Expo) - France.

Recommendation 18, 2005 NIST(USA) Final Report on 9-11 WTC 1 & 2 Tower Collapses



Structural Reliability

[ISO 2394:1986 + Addendum 1:1988]

The ability of a structural system to fulfil its design purpose, for a specified time, under the actual environmental conditions encountered in a building.

In structural design for fire, the concern must be that the structure will fulfil its purpose, both during the fire - and for a minimum period afterwards, during the 'cooling phase' ...

Structural Fire Engineering

Those aspects of fire engineering concerned with structural design for fire, and the complex architectural interaction between a building's structure and fabric, i.e. non-structure, under conditions of fire and its immediate aftermath.

Limit State Design ... ~~Ultimate Limit State &~~ (Fire) Serviceability Limit States
not acceptable ! with performance monitoring



Disproportionate Damage

The failure of a building's structural system ...

- (i) remote from the scene of an isolated overloading action ; and
- (ii) to an extent which is not in reasonable proportion to that action.

CIB W14 WG IV: Both are fundamental concepts in all Structural Fire Engineering !
[NIST Priority Buildings: High-Rise + Iconic + Critical Function + Innovative Design]

Fire-Induced Progressive Collapse

The sequential growth and intensification of distortion, displacement and failure of elements of construction in a building - during a fire and the 'cooling phase' afterwards - which, if unchecked, will result in disproportionate damage, and may lead to total building collapse.

Fire-Induced Progressive Collapse can commence before any breach occurs even in the improved and increased fire resistance of a Fire Compartment Boundary



Fire Resistance (Building Fabric)

The inherent capability of a building assembly, or an 'element of construction', to resist the passage of heat, smoke and flame for a specified time during a fire.

Fire Compartmentation

The division of a building into fire-tight compartments, by fire resisting elements of construction, in order ...

- to contain an outbreak of fire ;
- to prevent damage, within the building, to other adjoining compartments and/or spaces ;
- to protect a compartment interior from external fire attack, e.g. fire spread across the building's facade or from an adjacent building ;
- to minimize adverse, or harmful, environmental impacts outside the building.



Fire Serviceability Limit States

Fire Serviceability Limit States in Structural Fire Engineering, which are of more immediate and direct relevance to the protection of both human health and property, and necessary re-construction after a fire, would correspond to, for example ...

- deformations which affect the efficient use, i.e. the fire performance, or appearance of structural or non-structural elements ;
- local damage (including spalling and cracking) which reduces the durability of a structure or affects the efficiency or appearance of structural or non-structural elements.

To control 'hot form' serviceability limit states by design, therefore, it is necessary to use one or more constraints which describe acceptable deformations (+/- deflection, expansion, distortion, etc), accelerations, crack widths, spalling, etc.



Early 1990's Dublin Hotel Project

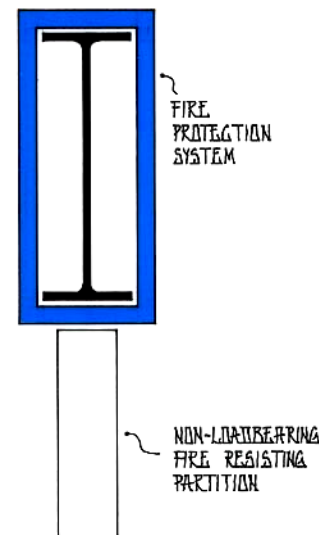
A Typical Architectural Detail:

10m Span Steel Beam ... with non-loadbearing steel stud partitioning beneath, separating corridor from bedrooms ... each with 1hr. fire resistance (??) ...



Situation A

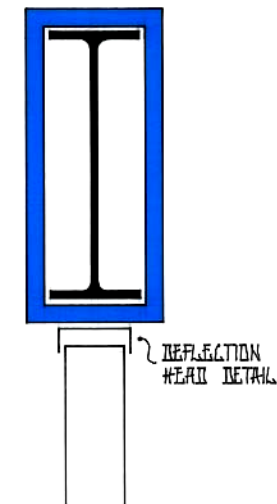
no deflection possible



as built

Situation B

25mm deflection possible



industry option / not tested



??? ... The ability of a component or construction of a building to satisfy, for a stated period of time, some or all of the appropriate criteria specified in the relevant standard test ... ???

