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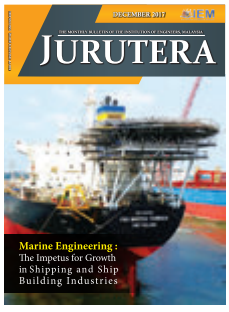

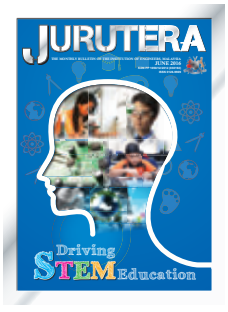

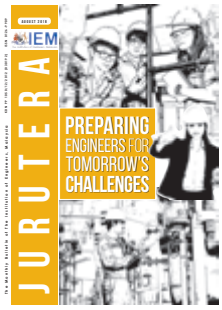

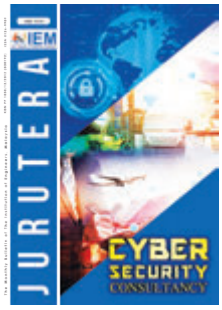

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COVER NOTE

FIRE SAFETY MANAGEMENT

by Ir. Yap Chee Hong
Chairman, Building Services Technical Division

High density, high-tech skyscrapers are being constructed in major cities. These are complex in terms of detailed planning, perplexity in design, tectonic structure and aesthetic architecture with smart systems and safety features.

There is no doubt that local councils and the Jabatan Bomba & Penyelamat Malaysia (JBPM) ensure that high rise buildings comply with all the relevant legislations and requirements when it comes to fire safety.

Upon completion, building owners must do their part to ensure that fire safety management is put in place. Well-planned fire safety management will ensure the protection of the building and the occupants.

Building Automation System (BAS) is an example of a smart system that can provide early detection of emergencies and with artificial intelligence (AI), can even predict if there's an emergency. The fire safety management concept is equally important for all existing buildings, in particular designated buildings under the Fire Services Regulation 2001 and one of the key requirements is a formalised and trained Emergency Response Team which can play a major role as being the first respondent in a fire incident.

The ultimate aim of fire safety management in new buildings is to utilise technology that can predict fire incidents so as to give early warning to the occupants while existing buildings should have effective systems implemented and put in place as well. ■

EDITOR'S NOTE

by Ir. Dr Bhuvendhraa Rudrusamy
Bulletin Editor

I'm honoured that the Standing Committee for Information & Publication has entrusted me with the job of Bulletin Editor. First, a hearty "thank you" to our previous editor, Ir. Razak Yakob, who had contributed so much to the success of our monthly publication. The current team pledges to continue to uphold the objectives of the publication and to share articles that will benefit and further enhance our readers' experiences.

As we start the New Year with new hope, we have also given the bulletin a fresh new look. The highlight of this month's *JURUTERA* is fire safety management, focusing in particular on the importance of fire safety, implementation, control, management and the standards. These should be continuously reviewed as a form of prevention and protection against the loss of property and/or lives. As the old saying goes, "prevention is better than cure".

We highly encourage members to go paperless to reduce the carbon footprint and to update their subscriptions. I would also like to take this opportunity to wish all members a prosperous Chinese New Year and happy holidays. Travel safe. ■

FIRE SAFETY MANAGEMENT: ARE WE DOING ENOUGH?

Y.Bhg. Dato' Mohammad Hamdan bin Haji Wahid, *is the Director-General of the Fire & Rescue Department of Malaysia. He holds a Master of Science in Emergency Response Planning and Management from University Putra Malaysia and a Bachelor of Science from University of Malaya. He is Chairman of the State Sports, Charity & Culture Society, Chairman of the Cooperative, Fire & Rescue Department (KOBOPEM) and President of the Institute of Fire Engineers (IFE) Malaysia.*

FIRE SAFETY MANAGEMENT

Fire safety management is an essential part of a building's security and safety system. It ensures that the integrity and protection of the structure, content and lives of the occupants are secured. Primarily, it involves the design, management, planning and coordination of appropriate safety procedures in order to reduce the risk of fire and to enhance the safety of the occupants of a building. These strategic measures amplify the Loss Prevention & Risk Reduction plans which protect a developer's investments and sustain the owner's business continuity.

