MECH 1905 Buildings for Contemporary Living Introduction

Prof. Yi-Kuen Lee
Department of Mechanical and Aerospace Engineering
Hong Kong University of Science and Technology

Course Instructor

Yi-Kuen Lee Associate Professor
Department of Mechanical and Aerospace Engineering
Dept of Chemical & Biological Engineering
Nanosystem Fabrication Facility
Hong Kong Center for Construction Robotics (led by DJI President)
The Hong Kong University of Science and Technology
Clear Water Bay, Kowloon, Hong Kong

Room 2547
Tel: 2358 8663, Zoom Personal ID: 631-227-6968
Fax: 2358 1543
E-mail: meyklee@ust.hk

Brief Bio: Yi-Kuen Lee

- Associate Professor, Mechanical and Aerospace Engineering
- PhD UCLA in ME, major: MEMS, USA (2001)
- BS and MS National Taiwan University, (1992, 1995)
- Associate Director, Nanosystem Fabrication Facility (NFF)
- International Steering Committee of APCOT (Asia Pacific Conference of Micro/Nanotechnology)
- International Committee of iCAN
- Associate Editor, Microfluidics and Nanofluidics (Springer-Nature), Editorial Board Member of Biodesign and Manufacturing
- Former President , Hong Kong Society of Theoretical and Applied Mechanics
- **Research Areas**: MEMS and Microfluidics, Fluid Mechanics and Heat Transfer, Mechanical Vibration, CMOS MEMS sensors for Internet of Things (IoT) in Smart Buildings and Smart Construction

TA

Simon LI (Teaching Associate)

E-mail: simonli@ust.hk, Tel: 3469-2219, Rm 2567

Wenaho Chen (TA)

E-mail: wenhao.chen@connect.ust.hk, Tel: 2358-7206

Office Hours:

Tue: 2 pm - 3 pm

E-mail me first if you plan to have the online Zoom meeting (Zoom ID: 631-227-6968)

Course Website and Grading Policy

Course Website:

Lecture notes available for download on Canvas

Grading Policy:

Attendance and Quiz (via Canvas)	15 %
Mid-term Examination	35 %
Final Examination	50 %

Tentative Schedule

Venue

Zoom videoconf (till notice from HKUST admin)

Time

Tuesday: 10:30am ~ 11:50am

Thursday: 10:30am ~ 11:50am


PHILIPS
SAMSUNG
OLYMPUS
KAL
HITACHI
SIEMENS
NEC
ONWARD
Canon

Human Habitat

- Human habitat is the environment in which human beings live, work, play and move about. It is not just a dwelling place – a house, but also the sum of all factors that constitute the total environment.
- One of the most basic human requirements for survival beside water, food and clothing is shelter.
- Shelter is required for protection against weather, wild animals and enemy attacks.

Zhoukoudian Cave Site near Beijing

(周口店北京人遗址)

https://goo.gl/maps/eaqNB9AVSm6RaUkL6

https://whc.unesco.org/en/list/449

https://youtu.be/UIYbp8I1Hy8 (Chinese)

https://youtu.be/-5KEsQP5i6M (English)

Modern Shelters (1)

- Human body can be sustained and may effectively function only within a limited range of climatic conditions such as temperature, humidity, moisture, sunlight, and amount of oxygen and pollutants in the air, etc.
- Along with access to food and drinking water, the need to creating places that are protected from the outdoors and where one can comfortably live, work, eat, sleep, procreate or engage in leisurely activities has always been a top priority for humans.
- Modern technologies enable us to build spaces suitable for human habitat with controllable techniques in creating best conditions for living.

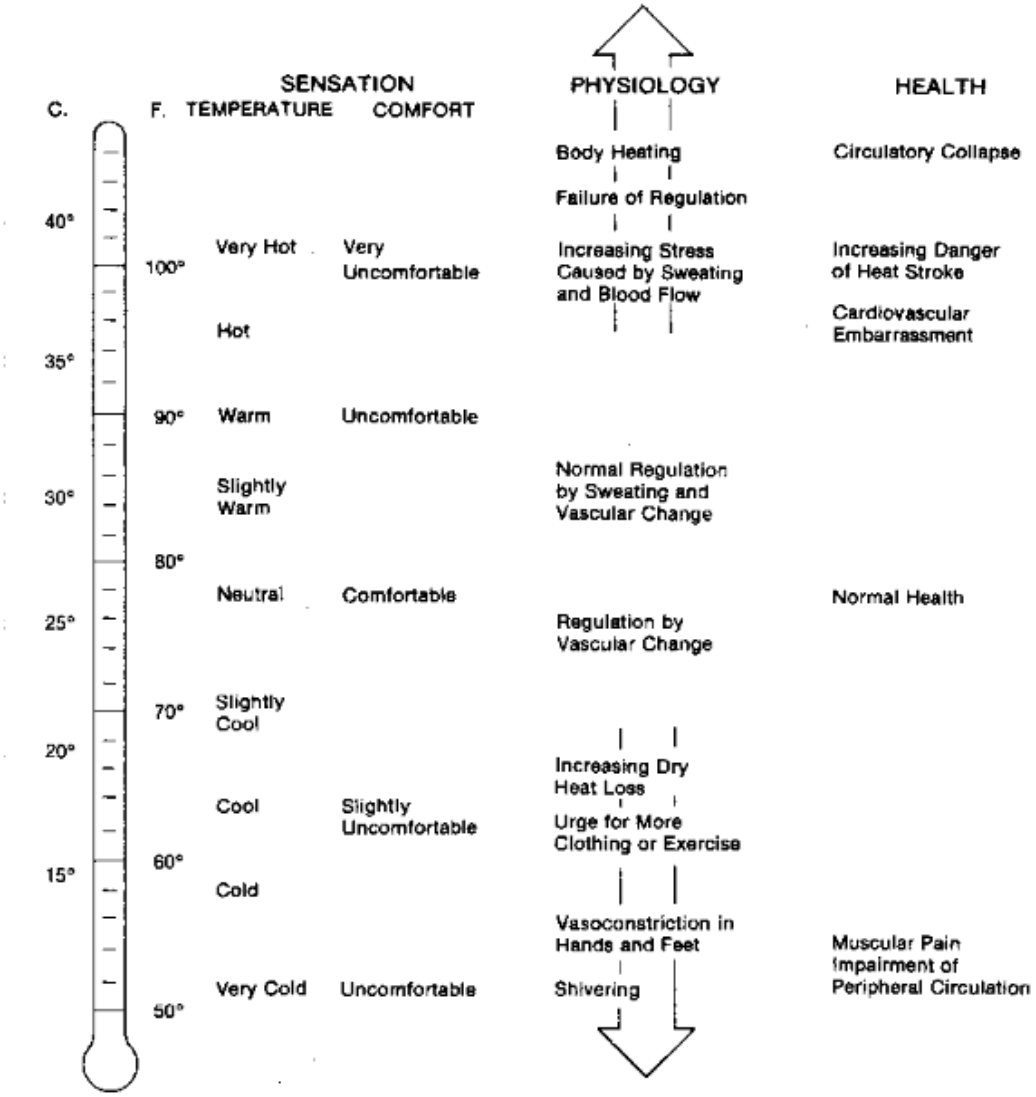
Modern Shelters (2)

- Most technologies require energy to provide the services needed. Understandably, energy is becoming more valuable as the common fossil fuels are resources with limited quantity that care has to be taken in using them more efficiently. In addition, the unwise use of energy makes big contribution to the intrusion to the environments.
- These problems are made even more acute as more than 50% of energy is being consumed in buildings especially in the metropolises which are the core of contemporary living, and agglomerate living in the cities makes the situation worse as the climatic conditions mentioned above would be more inferior as the population density increases.