10.2.3 Loadbearing horizontal elements. The test specimen shall be deemed to have failed if it is no longer able to support the test load. For the purposes of this standard, this shall be taken as either of the following, whichever is exceeded first:

(a) a deflection of $L/20$; or

(b) where the rate of deflection (in mm/min), calculated over 1 min intervals, starting at 1 min from the commencement of the heating period, exceeds the limit set by the following equation:

$$\text{rate of deflection} = \frac{L^2}{9000d}$$

where

L is the clear span of specimen (in mm);

d is the distance from the top of the structural section to the bottom of the design tension zone (in mm).

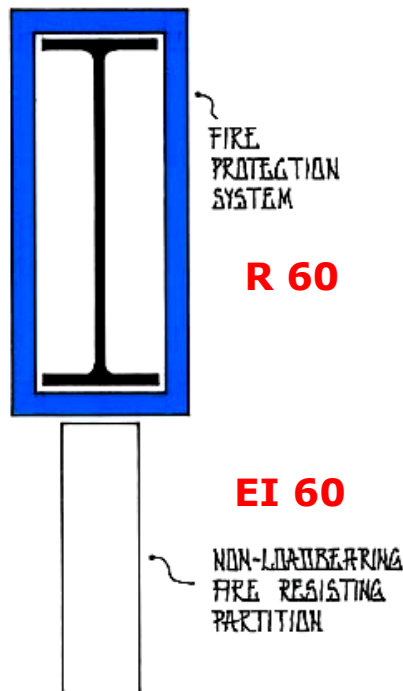
However, this rate of deflection limit shall not apply before a deflection of $L/30$ is exceeded.

Test Failure (60 mins.) Deflection of 10m Steel Beam $L/20 > 500\text{mm}$



A Fundamental Flaw in Fire Engineering

Long before 60 minutes has elapsed, the steel beam will have deflected more than sufficiently ... to seriously impair the fire resistance capability of the partition below.



This is where, and how, 'fire-induced progressive collapse' begins; and that is why, in large fire compartments, it commences before any breach occurs in a compartment boundary with improved and increased fire resistance.

"Possible options ... include:

- Better thermal insulation (i.e. reduced conductivity and/or increased thickness) to limit heating of structural steel and to minimize both thermal expansion and weakening effects. **Currently, insulation is used to protect steel strength, but it could also be used to maintain a lower temperature in the steel framing to limit thermal expansion.**" [Page 59, NIST NCSTAR 1A]

Durability of Thermal Insulation ? Resistance to Mechanical Damage ?



New Recommendation B (2008 NIST NCSTAR 1A)

NIST recommends that buildings be explicitly evaluated to ensure the adequate performance of the structural system under **worst-case design fires** with any active fire protection system rendered ineffective. **Of particular concern are the effects of thermal expansion in buildings with one or more of the following features:** (1) **long-span floor systems** which experience significant thermal expansion and sagging effects; (2) **connection designs** (especially shear connections) that cannot accommodate thermal effects; (3) floor framing that induces asymmetric thermally induced (i.e. net lateral) forces on girders; (4) shear studs that could fail due to differential thermal expansion in composite floor systems; and (5) lack of shear studs on girders. Careful consideration should also be given to the possibility of other design features that may adversely affect the performance of the structural system under fire conditions.