The protection measures and system stipulated under the building codes and fire safety regulations which encompass passive and active fire safety systems, should be fundamentally understood and well applied by all parties in the industry. In outlining and abiding by these legal and technical requirements, the professionals involved should hold and share the highest level of responsibilities and professionalism. Among others, the Principal Submitting Persons (PSPs) and regulatory agencies must be at the forefront of such commitments to ensure that all these practices are fully complied with and implemented.

STATISTICS

In 2018, 4,021 building plan applications were submitted to the Fire & Rescue Department of Malaysia; 2,582 (64%) submissions were approved and 1,439 (36%) were rejected. In comparison, in 2017, 2016 and 2015, about 37%, 38% 36% of applications were rejected respectively.

We spoke to Y.Bhg. Dato' Mohammad Hamdan bin Haji Wahid, the Director-General of the Fire & Rescue Department of Malaysia, regarding this issue and discussed measures to be taken to resolve it.

MAIN ISSUES & CHALLENGES

Dato' Mohammad said many applications were rejected because of the poor knowledge level of the PSPs with regards to the basic principles of fire safety technical and legal requirements, poor comprehension of the submission procedures, poor coordination of the project management and direct involvement of the project developers, contractors and unprofessional individuals with regards to the technical requirement and designs of the proposed projects or premises.

"Every year we conduct a performance study and evaluation of the data and records of the application/submissions for Forms G8 and G9. We have concluded that the numbers of submissions, approvals and rejections do not differ much from the performance records of the previous years. Such shortfalls are very disappointing and immediate action and solutions are needed," said Dato' Mohammad Hamdan.

"A high rate of failure was detected in the Mechanical & Electrical plans. Most of the drawings submitted were blank and unmarked and applications for the active fire protections system and installations were inappropriately allocated.

"The coordination between passive and active systems was not streamlined as required. Even after the rejections, new submissions showed that there were no rectifications taken and the same misinterpretations and mistakes were repeated. These scenarios indicate a lack of seriousness and ethics in providing professional services by qualified submitting persons and is still at a disappointing stage.

"Poor internal coordination between junior and senior engineers as well that as between engineers and regulatory agencies were also a contributing factor to such malpractices. When we looked at the drawings or designs submitted, it was clear that there was a lack of understanding of the concepts, technical details and safety requirements of the system. When technical consultations were initiated, the approving regulatory personnel were dealing with junior or fresh graduate engineers who were still incompetent and unclear on submission proposals and specifications which were way beyond their skills and experiences."

There had been accusations that some fire personnel were making it difficult for engineers to get plans and proposals approved. Dato' Mohammad Hamdan said that should such cases happen in the future, the professionals were welcomed to inform the department, so that a proper investigation could be carried out.

"The Fire and Rescue Department of Malaysia has set a very clear KPI (Key Performance Indicator) with regards to the approval of plans

submissions and applications, whereby all submission should be replied to within 14 days from the date of total complete submission," he said.

"Some PSPs submitted applications even though they knew their proposals were incomplete and would be rejected; this was just to show that a submission had been made. As there are no limits to the number of submissions, we find that many PSPs don't take the process seriously. This is one of the reasons for the 37% rejection rate."

THE WAY FORWARD

Dato' Mohammad Hamdan said that there is an urgent need to train, assess and register all PSPs. "We are seriously considering the possibility of registering PSPs with the Fire & Rescue Department. This is not an attempt to create another layer of registration, as we already know the Board of Engineers is responsible for such registrations under the Engineers Act. We want to ensure that all PSPs undergo special subject matter training and assessment programmes on fire safety management, in order to enhance their knowledge of passive and active fire protection systems and to create a professional learning community. Only PSPs who are competent will be registered administratively and be considered qualified as certified submitting engineers for fire safety submissions," he said.

"The registered PSPs will be rated in accordance to their performance during the training programmes, as well as on previous submission records, so as to motivate them. We will publish these ratings on our department portal for public reference and information. In time, developers who want certified fire safety engineers, will only need to look at our panel of star-rated engineers. Such initiatives will create a more competitive environment as well as produce competent and professional fire safety engineers."

> ***"Working closely with managements of large buildings in order to improve fire safety protections and procedures is important to me."***

Dato' Mohammad Hamdan also believed that the use of advanced digital technology will make the process for approval smoother and more efficient.

"In future, things will no longer be done over the counter and there will be little or no human interaction. Everything will be submitted online, so accuracy and competency will become even more crucial. This is already being done in other agencies and countries. The system itself will pull together the data and develop insights and statistics into the applications, from which will be drawn the ratings for the individual engineers or firms. One drawback is, of course, the loss of the human touch and the human experience, but efficiency and accuracy will increase," he said.