Living Environments

1. Temperature
2. Humidity
3. Pressure (altitude)
4. Lighting
5. Air Quality
6. Noise
7. Odor

Sensation and Physiological of Human Bodies at Different Temperature



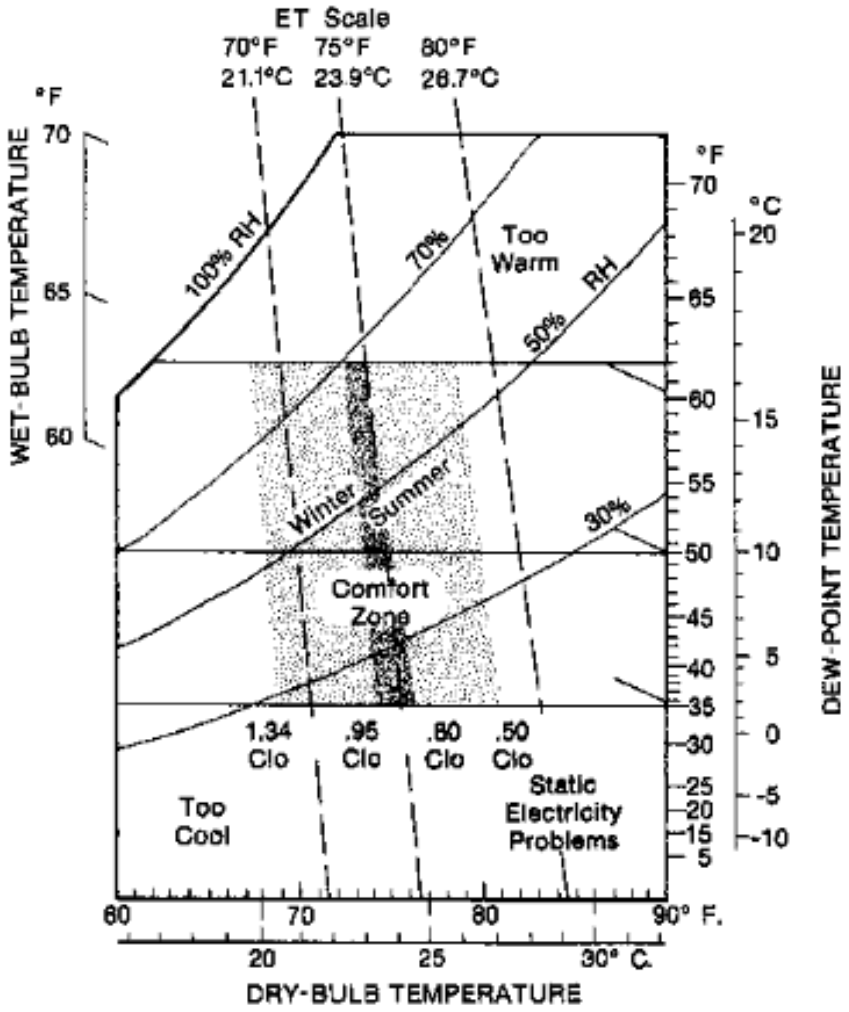
Human Temperature Variation Effects — HOT —

- **37 ˚C** - Normal body temperature (which varies between about 36.12–37.5 ˚C).
- **38 ˚C** - Sweating, feeling very uncomfortable, slightly hungry.
- **39 ˚C** - Severe sweating, flushed and very red. Fast heart rate and breathlessness. There may be exhaustion accompanying this. Children and people with epilepsy may be very likely to get convulsions at this point.
- **40 ˚C** - Fainting, dehydration, weakness, vomiting, headache and dizziness may occur as well as profuse sweating. Starts to be life- threatening.
- **41 ˚C** - (Medical emergency) - Fainting, vomiting, severe headache, dizziness, confusion, hallucinations, delirium and drowsiness can occur. There may also be palpitations and breathlessness.
- **42 ˚C** - Subject may turn pale or remain flushed and red. They may become comatose, be in severe delirium, vomiting, and convulsions can occur. Blood pressure may be high or low and heart rate will be very fast.
- **43 ˚C** - Normally death, or there may be serious brain damage, continuous convulsions and shock. Cardio-respiratory collapse will likely occur.
- **44 ˚C or more** - Almost certainly death will occur; however, patients have been known to survive up to 46.5 ˚C.

Human Temperature Variation Effects — COLD —

- **37 ˚C** - Normal body temperature (which varies between about 36–37.5 ˚C).
- **36 ˚C** - Mild to moderate shivering (body temperature may drop this low during sleep). May be a normal body temperature.
- **35 ˚C** - (Hypothermia) is less than 35 ˚C - Intense shivering, numbness and bluish/grayness of the skin. There is the possibility of heart irritability.
- **34 ˚C** - Severe shivering, loss of movement of fingers, blueness and confusion. Some behavioural changes may take place.
- **33 ˚C** - Moderate to severe confusion, sleepiness, depressed reflexes, progressive loss of shivering, slow heart beat, shallow breathing. Shivering may stop. Subject may be unresponsive to certain stimuli.
- **32 ˚C** - (Medical emergency) Hallucinations, delirium, complete confusion, extreme sleepiness that is progressively becoming comatose. Shivering is absent (subject may even think they are hot). Reflex may be absent or very slight.
- **31 ˚C** - Comatose, very rarely conscious. No or slight reflexes. Very shallow breathing and slow heart rate. Possibility of serious heart rhythm problems.
- **28 ˚C** - Severe heart rhythm disturbances are likely and breathing may stop at any time. Patient may appear to be dead.
- **24–26 ˚C or less** - Death usually occurs due to irregular heart beat or respiratory arrest; however, a woman named Anna Bågenholm was recorded to have survived with body temperatures as low as 13.7 ˚C.

Comfortable Humidity Zone



Living under Reduced Atmospheric Pressure

- Living under reduced atmospheric pressure comes with some conditions, as the thinner air results in fewer molecules of oxygen taken in with each breath.
- Acclimatization is slow, taking place over days to weeks, after which the body can function comfortably at moderately **high altitudes**. **Altitude sickness** occurs when the body fails to acclimatize. **High altitude** is defined as 1,500 to 3,500 meters, while very **high altitude** is 3,500 to 5,500 meters, and extreme **altitude** is anything above 5,500 meters.
- The most common condition is altitude sickness or "acute mountain sickness" (AMS), which affects 40-50% of people who ascend over 4,267.20 meters. Typical symptoms are similar to that of a bad hangover: dizziness, headache, nausea, prolonged shortness of breath, prolonged fatigue, vomiting and exhaustion. In extreme cases, the subject may experience agitation, anxiety or mental confusion, lack of coordination or imbalance.
- A potentially serious health consequence of climbing to a **high altitude** location is a pulmonary or cerebral edema, a condition involving fluid leaking into a vital organ. The symptoms of **altitude sickness** will start within two days of arriving at a **high altitude** location.

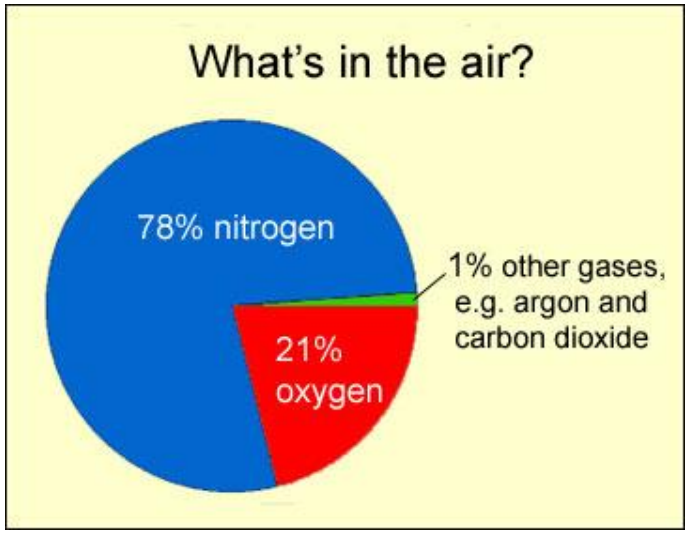
Atmospheric Pressure at Different Altitude

Altitude Above Sea Level		Absolute Barometer		Absolute Atmospheric Pressure		
feet	*meter*	*inches Hg*	*mm Hg*	*psia*	*kg/cm^2*	*kPa*
0	0	29.92	760.0	14.696	1.0333	101.33
500	153	29.38	746.3	14.43	1.015	99.49
1,000	305	28.86	733.0	14.16	0.996	97.63
1,500	458	28.33	719.6	13.91	0.978	95.91
2,000	610	27.82	706.6	13.66	0.960	94.19
2,500	763	27.32	693.9	13.41	0.943	92.46
3,000	915	26.82	681.2	13.17	0.926	90.81
3,500	1,068	26.33	668.8	12.93	0.909	89.15
4,000	1,220	25.84	656.3	12.69	0.892	87.49
4,500	1,373	25.37	644.4	12.46	0.876	85.91
5,000	1,526	24.90	632.5	12.23	0.86	84.33
6,000	1,831	23.99	609.3	11.78	0.828	81.22
7,000	2,136	23.10	586.7	11.34	0.797	78.19
8,000	2,441	22.23	564.6	10.91	0.767	75.22
9,000	2,746	21.39	543.3	10.5	0.738	72.40
10,000	3,050	20.58	522.7	10.1	0.71	69.64
15,000	4,577	16.89	429.0	8.29	0.583	57.16
20,000	6,102	13.76	349.5	6.76	0.475	46.61
25,000	7,628	11.12	282.4	5.46	0.384	37.65
30,000	9,153	8.903	226.1	4.37	0.307	30.13
35,000	10,679	7.06	179.3	3.47	0.244	23.93

Lighting and Living

- Lighting refers to either artificial light sources such as lamps or to natural illumination of interiors from daylight.
- Lighting represents a major component of energy consumption, accounting for a significant part of all energy consumed worldwide.
- In major cities, light pollution is of growing concern.
- Artificial lighting is provided today by electric lights, but previously by gas lighting, candles or oil lamps.
- Proper lighting can enhance task performance or aesthetics, while there can be energy wastage and adverse health effects of lighting.
- Indoor lighting is a form of fixture or furnishing, and a key part of interior design.
- Lighting can also be an intrinsic component of landscaping.