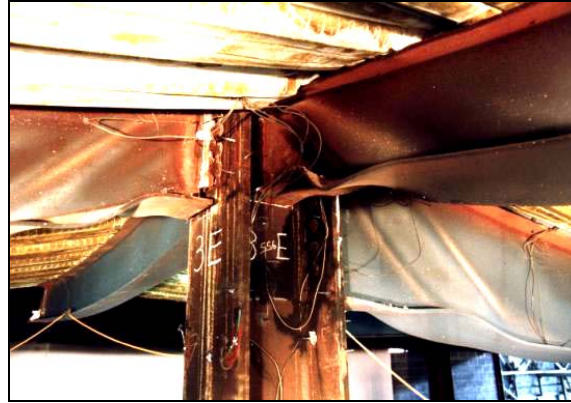
"Possible options ... include:

- **More robust connections and framing systems** to better resist the effects of thermal expansion on the structural system ;
- **Structural systems expressly designed to prevent progressive collapse. The current model building codes do not require that buildings be designed to resist progressive collapse."**

[Page 59, 2008 NIST(USA) Final Report on 9-11 WTC 7 Building Collapse]



Specify Fire Serviceability Limit States



Robust Connections ? Permissible Beam & Column Deformations ?
Whole Frame Structural Reliability ? Adjoining Fire Resisting Fabric ?



Specify Steel Fire Protection System

TABLE 5.4. Thermal Properties of Common Fire Protection Material (ECCS 1995)

Material	unit mass ρ_p [kg / m ³]	moisture content p [%]	thermal conductivity λ_p [W / (m·K)]	specific heat c_p [J/(kg·K)]
Sprays				
- mineral fibre	300	1	0.12	1200
- vermiculite cement	350	15	0.12	1200
- perlite	350	15	0.12	1200
High-density sprays				
- vermiculite (or perlite) and cement	550	15	0.12	1100
- vermiculite (or perlite) and gypsum	650	15	0.12	1100
Boards				
- vermiculite (or perlite) and cement	800	15	0.20	1200
- fibre-silicate or fibre-calcium-silicate	600	3	0.15	1200
- fibre-cement	800	5	0.15	1200
- gypsum board	800	20	0.20	1700
Compressed fibre boards				
- fibre silicate, mineral- wool, stone-wool	150	2	0.20	1200
Concrete	2300	4	1.60	1000
Light weight concrete	1600	5	0.80	840
Concrete bricks	2200	8	1.00	1200
Bricks with holes	1000	-	0.40	1200
Solid bricks	2000	-	1.20	1200

NISTIR 7563 / 2009

Draft for Comment

1. Check that the **Fire Protection System** is **Fit for its Intended Use**
2. Check **Robustness of Connections**, i.e. what is their capacity to withstand the deformation effects of connected steel members in fire ?
3. Check **Whole Frame Reliability** in fire - **Frame Structural Reliability Matrix**
4. Check **Fire Resisting Fabric** adjoining/adjacent to Structural Elements
5. Specify **Thermal Insulation Thicknesses** to ensure that ...
Steel Deformations Remain Within Design Parameters !



Design Professional in Responsible Charge

Following the 9-11 WTC Incident ... Architectural Design, Structural Engineering & Fire Engineering must be Seamlessly Integrated

Recommendation 28 - 2005 NIST(USA) Final Report on 9-11 WTC 1 & 2 Tower Collapses
NIST recommends that the role of **Design Professional in Responsible Charge** be clarified.

Footnote 49 states that the **Design Professional in Responsible Charge** ensures that All Members of the Building Design Team use consistent design data and assumptions, co-ordinates overlapping specifications, and serves as the liaison between all parties involved in the project, including enforcement and review officials, and the client or client organization.

The Fire Engineer(?) must act as an Effective Member of a
Trans-Disciplinary Design Team !

Fire Engineering must have an Ethical Foundation !

Fire Engineers must have Design & Construction Competence !



Conclusions

A Paradigm Shift to Sustainable Fire Engineering ...

- Is Necessary and Inevitable
- It Is The Future !

The International Fire Science & Engineering Community must communicate meaningfully, and integrate fully, with the Mainstream Construction Sector !

CIB W14 - 'Fire Safety':

A CIB Working Commission ... W14 is an **international, multi-stakeholder, trans-disciplinary, pre-normalization forum** for discussion, and action, on research and innovation in Fire Science and Engineering for the **design, construction and operation** of a Safe and Sustainable Built Environment.