ARE EXISTING BUILDING CODES SUFFICIENT?

Dato' Mohammad Hamdan stressed that the Uniform Building By-Law 1984 (UBBL) and Malaysian Standards (MS) had undergone various phases of amendment and revisions. He said the UBBL 1984 is clear and easy to follow if the submitting persons understand the basic principles of fire science and engineering. However, some professionals had mentioned that different states had different versions of UBBL and had said that this contributed to the large number of rejections.

However, excuses such as these are not acceptable as ambiguities are few and, if at all such cases should happen again, further guidelines and explanations can

With Dato' Mohammad Hamdan are (standing left - right) Ir. Tan Chew, Ir. Yap Chee Hong, Chairman of BSTD, Ir. Cha Hoong Kum, Deputy Chairman of BSTD and Ir. Gary Lim Eng Hwa

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BSTD Chairman Ir. Yap Chee Hong with Dato' Mohd. Hamdan

> ***"Let us blaze the way, to keep the blazes away".***

still be sought from the regulatory agency. Experienced professionals acknowledge and use the same standard of technical requirements even if they are engaging and practising in different states. After all UBBL 1984 was designed and formulated by the professionals and industry players.

"Most of the professionals and contractors are well-versed in the standard requirements. Of course, if it was found that there were conflicting technical specifications in some of the clauses, tables or calculations, corrective measures would be taken and the conflicting information standardised accordingly… and if the requirements were found to be different, then the engineers would need to refer to our department as it could be due to wrong interpretations," he said.

"We will always follow the latest amendment as long it is in accordance with the standards. If it is not, then we will need to amend the MS or the UBBL. Currently, the professionals are involved in an amendment being made to the UBBL, so there shouldn't be any issue regarding this in the future. If engineers have problems, they should write to the officer and point out what had been accepted before.

"The performance-based and engineering approach is a customised new measure for large and mega projects. It is used as such projects have greater dimensions, special purposes and unique designs. As such, the fire defence and protection strategies are above the prescriptive technical specifications under UBBL 1984. Big projects such as KLIA, KL Sentral, KL Tower, TRX, Menara PNB and other huge volume commercial structures and shopping malls normally need highly intensive focus and coordination among the professionals and the fire personnel. Projects like these need thorough deliberations, consultations and auditing to ensure that the investments are properly secured. They also require a longer approval process and therefore, the Fire & Rescue Department will form a special task force to facilitate the approvals of these submissions."

Dato' Mohammad Hamdan believed that cooperation between engineers, fire officers and building management is the key factor to ensuring that buildings are properly designed and well-maintained at all times and that they are safe for both occupants and visitors.

"In our continuing efforts to ensure public safety, The Fire & Rescue Department welcomes ideas and is always open to collaborations with professional bodies, especially those associated with engineers," he said.

"We have carried out many CSR (Corporate Social Responsibility) and non-CSR programmes with our strategic partners. Some of these include dialogues with professional bodies such as IEM, government agencies and certification bodies. This facilitates our enforcement of fire safety regulations and enhances public awareness on the importance of safety in their daily life. The Fire Services Act 1988 is more than 30 years old and many lessons have been learnt from its enforcement. However, it is critical that the public be aware of and understand the importance of fire safety. Community involvement and participation are crucial towards making our nation safe.

"IEM has been one of our strongest partners in our bid to create such awareness with regards to fire safety management and in our efforts to stimulate and transform the industry into a more healthy and progressive one, in order to contribute to nation building and the country's economic growth."

CONCLUSION

With the soon-to-be-implemented professional training programmes, registration and star-rating system for PSPs, Dato' Mohammad Hamdan believed that the approval rate for fire safety proposals for developments will improve and the number of submissions rejections will be reduced. ■

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CHANGES IN COMBUSTIBLE FAÇADE REGULATIONS AND TESTING IN AUSTRALIA

by Mr. Alexander Webb *Mr. Nathan White*

Facade fires around the world have instigated a change in regulations for cladding fire safety in many parts of the world. The Grenfell Tower fire in London 2017 had resulted in an extensive investigation of many aspects of the fire, including into UK building regulations by Dame Judith Hackitt[1,2]. Key findings of the review of building regulations by Judith Hackitt are:

- Current regulations and guidance are too complex and unclear.
- Clarity of roles and responsibilities is poor.
- Despite many who demonstrate good practice, the means of assessing and ensuring the competency of key people throughout the system is inadequate.
- Compliance, enforcement and sanctions processes are too weak.
- The route for residents to escalate concerns is unclear and inadequate.
- The system of product testing, marketing and quality assurance is not clear.