Air Quality



LIVE CAMERA

Image Taken On: 2013-09-13 10:30
Direction: East

EXAMPLES OF GOOD, FAIR AND POOR VISUAL AIR QUALITY

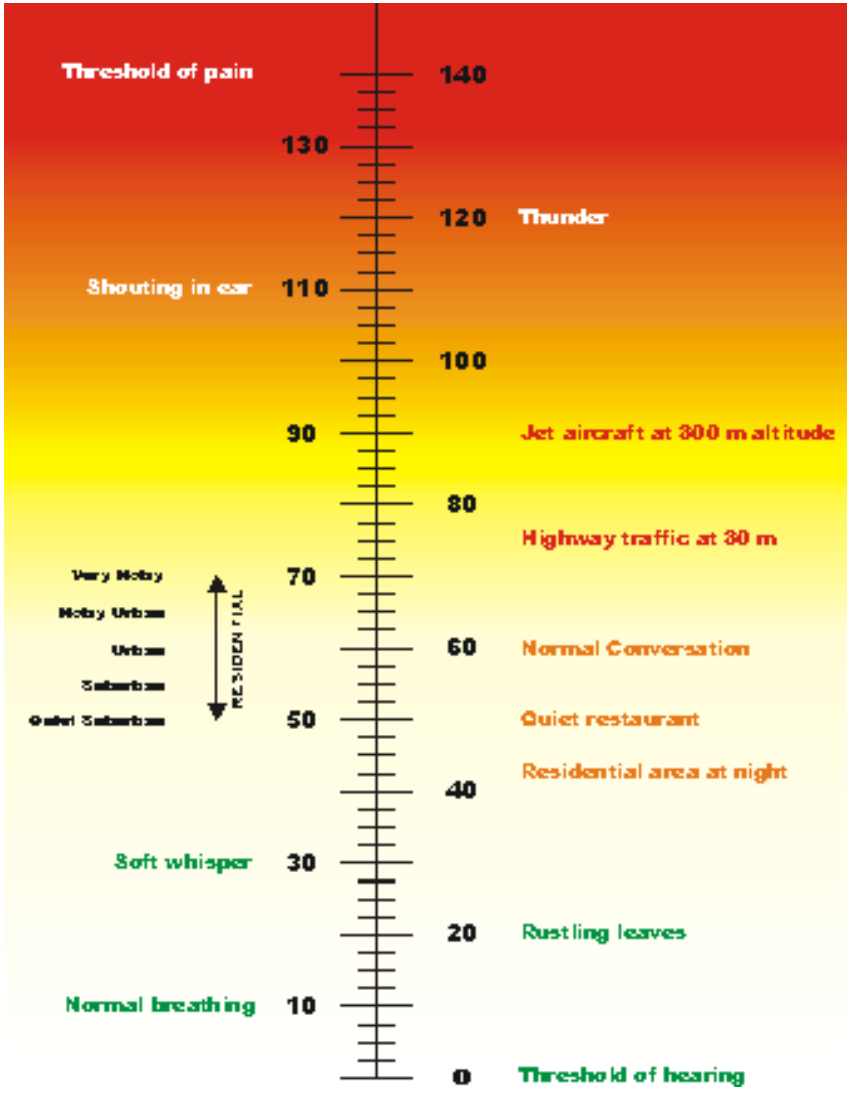
GOOD

FAIR

POOR

Noise

- Near total silence - 0 dB
- A whisper - 15 to 30 dB
- Refrigerator - 40 dB
- Normal conversation - 60 dB
- Dishwasher - 75 dB
- Heavy city traffic or school cafeteria 85 dB
- A lawnmower - 90 dB
- Snowmobile - 100 dB
- Personal stereo (iPod) at maximum level - 105 dB
- A car horn, rock concert, or orchestra - 110 dB
- A rock concert, jet engine or siren - 120 dB
- A gunshot, firecracker or jet taking off - 140 dB
- Firecracker or shot gun firing at close range - 140 to 165 dB



Government research suggests the safe exposure limit is 85 decibels for eight hours a day.

Noise Pollution

- Noise pollution is excessive, displeasing human, animal or machine-created environmental noise that disrupts the activity or balance of human or animal life.
- The source of most outdoor noise worldwide is mainly construction and transportation systems, including motor vehicle noise, aircraft noise and rail noise.
- Poor urban planning may give rise to noise pollution, since side-by-side industrial and residential buildings can result in noise pollution in the residential area.

Odor

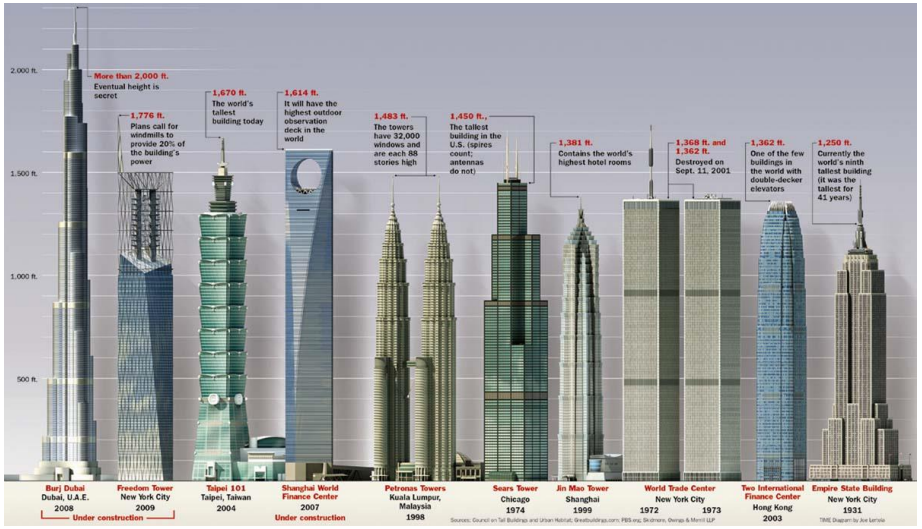
- Has insignificant effects on the global or national environment
- Has major effects on the local environment
  - Nearest dwelling
  - Sources
    - Animal buildings and lots
    - Manure treatment and storage
    - Land application
    - Silage
    - Food processing
    - Dead animal disposal
  - Difficult to define, quantify, and control

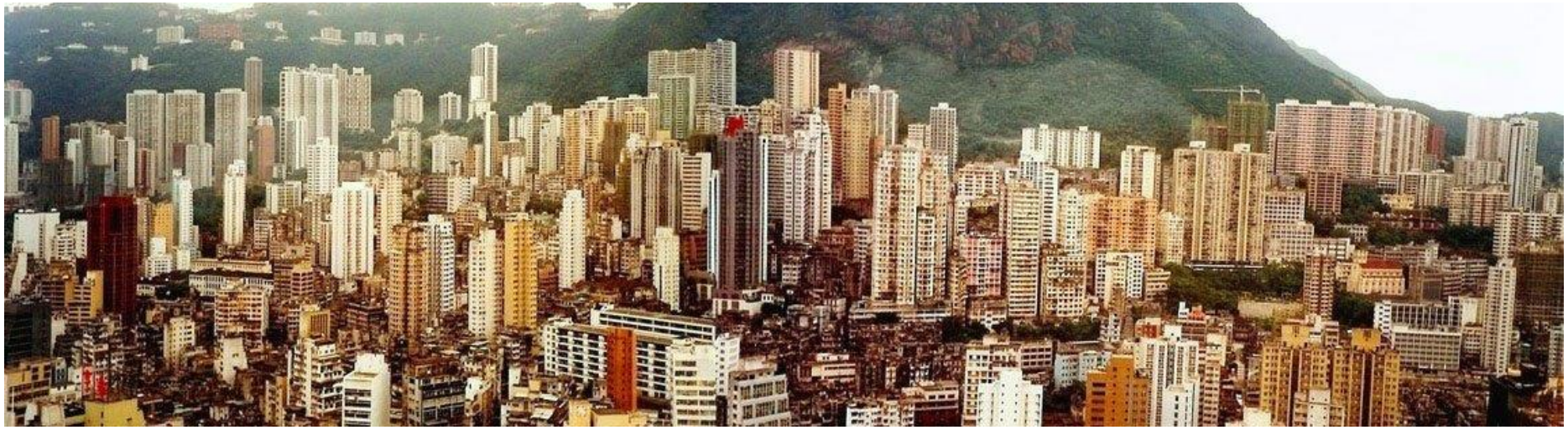
What is a Building?