Appendix



A Sustainable 'Human' Environment

Social Environment

The complex network of real and virtual human interaction - at a communal or larger group level - which operates for reasons of tradition, culture, business, pleasure, information exchange, institutional organization, legal procedure, governance, human betterment, social progress and spiritual enlightenment, etc.

The **Social Environment** shapes, binds together, and directs the future development of the Built and Virtual Environments.

Built Environment

Anywhere there is, or has been, a man-made or wrought (worked) intervention by humans in the Natural Environment, e.g. cities, towns, villages, rural settlements, service utilities, transport systems, roads, bridges, tunnels, and cultivated lands, lakes, rivers, coasts, seas, etc ... including the Virtual Environment.

Economic Environment

The intricate web of real and virtual human commercial activity – operating at micro and macro-economic levels – which facilitates, supports, but sometimes hampers or disrupts, human interaction in the Social Environment.



Environmental Impact

Any effect caused by a given activity on the environment, including human health, safety and welfare, flora, fauna, soil, air, water, and especially representative samples of natural ecosystems, climate, landscape and historical monuments or other physical structures, or the interactions among these factors; it also includes effects on accessibility, cultural heritage or socio-economic conditions resulting from alterations to those factors.

[1991 European Energy Charter & 1972 UN Stockholm Declaration on the Human Environment](#)

Energy Cycle

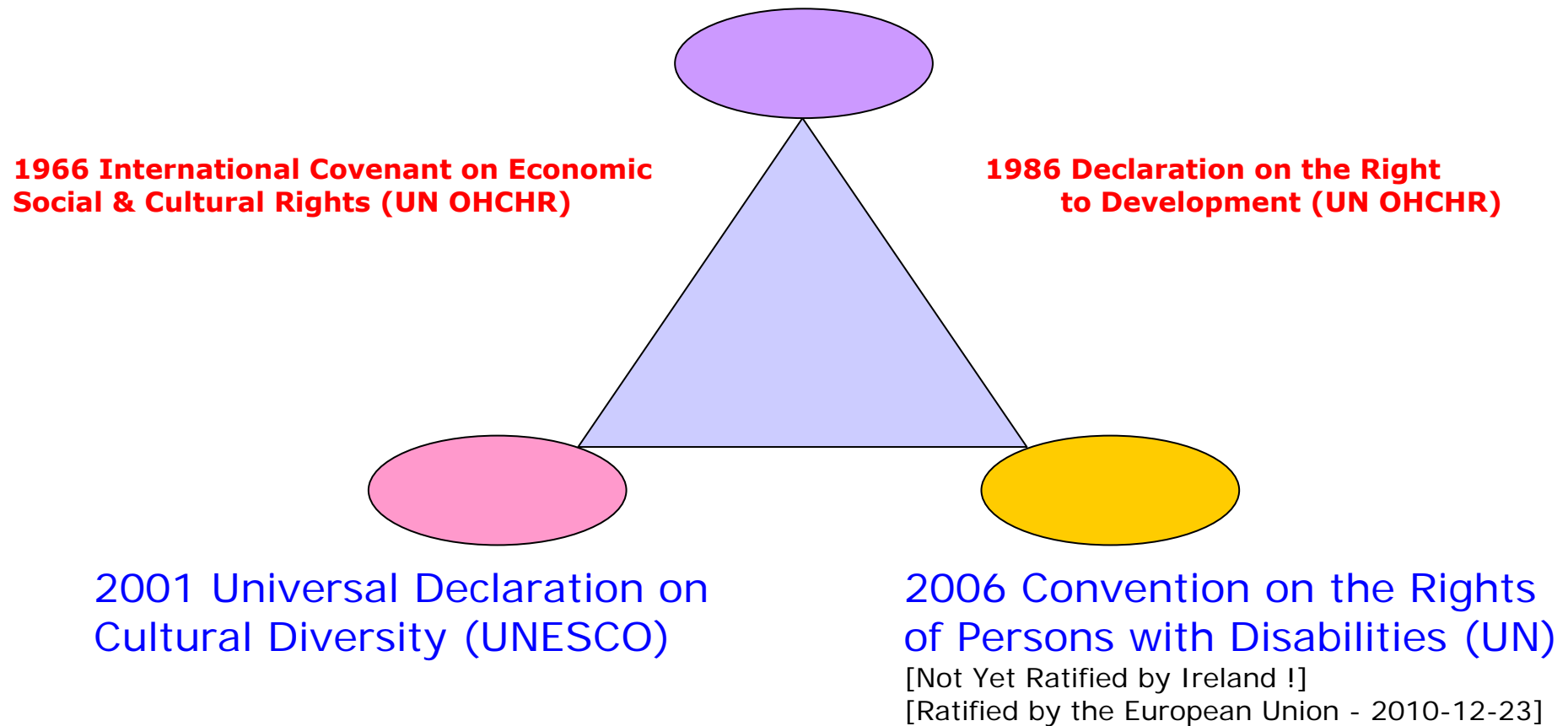
The entire energy chain, including activities related to prospecting for, exploration, production, conversion, storage, transport, distribution and consumption of the various forms of energy, and the treatment and disposal of wastes, as well as the decommissioning, cessation or closure of these activities, minimizing harmful environmental impacts.