Malaysia cladding requirements in the UBBL are drawn from British standards so while regulatory review conclusions are not directly applicable, there are some parallels. Australia's building regulations are performance based, with prescriptive options. A review of the Australian building compliance system was published in early 2018[3] with similar issues as raised by the Hackitt report. Changes have occurred in Australian state regulation, national construction code and fire test methods in response. Key findings are relevant for the comparison with the situation in UK, and Australia.

DEVELOPMENTS IN AUSTRALIA

Australia had several fires involving external wall cladding with two fires of note being the LaCrosse building[4] on 25 November 2014 and the Neo200 building[5] on 4 February 2019. These fires, in conjunction with several structural failures and the 2015 recall of Infinity electrical cabling, have also driven government response to the wider risk of non-conforming building products.

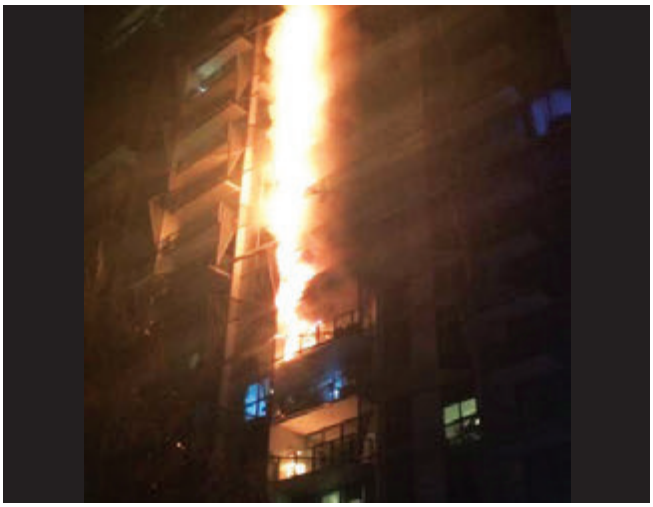


Figure 1: Lacrosse Façade fire, 2014, Docklands, Melbourne, Australia

A review of the Australia building compliance system is presented in the Shergold & Weir report[3], published in early 2018. This report, although from an Australian context identified some issues similar to those raised by Dame Judith in the Hackitt report. Twenty-four recommendations were made in the following areas:

- registration and training of practitioners
- roles and responsibilities of regulators
- role of fire authorities
- integrity of private building surveyors
- collecting and sharing building information and intelligence
- adequacy of documentation and record keeping
- inspection regimes
- post-construction information management
- building product safety

The Senate Economics Reference Committee (SERC) launched an inquiry into the use of non-conforming building products. The interim report was released on 6 September 2017. The Government response was released in February 2018. The final report was released in December 2018 (https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Economics/Non-conforming45th/Report).

Australia has a model building code; however, the country is a federation of states. The *National Construction Code Volume 1 Building Code of Australia Class 2 to 9 buildings*[6] (NCC) is indeed national. However, there are variations for each state both in the NCC and in state regulation and guidelines. The NCC sets requirements for fire safety by height and use (Class) of the building.

Buildings are generally divided into classes from 1 to 10. Domestic residences (single dwelling homes) are covered by 1 and 10 and are not relevant to this article. Residential apartments are covered by Class 2, hotel accommodation by Class 3 and public buildings (including hospitals and schools) by Class 9. While class 2, 3 and 9 have been the main focus of cladding safety audits and reviews in Australia due to the increased risk of sleeping occupants, combustible cladding presents problems on other classes of buildings, including office and retail.

The NCC does not provide a separate class for high-rise buildings. Instead fire safety requirements increase with building height within each building usage class. Unlike some countries, high-rise buildings are not considered separately and have additional requirements located in the main text.

Sprinklers are required for all buildings over 25m effective height and (as from NCC 2019) Class 2 and 3 buildings of 4 storeys or more but less than 25m effective height, require sprinklers with rationalised water supply and design requirements. The Fire Resistance Levels (FRL) of elements and other requirements are dictated by the type of construction, designated as Type A, B and C. Type C is most lenient. Type A construction is required for 3 or 4 level buildings (depending on Class).