- A building includes the whole, or any part, of
  - any domestic or public building or
  - building which is constructed or adapted for use for public entertainment, arch, bridge, cavern adapted or
    - constructed to be used for the storage of petroleum products, chimney, cook-house, cowshed, dock, factory, garage, hanger, hoarding, latrine, matshed, office, oil storage installation, out-house, pier, shelter, shop, stable, stairs, wall, warehouse, wharf, workshop or
    - tower, sea-wall, breakwater, jetty, mole, quay, cavern or
  - any underground space adapted or
    - constructed for occupation or
    - Use for any purpose including its associated access tunnels and access shafts, pylon or other similar structure supporting an aerial ropeway and
  - such other structures as the Building Authority may be notice in the Gazette declare to be a building.

Definition of a Building ?

- A ‘building’ is usually understood as a structure of considerable size, and intended to be permanent, or at least to endure for a considerable time.
- What for ?





Requirements of Buildings

- Functional Requirements
- Performance Requirements
- Statutory Requirements (for Public Requirements)
- User (specific) Requirements
- International Benchmarks
- Others
  - Intended design life and durability
  - Environmental impacts
  - Future requirements
  - Costs of alternative solutions
  - Consequences and likelihood of failure

Requirements of Buildings (cont'd)

- User Requirements
  - Functional Requirements
  - Performance Requirements
  - Other User-specific Requirements (aesthetics)
- Public Requirements
  - Health and Safety
  - Environmental Impacts
  - Building Safety during Construction

Buildings Offer Protections

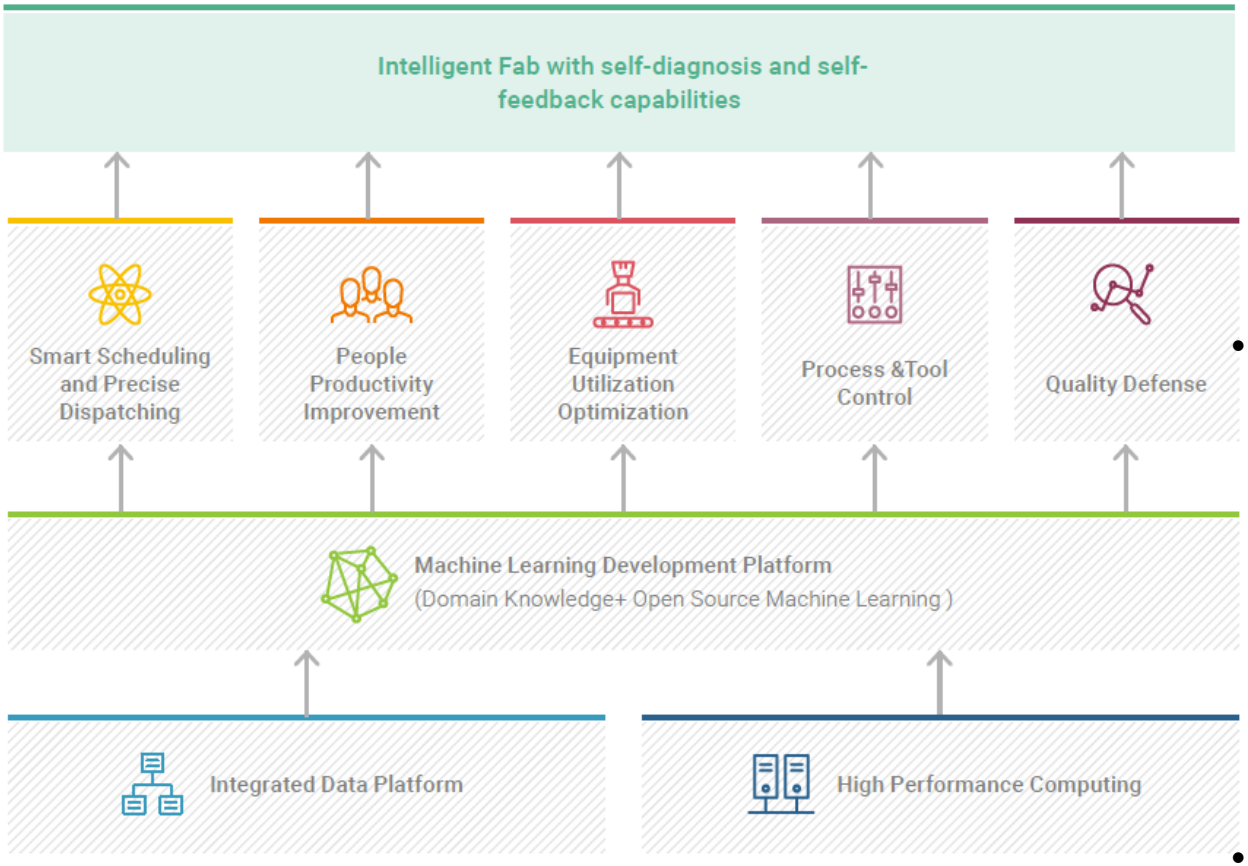
- Sunlight
- Wind
- Rain
- Heat/cold weather
- Noise
- Light/shade
- Air pollution
- Intrusion
- Privacy
- Others

What is This Building?

TSMC Fab 15: 7nm CMOS foundry in Taichung, Taiwan

This fab cost US$18billion: is making the IC chips (140k wafers/mon): processors for Apple iPhone 10/11, AMD Ryzen CPU and Huawei's Kirin processor and Nvidia GPU

TSMC Smart Autonomous Semiconductor Factory: World's Most Advanced AI-Powered Fab, Industry 4.0



- Fab equipment automation
  Transportation automation
  Dispatch automation
  Machine learning and deep learning are applied to achieve manufacturing with self-diagnosis and self-feedback
- Each equipment (per 12-inch fab chief tech director, Dr Yu-Fong Huang)
  before '14: 200~500 sensors
  2014: 500~1,000 sensors

  The most advanced lithography system: 7,000 sensors

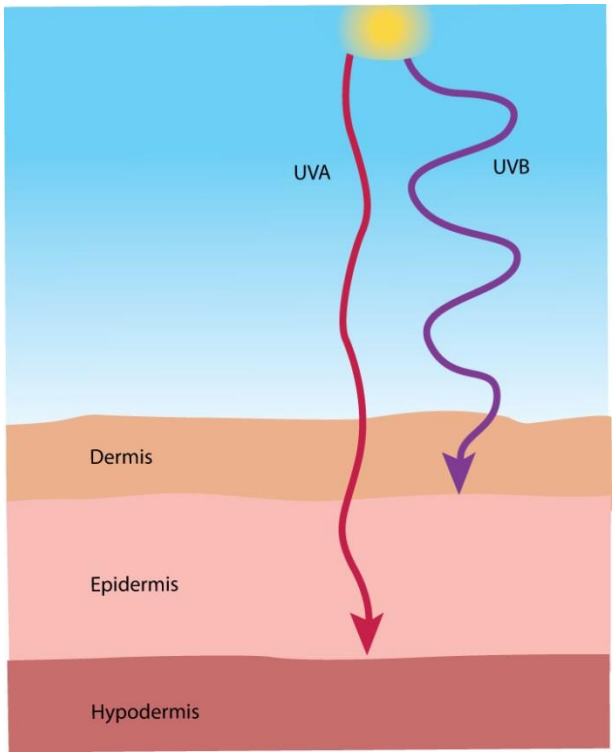
- 12-inch fab: generate 1 million data per second

Sun Damage (1)

- Repeated sunburns are now recognized as a major risk factor for melanoma, the most deadly form of skin cancer.
- The sun reaching the earth's surface can be divided into four wavelength regions,
  - ultraviolet B (UVB, 280-315 nm)
  - ultraviolet A (UVA, 315-400 nm)
  - visible light (400-760 nm)
  - infrared (760-106 nm)
- the major source of the damaging effects of sunlight stem primarily from the ultraviolet portion of the spectrum between 290 and 400 nm (UVB and UVA)

Smartphone App: Smart UV Checker:
https://tinyurl.com/uya6ca9

- The damaging effects of ultraviolet on skin consist principally of direct cellular damage and alterations in immunologic function.
- Direct effects include photoaging, DNA damage and carcinogenesis.