[1991 European Energy Charter](#)



Framework of International Rights Instruments

1948 Universal Declaration of Human Rights (UN OHCHR)



2007 Leipzig Charter on Sustainable European Cities

The Ministers Declare:

Paragraph #2 ...

" With the objective of protecting, strengthening and further developing our cities, we strongly support the EU Sustainable Development Strategy, building on the Lille Action Programme, the Rotterdam Urban Acquis and the Bristol Accord. In doing so, **all dimensions of sustainable development should be taken into account at the same time and with the same weight.** These include economic prosperity, social balance and a healthy environment. At the same time, attention should be paid to cultural and health aspects. In this, due attention should be paid to the institutional capacity in the Member States."



Dysfunctional Institutional Implementation

European Union Public Procurement ...

Sustainable Public Procurement (SPP):

Public Authorities seek to achieve the **Appropriate Balance between the Three(?) Pillars of Sustainable Development** - economic, social and environmental - when procuring goods, services or works at all stages of the project.

Green Public Procurement (GPP) :

Public Authorities seek to procure goods, services and works with a **Reduced Environmental Impact throughout their Life Cycle** compared to goods, services and works with the same primary function that would otherwise be procured.

Very Different Implementation & Impacts !

GPP is often more easily accommodated than SPP within the existing legal and practical framework of procurement. Green requirements can be included in technical or performance-based specifications for products, services and works. Provided the conditions set out in the Helsinki Bus and Wienstrom Cases are met, green award criteria can also be applied.

The application of criteria aimed at addressing social or ethical concerns can be more difficult in the context of regulated public procurement procedures. Public Authorities are specifically empowered to include social requirements in their conditions for the performance of contracts or to reserve certain contracts for performance by sheltered workshops or employment programmes (Articles 26 and 19 of Directive 2004/18/EC respectively).

[European Commission (DG ENV) WebSite on 2010-09-12]



European Union

Regulation (EU) No. 305/2011 of the European Parliament and of the Council, of 9 March 2011, laying down Harmonized Conditions for the Marketing of Construction Products and Repealing Council Directive 89/106/EEC

ANNEX I - 'Basic Requirements for Construction Products' 1 & 2 (of 7 !) ...

1. Mechanical Resistance & Stability

The construction works must be designed and built in such a way that the loadings that are liable to act on them during their construction and use will not lead to any of the following:

- (a) collapse of the whole or part of the works ;
- (b) major deformations to an inadmissible degree ;
- (c) damage to other parts of the construction works or to fittings or installed equipment as a result of major deformation of the load-bearing construction ;
- (d) damage by an event to an extent disproportionate to the original cause.

2. Safety in Case of Fire

The construction works must be designed and built in such a way that in the event of an outbreak of fire:

- the load-bearing capacity of the construction can be assumed for a specific period of time ;
- the generation and spread of fire and smoke within the construction works are limited ;
- the spread of fire to neighbouring construction works is limited ;
- occupants can leave the construction works or be rescued by other means ;
- the safety of rescue teams is taken into consideration.