Sun Damage (2)

- Sunburn is the marked erythema and pain that commonly follows injudicious sun exposure.
- The underlying cause of this vascular reaction is direct and indirect damage to specific cellular targets from photochemical reactions and the generation of reactive oxygen species.
- Chronic exposure to sunlight accentuates and accelerates many of the changes of intrinsic aging, including telangietasia, blotchy pigmentation, loss of elasticity, and thinning. While thickening of the epidermis may be a short-term effect of sun exposure, the eventual result will be exacerbation of the age-associated thinning.
- Ultraviolet exposure causes a number of adverse consequences for the immune system including suppression of cutaneous immune responsiveness and immunologic unresponsiveness to cutaneous tumors.
- Sunlight is a major etiologic factor in melanoma.

Beaufort scale	Descriptive term	Units in m/s	Units in km/h	Description on Land	Description at Sea
0	Calm	0	0	Smoke rises vertically	Sea like a mirror.
1-3	Light winds	5 m/s or less	19 km/h or less	Wind felt on face; leaves rustle; ordinary vanes moved by wind.	Small wavelets, ripples formed but do not break: A glassy appearance maintained.
4	Moderate winds	5-8 m/s	20 - 29 km/h	Raises dust and loose paper; small branches are moved.	Small waves - becoming longer; fairly frequent white horses.
5	Fresh winds	8-11 m/s	30 - 39 km/h	Small trees in leaf begin to sway; crested wavelets form on inland waters	Moderate waves, taking a more pronounced long form; many white horses are formed - a chance of some spray
6	Strong winds	11-14 m/s	40 - 50 km/h	Large branches in motion; whistling heard in telephone wires; umbrellas used with difficulty.	Large waves begin to form; the white foam crests are more extensive with probably some spray
7	Near gale	14-17 m/s	51 - 62 km/h	Whole trees in motion; inconvenience felt when walking against wind.	Sea heaps up and white foam from breaking waves begins to be blown in streaks along direction of wind.
8	Gale	17-21 m/s	63 - 75 km/h	Twigs break off trees; progress generally impeded.	Moderately high waves of greater length; edges of crests begin to break into spindrift; foam is blown in well-marked streaks along the direction of the wind.
9	Strong gale	21-24 m/s	76 - 87 km/h	Slight structural damage occurs - roofing dislodged; larger branches break off.	High waves; dense streaks of foam; crests of waves begin to topple, tumble and roll over; spray may affect visibility.
10	Storm	24-28 m/s	88 - 102 km/h	Seldom experienced inland; trees uprooted; considerable structural damage.	Very high waves with long overhanging crests; the resulting foam in great patches is blown in dense white streaks; the surface of the sea takes on a white appearance; the tumbling of the sea becomes heavy with visibility affected.
11	Violent storm	28-33 m/s	103 -117 km/h	Very rarely experienced - widespread damage	Exceptionally high waves; small and medium sized ships occasionally lost from view behind waves; the sea is completely covered with long white patches of foam; the edges of wave crests are blown into froth.
12+	Hurricane	33 m/s or more	118 km/h or more		The air is filled with foam and spray. Sea completely white with driving spray; visibility very seriously affected

Classification of Tropical Cyclones

Tropical cyclones are classified in accordance with the World Meteorological Organization's recommendation by their maximum sustained wind speeds near the center. In Hong Kong, the classification is defined in terms of wind speeds averaged over a period of 10 minutes as follows :

Tropical Cyclone Classification	**Maximum 10-minute mean wind near the center**
Tropical Depression	up to 62 km/h (< 17 m/s)
Tropical Storm	63 to 87 km/h (17.5 to 24 m/s)
Severe Tropical Storm	88 to 117 km/h (24.4 to 32.5 m/s)
Typhoon	118 km/h or more (> 32.8 m/s)

Storm Warning System (1)

AMBER RAINSTORM SIGNAL

Heavy rain has fallen or is expected to fall generally over Hong Kong, exceeding **30** millimeters in an hour, and is likely to continue.

ACTION

- Members of the public should take necessary precautions to reduce their exposure to risk posed by heavy rain, such as flooding.
- Parents, students, school authorities and school-bus drivers should listen to radio or television announcements on the weather, road and traffic conditions.
- Candidates for public examinations should attend the examination as normal, but should listen to radio or watch television in case the weather deteriorates suddenly.
- Farmers and fish pond owners, particularly those in low lying or flood frequented areas, should take the necessary precautions to minimize losses, which include checking and clearing the drainage system within and around the farm/fish ponds to ensure that all the drains are not blocked. Where possible, fish pond operators should reduce the water level of ponds which are likely to be flooded.

Storm Warning System (2)

RED RAINSTORM SIGNAL

Heavy rain has fallen or is expected to fall generally over Hong Kong, exceeding **50** millimeters in an hour, and is likely to continue.

ACTION

- Employees working outdoors in areas exposed to rain should suspend outdoor duties if weather conditions in those areas so warrant.
- People who have to travel should carefully consider weather and road conditions.
- If the RED signal is issued before working hours, employees should report for duty as usual, provided that transport services are available. Supervisors are encouraged to adopt a flexible attitude in case their staff have genuine difficulties in arriving at work on time.
- If the RED signal is issued during office hours, employees working indoors should remain on duty as usual unless it is dangerous to do so. Employees in areas where transport services are about to be suspended can be exceptionally released at the discretion of the supervisor. In exercising their discretion, supervisors should take into account the weather and road conditions.

Storm Warning System (3)

BLACK RAINSTORM SIGNAL

Very heavy rain has fallen or is expected to fall generally over Hong Kong, exceeding **70** millimeters in an hour, and is likely to continue.

ACTION

- Stay indoors or take shelter in a safe place until the heavy rain has passed.
- Employees working outdoors in exposed areas should stop work and take shelter.
- People having no safe place to go may take temporary refuge in any of the special temporary shelters opened by the Home Affairs Department.
- Employers are advised not to require their employees to go to work unless prior agreement on work arrangements during rainstorms has been made.
- People who are already at work should stay where they are unless it is dangerous to do so.

Special Actions to be Taken for RED/BLACK SIGNAL

- Students should stay home or, if already at school, should remain there until the end of school hours and conditions are safe for them to return home.
- If the **RED/BLACK** signal is issued when some students have set out for school -
- School-bound students should normally proceed to school unless the road or traffic conditions ahead are not safe.
- School-bus drivers should listen to radio broadcasts on the latest development of the rainstorm and ensure that students are taken to a safe place, normally the school, unless road or traffic conditions ahead warrant otherwise.
- Schools should arrange to be open and appropriately staffed to look after any students arriving until it is safe for them to return home.
- Candidates for public examinations should listen to radio or watch television for an announcement to be made by the Hong Kong Examinations Authority.
- Drivers should beware that there are likely to be serious road flooding and traffic congestion.
- People should avoid going near easily flooded watercourses or passing through flooded areas. People whose home may be seriously flooded should consider evacuating their home until the rain has eased and flood water subsided.

Heat

- In recent years, excessive heat has caused more deaths than all other weather events, including floods.
- A heat wave is a prolonged period of excessive heat, often combined with excessive humidity.
- Generally temperatures are 5 degrees or more above the average high temperature for the region during summer months, last for a long period of time and occur with high humidity as well.
- 465 (or 739) died in 1 week during heat wave in Chicago in July 1995

- **Excessive Heat Watch**—Conditions are favorable for an excessive heat event to meet or exceed local Excessive Heat Warning criteria in the next 24 to 72 hours.
- **Heat Advisory**—Heat Index values are forecast to meet locally defined advisory criteria for 1 to 2 days (daytime highs = 38 - 41° C).
- **Excessive Heat Warning**—Heat Index values are forecast to meet or exceed locally defined warning criteria for at least 2 days (daytime highs = 41- 44° C).

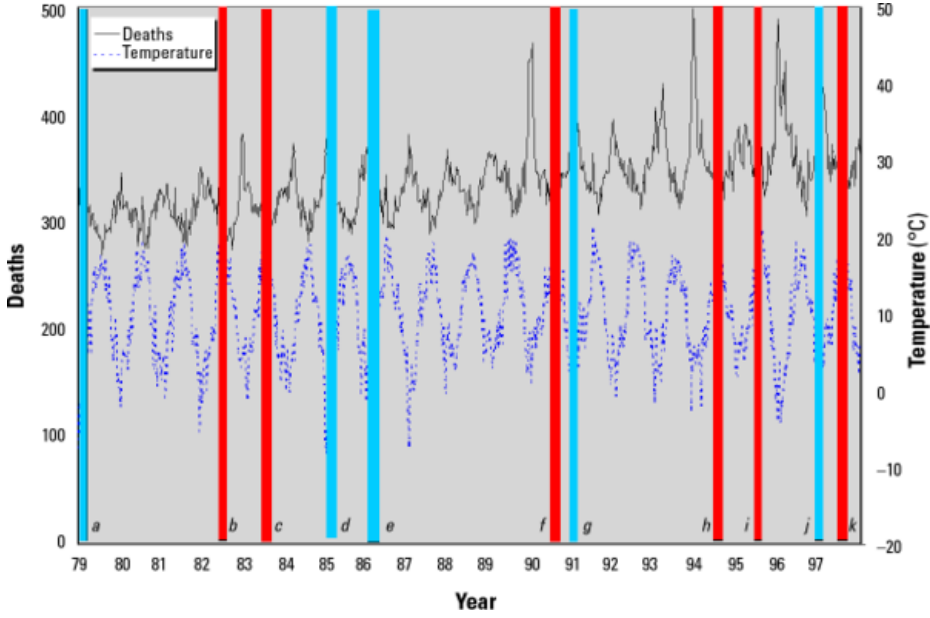
https://www.who.int/globalchange/publications/heat-and-health/en/

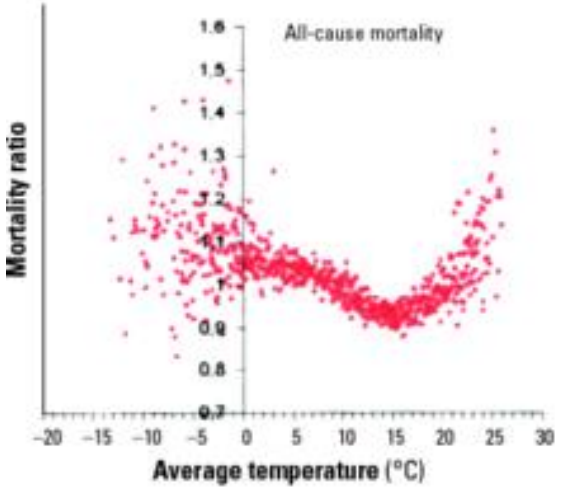
Actions to be taken for Very Hot Weather Warning

1. When engaged in outdoor work or activities, drink plenty of water and avoid over exertion. If not feeling well, take a rest in the shade or cooler place as soon as possible.
2. People staying indoors without air-conditioning should keep windows open as far as possible to ensure that there is adequate ventilation.
3. Avoid prolonged exposure under sunlight. Loose clothing, suitable hats and UV-absorbing sunglasses can reduce the chance of sunburn by solar ultraviolet radiation.
4. Swimmers and those taking part in outdoor activities should use a sunscreen lotion of SPF 15 or above, and should re-apply it frequently.

What Are Dangerously Low Temperatures?

- A cold spell as a period of at least 9 consecutive days in which the lowest temperature reaches –5°C or lower, including at least 6 days in which the lowest temperature touches –10°C or lower. (Dutch)
- High-risk groups needing special attention are:
  - the elderly,
  - children (who lose heat faster due to their higher body surface/weight ratio),
  - people with ischemic diseases (mainly heart disease and stroke),
  - people with chronic respiratory diseases or asthma
- Coronary heart disease, strokes and respiratory diseases are responsible for most part of excess winter deaths. Other contributing factors are influenza and COVID-19, social class and per capita gross national product.