European Union (contd.)

ANNEX I - 'Basic Requirements for Construction Products' 3, 4 & 7 ...

3. Hygiene, Health and the Environment

The construction works must be designed and built in such a way that they will, throughout their life cycle, **not be a threat to the hygiene or health and safety of workers, occupants or neighbours, nor have an exceedingly high impact, over their entire life cycle, on the environmental quality or on the climate during their construction, use and demolition**, in particular as a result of any of the following:

(b) the emissions of dangerous substances, volatile organic compounds (VOC's), greenhouse gases or dangerous particles into indoor or outdoor air ;

4. Safety and Accessibility in Use

The construction works must be designed and built in such a way that they do not present unacceptable risks of accidents or damage in service or in operation such as slipping, falling, collision, burns, electrocution, injury from explosion and burglaries. **In particular, construction works must be designed and built taking into consideration accessibility and use for disabled persons.**

7. Sustainable Use of Natural Resources

The construction works must be designed, built and demolished in such a way that the use of natural resources is sustainable and in particular ensure the following:

(a) re-use or recyclability of the construction works, their materials and parts after demolition ;
(b) durability of the construction works ;



People with Activity Limitations (En) Personnes à Performances Réduites (Fr)

Those people, of all ages, who are unable to perform, independently and without aid, basic human activities or tasks - because of a health condition or physical / mental / cognitive / psychological impairment of a permanent or temporary nature.

This definition is derived from the World Health Organization's International Classification of Functioning, Disability & Health (ICF), which was adopted on 22 May 2001.

The above **Terms** (in English and French) include ...

- a) wheelchair users ;
- b) people who experience difficulty in walking, with or without a facilitation aid, e.g. stick, crutch, calliper or walking frame ;
- c) frail, older people ;
- d) the very young (people under the age of 5 years) ;
- e) people who suffer from arthritis, asthma, or a heart condition ;
- f) the visually and/or hearing impaired ;
- g) people who have a cognitive impairment disorder, including dementia, amnesia, brain injury, or delirium ;
- h) women in the later stages of pregnancy ;
- i) people impaired following the use of alcohol, other 'social' drugs e.g. cocaine and heroin, and some medicines ;
- j) people who suffer any partial or complete loss of language related abilities, i.e. aphasia ;
- k) people impaired following exposure to environmental pollution and/or other irresponsible human activities, e.g. war and terrorism ;

and ...

- l) people who experience a panic attack in a fire situation or other emergency ;
- m) people, including firefighters, who suffer incapacitation as a result of exposure, during a fire, to poisonous or toxic substances, and/or elevated temperatures.



2 Different Concepts - Wide Confusion !

2007 NISTIR 7396: 'Best Practices for Reducing the Potential for Progressive Collapse in Buildings'

Chapter 1 - Introduction / Paragraph #1.1 - Progressive Collapse / Page 1 ...

" Based on the above description, it is proposed that the professional community adopt the following definition, which is based largely on ASCE 7-05:

progressive collapse - *the spread of local damage, from an initiating event, from element to element resulting, eventually, in the collapse of an entire structure or a disproportionately large part of it; also known as disproportionate collapse.*

The concept of progressive collapse can be illustrated by the famous 1968 collapse of the Ronan Point apartment building."



Regulatory Approach in Britain

Building Regulations for England & Wales

[2004 / Part A - Structure:

Requirement A3. Disproportionate Damage ...

The building shall be constructed so that, in the event of an accident, the building will not suffer collapse to an extent disproportionate to the cause.]

◆ 2006 - amended 2007 / Approved Document B - Fire Safety:

Requirement B3.(1) Internal Fire Spread (Structure) ...

The building shall be designed and constructed so that, in the event of a fire, its stability will be maintained for a reasonable period.