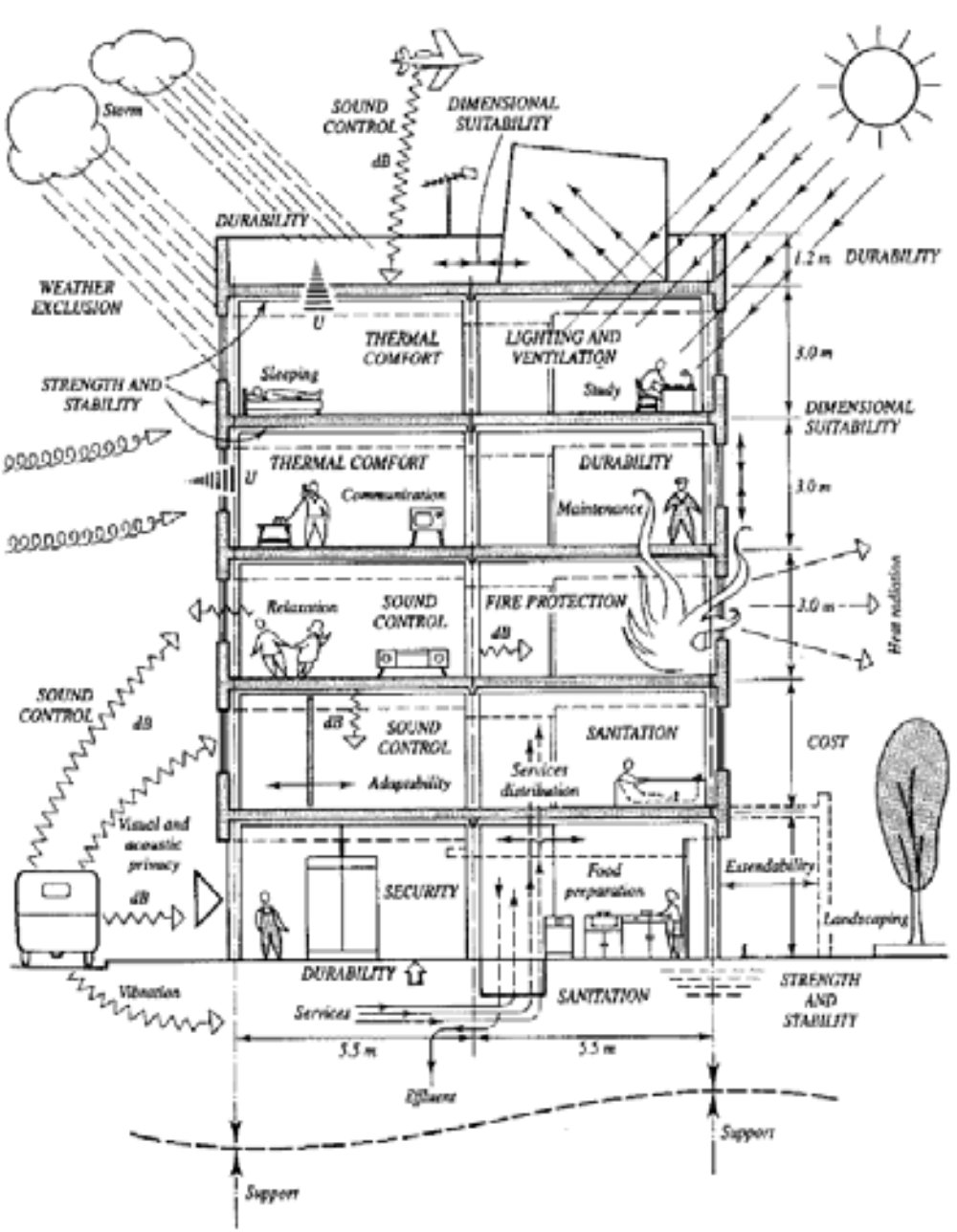


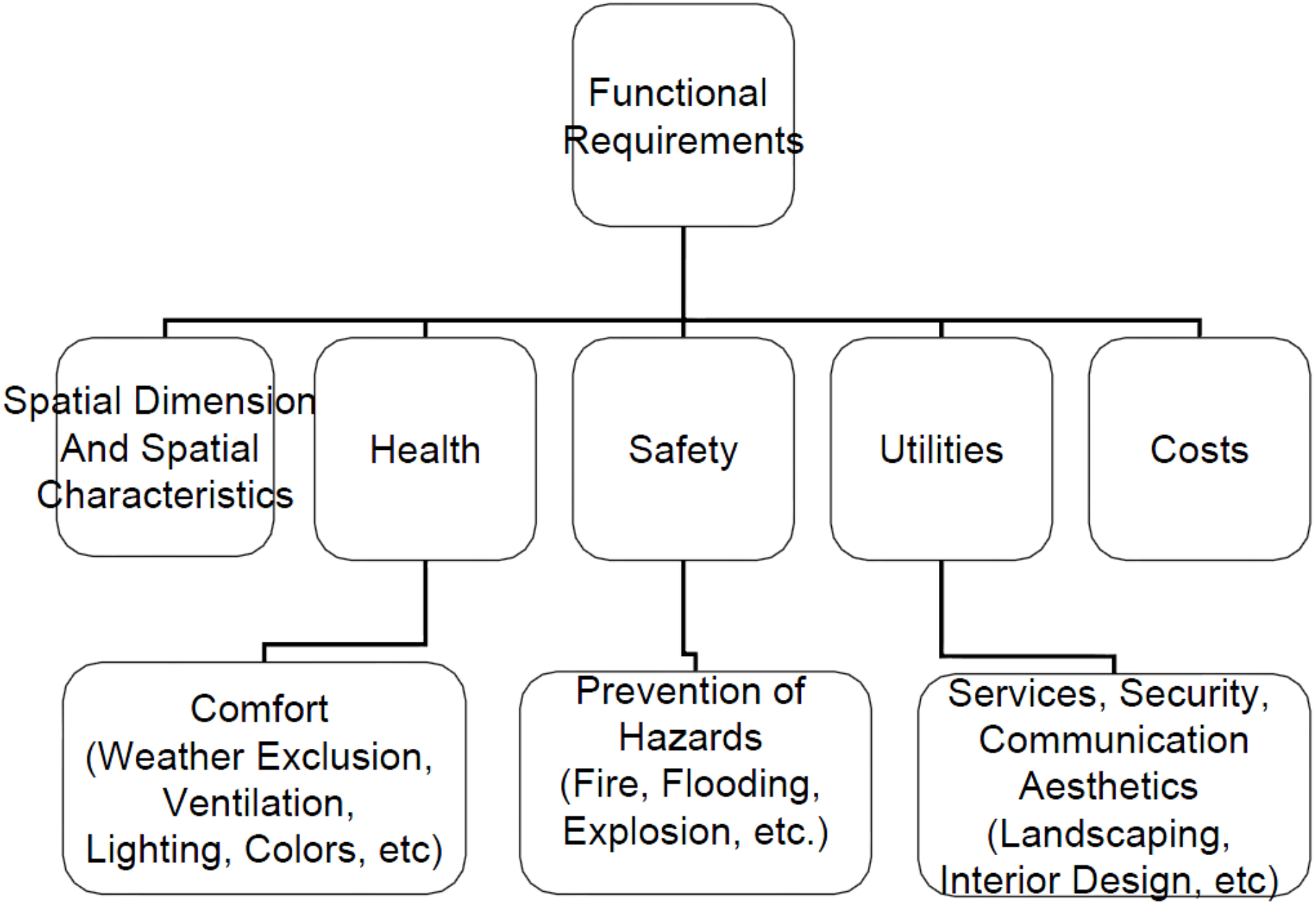
Actions to be taken for Cold Weather Warning

1. Members of the public are advised to put on warm clothes and to avoid adverse health effects due to the cold weather. Make sure there is adequate indoor ventilation.
2. If you must go out, avoid prolonged exposure to wintry winds.
3. If you know of elderly or persons with chronic medical conditions staying alone, call or visit them occasionally to check if they need any assistance.
4. Make sure heaters are safe before use, and place them away from any combustibles. Do not light fires indoors as a means to keep warm.
5. Whatever the temperature, ensure that there is plenty of fresh air in your room when you are using an old-type gas water heater.

Building Components

- Structural systems
- Closure
- Environmental modification systems
- Protection systems
- Utilities systems
- Communication (WiFi, Zigbee, 5G, Lora,..) & IoT
- Pathogen control

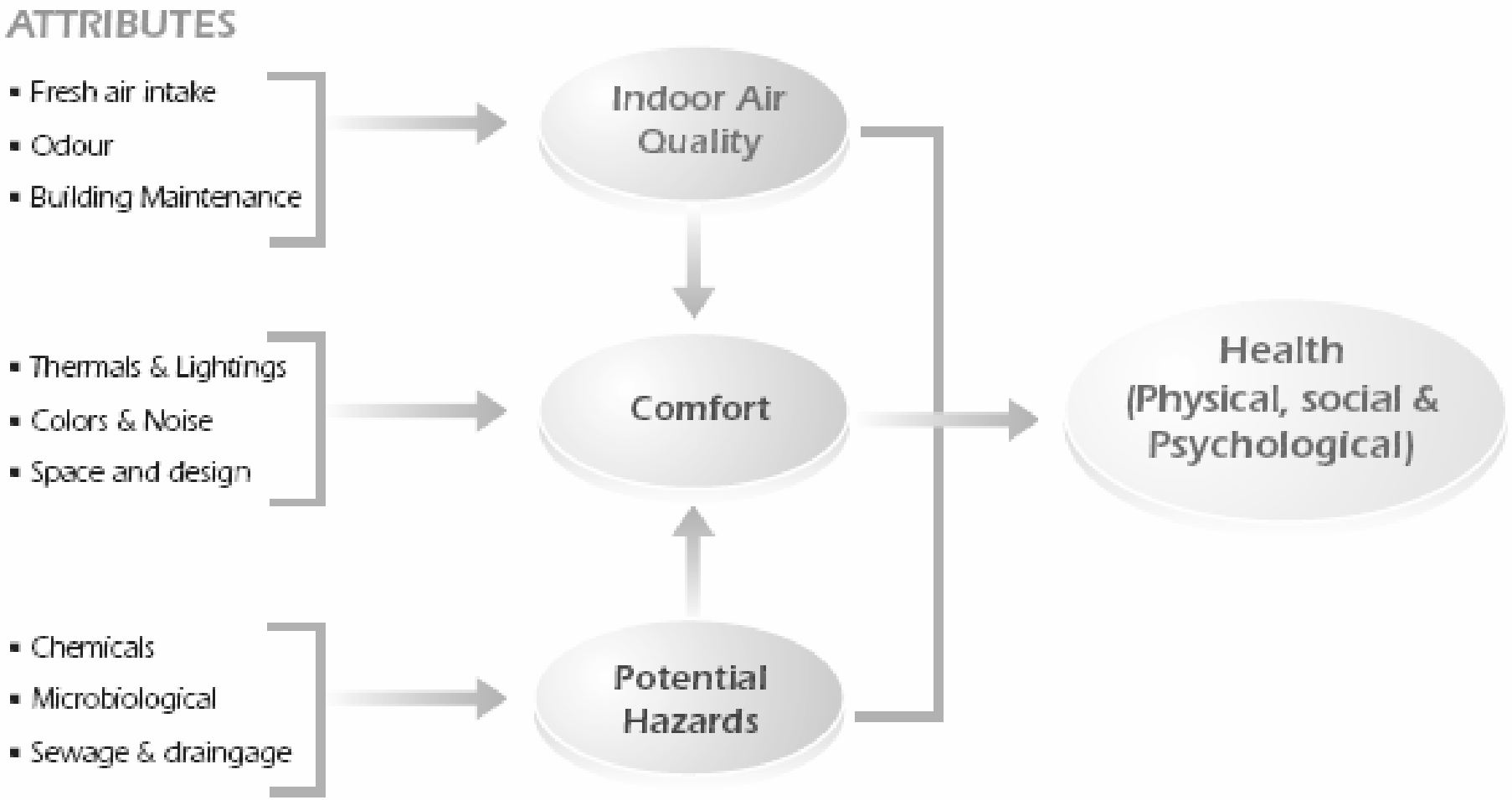



Functional Requirements
Spatial Dimension And Spatial Characteristics
Health
Safety
Utilities
Costs
Comfort (Weather Exclusion, Ventilation, Lighting, Colors, etc)
Prevention of Hazards (Fire, Flooding, Explosion, etc.)
Services, Security, Communication Aesthetics (Landscaping, Interior Design, etc)

Performance Requirements

- Strength – sustain loads
- Stability – remain balanced
- Rigidity – resist deformation
- Equilibrium – achieve a balance of forces
- Robustness – perform adequately for intended purpose
- Serviceability – function to satisfaction of occupants

Health and Safety of Buildings



Elements of Buildings (1)

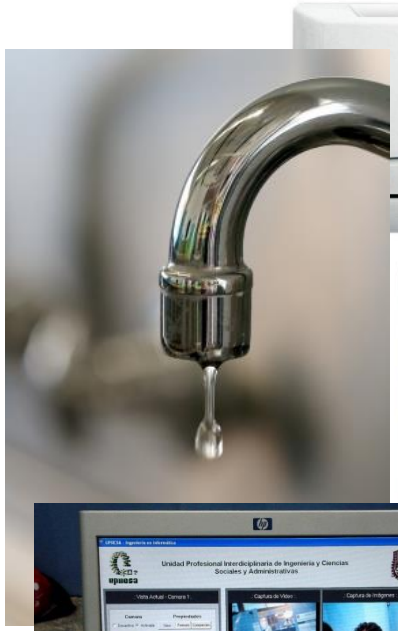
- Façade
  - the face or exterior wall of a building, often specifically the main / front side that is shown to the public.
- Floors
  - are the most immediate sensation that we have of a building, as they are the part that we are most often in direct contact with.
- Railings (Guard Rail)
  - provide something to hold on to so that one does not fall, installed on stairs and other slippery surfaces, at the edge of balconies, mezzanines, or other dangerous heights, and glass railings integral to form of building.