British National Standard BS 9999:2008

Code of Practice for Fire Safety in the Design, Management and Use of Buildings

Takes no account of any of the NIST WTC 9-11 Recommendations, Fire-Induced Progressive Collapse, or Disproportionate Damage ... and conflicts with Building Regulations



Notional Hotel Project in Cardiff, Wales

Same Typical Architectural Detail: 10m Span Steel Beam ... with non-loadbearing steel stud partitioning beneath, separating corridor from bedrooms

Approved Document B is 'deemed-to-satisfy' the Part B Requirements

◆ Approved Document B / Appendix E - Definitions ...

Fire-Resisting (Fire Resistance):

The ability of a component or construction of a building to satisfy, for a stated period of time, some or all of the appropriate criteria specified in the relevant standard test.

[This definition does not actually explain the concept of 'fire resistance'.]

◆ Approved Document B / Table D1 - Classification of Purpose Groups ...

Group 2(b)	Residential (Other)	Hotel, Boarding House, etc.
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◆ Approved Document B / Table A1 - Specific Provisions of Test for Fire Resistance of Elements of Structure, etc ...

Structural Frame, Beam or Column

See table A2

Enclosure / Fire Resisting Construction

EI 30 (minutes) EI 60 ✓

(sleeping hazard & part m)



◆ Approved Document B / Table A2 - Minimum Periods of Fire Resistance ...

Purpose Group: Residential - Other Residential

Elements of Structure at
Ground or Upper Storey

Height of top floor above ground is not
more than 18 metres [Diagram C6]

Minimum Period of Fire Resistance

60 minutes ... R 60

[1992 - amended 2000 / Regulation 7 - Materials & Workmanship:

- (1) Building work shall be carried out:
 - (a) with adequate and proper materials which:
 - (i) are appropriate for the circumstances in which they are used;
 - (ii) are adequately mixed and prepared; and
 - (iii) are applied, used or fixed so as adequately to perform the functions for which they are designed;
 - and
 - (b) in a workmanlike manner.]

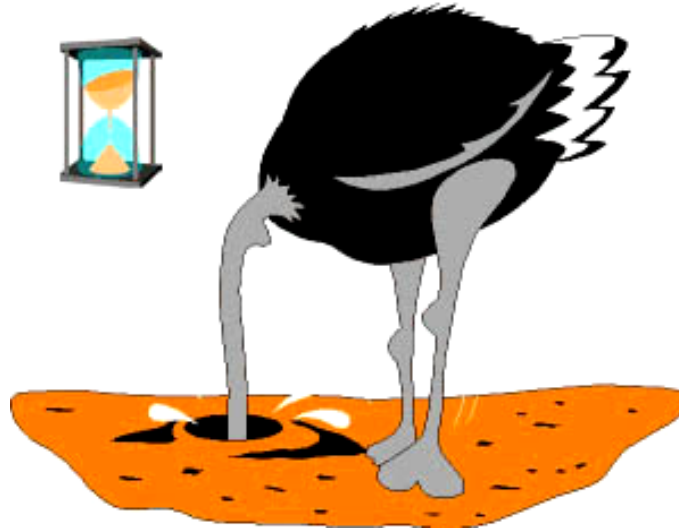
{ In this Part,

Requirement D3 of Irish Building Regulations

'proper materials' means materials which are fit for the use for which they are intended and for the conditions in which they are to be used, and includes materials which:

- (a) bear a CE Marking in accordance with the provisions of the Construction Products Directive; or
- (b) comply with an appropriate harmonized standard, European Technical Approval or national technical specification as defined in article 4(2) of the Construction Products Directive; or
- (c) comply with an appropriate Irish Standard or Irish Agrément Board Certificate or with an alternative national technical specification of any State which is a contracting party to the Agreement on the European Economic Area, which provides in use an equivalent level of safety and suitability. }





2009 International Standard ISO 23932: 'Fire Safety Engineering - General Principles'

An inward-looking document ... difficult to assimilate ... and using confusing and/or inadequate technical terminology ... [evacuation/egress/escape ?](#) ... [fire door ?](#)

The document is concerned with 'process' ... not 'principles'

It takes no account of any of the NIST WTC 9-11 Recommendations,
Fire-Induced Progressive Collapse, or Disproportionate Damage

This Standard is not relevant to Fire Engineering Practice after 9-11 !