Elements of Buildings (2)

- Roofs
  - can be made to extend well past walls to give a strong sense of shelter.
- Building Envelope
  - encompasses the exterior of the building. It is therefore the sum of the roof, wall, fenestrations and floor. It also forms part of the structural support for the building and makes the "face" of the building.
- Windows
  - allows natural light and provide spacious feelings to the building.

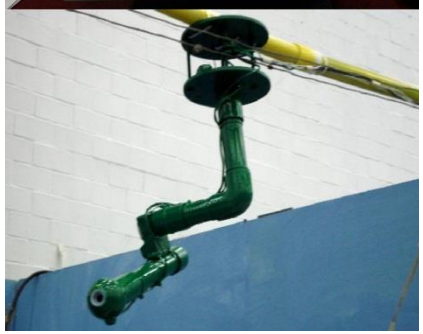
Basic Building Constituents

- Indoor comfort
  - temperature
  - humidity
  - indoor air quality
  - CO_2 concentration
  - pathogens control
- Water supply
  - sanitation / purification
- Waste disposal
  - water drainage
  - solid waste
- Lighting and automation
  - sensors
  - information and security
- Electricity
  - appliances
- Thermal energy
  - cooking
  - heating










Destruction of Buildings

- Fire/Explosion
- Wind
- Rain
- Mudslides
- Earthquakes
- Tsunami
- Structural collapse
- Others

Demolition of Buildings

- Demolition is the tearing-down of buildings and other structures, because of financial progress or new urban planning.
- Small building is pulled down either manually or mechanically using large hydraulic equipment: elevated work platforms, cranes, excavators or bulldozers.
- Larger buildings may require the use of a wrecking ball, a heavy weight on a cable that is swung by a crane into the side of the buildings.
- Large buildings, tall chimneys, smokestacks, and increasingly some smaller structures may be destroyed by building implosion using explosives.

Deconstruction of Buildings

- A new approach to demolition is the deconstruction of a building with the goal of minimizing the amount of materials going to landfills.
- This "green" approach is applied by removing the materials by type material and segregating them for reuse or recycling.
- With proper planning this approach has resulted in landfill diversion rates that exceed 90% of an entire building and its contents in some cases.
- The development of plant and equipment has allowed for the easier segregation of waste types on site and the reuse within the construction of the replacement building.
- On site crushers allow the demolished concrete to be reused as type 1 crushed aggregate either as a piling mat for ground stabilization or as aggregate in the mixing of concrete.
- Timber waste can be shredded using specialist timber shredders and composted, or used to form manufactured timber boards.

Engineering Calculations
Basic Methods

- Dimensional analysis
  - mass [M]
  - length [L]
  - time [T]
  - temperature [θ]
  - electric current [j]
  - amount of light [ν]
  - amount of matter [-]
- Equivalents
  - unit conversion (e.g. : 1 hr = 60 min)
  - system conversion (e.g. : cgs to fps)
  - conventional conversion (e.g. : energy statistics)

Dimensions of Some Common Physical Quantities

[x]: Length – L

[m]: Mass – M

[t]: Time – T

[v]: Velocity – LT^{-1}

[a]: Acceleration – LT^{-2}

[F]: Force – MLT^{-2}

[ρ]: Mass Density – ML^{-3}

[P]: Pressure – $ML^{-1}T^{-2}$

[E]: Energy – $ML^{2}T^{-2}$

[I]: Electric Current – QT^{-1}

[q]: Electric Change – Q

[E]: Electric Field – $MLQT^{-2}$

All are powers of the fundamental dimensions:

[Any Physical Quantity] = $M^aL^bT^cQ^d$

Dimensional Analysis energy as example

- work = force x distance = $m \cdot a \cdot s$
  $= [M]\ [L]\ [L] / [T]^2$
- K.E. = $[mv^2/2] = [M]\ ([L] / [T])^2$
- P.E. = $[m \cdot g \cdot h] = [M]\ ([L] / [T]^2)\ [L]$
- A.E. = $[m\ C^2] = [M]\ ([L] / [T])^2$
- Photovoltaic energy = $h_p \nu = \left(\frac{[M]\,[L]^2}{[T]^2}\ [T] \right) \div \frac{1}{[T]}$

$$= [M]\,[L]^2 / [T]^2$$

$$= [M]([L]/[T])^2$$

Equivalents : system conversion
useful conversion factor

TABLE A-1*b* ***Useful conversion factors between SI and English units***

Physical quality	*Symbol*	*SI to English conversion*	*English to SI conversion*
Length	L	1 m = 3.2808 ft	1 ft = 0.3048 m
Area	A	1 m^2 = 10.7639 ft^2	1 ft^2 = 0.092903 m^2
Volume	V	1 m^3 = 35.3134 ft^3	1 ft^3 = 0.028317 m^3
Velocity	v	1 m/s = 3.2808 ft/s	1 ft/s = 0.3048 m/s
Density	ρ	1 kg/m^3 = 0.06243 lb_m/ft^3	1 lb_m/ft^3 = 16.018 kg/m^3
Force	F	1 N = 0.2248 lb_f	1 lb_f = 4.4482 N
Mass	m	1 kg = 2.20462 lb_m	1 lb_m = 0.4359 kg
Pressure	p	1 N/m^2 = 1.45038 × 10^{-4} lb_f/in^2	1 lb_f/in^2 = 6894.76 N/m^2
Energy, heat	q	1 kJ = 0.94783 Btu	1 Btu = 1.05504 kJ
Heat flow	q	1 W = 3.4121 Btu/h	1 Btu/h = 0.29307 W
Heat flux per unit area	q/A	1 W/m^2 = 0.317 Btu/h·ft^2	1 Btu/h·ft^2 = 3.154 W/m^2
Heat flux per unit length	q/L	1 W/m = 1.0403 Btu/h·ft	1 Btu/h·ft = 0.9613 W/m
Heat generation per unit volume	q	1 W/m^3 = 0.096623 Btu/h·ft^3	1 Btu/h·ft^3 = 10.35 W/m^3
Energy per unit mass	q/m	1 kJ/kg = 0.4299 Btu/lb_m	1 Btu/lb_m = 2.326 kJ/kg
Specific heat	C	1 kJ/kg·°C = 0.23884 Btu/lb_m·°F	1 Btu/lb_m·°F = 4.1869 kJ/kg·°C
Thermal conductivity	k	1 W/m·°C = 0.5778 Btu/h·ft·°F	1 Btu/h·ft·°F = 1.7307 W/m·°C
Convection heat-transfer coefficient	h	1 W/m^2·°C = 0.1761 Btu/h·ft^2·°F	1 Btu/h·ft^2·°F = 5.6786 W/m^2·°C
Dynamic viscosity	μ	1 kg/m·s = 0.672 lb_m/ft·s = 2419.2 lb_m/ft·h	1 lb_m/ft·s = 1.4881 kg/m·s
Kinematic viscosity and thermal diffusivity	ν, α	1 m^2/s = 10.7639 ft^2/s	1 ft^2/s = 0.092903 m^2/s

Equivalents : conventional conversion *common consistent values*

- Physical conversion constants

  1 barrel = 42 US gallon (159 liter)

  1 calorie = 4.184 joule

  1 Faraday = 96,487 coulomb

  1 horsepower = 746 watts

- Regulatory conversion constants

  1 kg of coal equivalents = 6,200 kcal

  1 liter of oil equivalents = 9,000 kcal