Table 1: Type of fire resisting construction (from NCC Vol. 1 2019 Table C1.1)

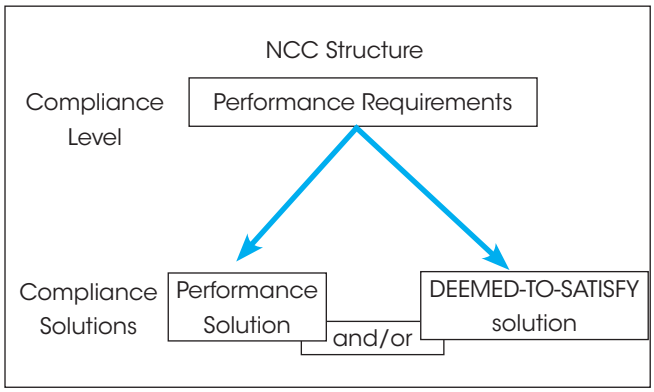
RISE IN STOREYS	CLASS OF BUILDING	
	2, 3, 9	5, 6, 7, 8
4 or more	A	A
3	A	B
2	B	C
1	C	C

NATIONAL CONSTRUCTION CODE (NCC)

The national construction code is a performance-based building code. Compliance with the NCC is achieved by complying with the performance requirements.

Performance requirements are satisfied by one of the following, as shown in Figure 1:

1. A Performance Solution.
2. A Deemed-to-Satisfy Solution (DTS).
3. A combination of (1) and (2).



For more than 20 years, the NCC (previously the Building Code of Australia) had set the DTS requirement that external walls for Type A and B construction must be either non-combustible, in accordance with AS 1530.1 testing or a limited set of materials (including plasterboard and coated metal sheeting and bonded laminates where the thickness of coatings or adhesives are strictly limited) which may be used wherever a non-combustible material is required.

However, due to industry failures identified by the referenced studies above, installation of DTS non-compliant combustible cladding on Type and B buildings in Australia had been prolific, in most cases not being appropriately supported by adequate performance solutions.

The NCC is amended on a three-year cycle, with the latest revision (NCC2019) coming into effect on 1 May 2019. However, more urgent changes driven by the Lacrosse and Grenfell fires were published in an out-of-cycle amendment to NCC 2016 (Vol. 1 Amendment 1), adopted on 12 March 2018[7].

NCC 2016 Volume One Amendment 1 includes the following changes:

1. The introduction of a new Verification Method (CV3) for testing of external wall assemblies for fire propagation. CV3 references a new testing standard, AS 5113-2016: "Fire propagation testing and classification of external walls of buildings"[8] and, in most circumstances, requires additional measures (e.g. enhanced sprinkler protection) and cavity barriers to mitigate the hazard presented by a combustible façade.
2. Revision of the NCC's evidence of suitability provisions, including clarifying the application and language of A2.2, strengthened wording of the current options, and a new requirement to consider the "appropriateness" of the evidence being presented to support the use of the material, product, design or form of construction.

3. Clarification of provisions, including provisions relating to external wall claddings and attachments, provisions that provide exemption to the non-combustibility requirements, and provisions that control the fire hazard properties of building elements.
4. Increased stringency for the sprinkler protection of balconies of residential high rise buildings through referencing an updated sprinkler standard, AS 2118.1-2017: Automatic fire sprinkler systems – general systems.

NCC 2019 Volume One includes the following changes:

1. Bonded Laminate Concession. The DTS clause permitting bonded laminated materials to be used with specified characteristics including limited adhesive layer thickness and controlled fire hazard properties, where a non-combustible material would otherwise be required remains for NCC 2019. The retention of the concession includes clarification that the lamina required to be non-combustible and includes any core. This clarification was made to prevent the incorrect interpretation that the concession could be applied to aluminium composite panels (ACPs) with a combustible core. A similar concession has been included to permit sarking-type materials up to 1 mm thick, and some other minor components (ancillary elements) have been exempted from the requirement to be non-combustible.
2. Fire sprinklers in Class 2 & 3 buildings. A requirement for fire sprinklers to be installed in apartment buildings and other residential buildings 4 storeys and above up to 25m in effective height, is included in the Deemed-to-Satisfy (DTS) Provisions with concessions for other fire safety features on account of the additional protection afforded by the fire sprinkler systems. As part of these requirements, two new types of fire sprinkler systems standards, FPAA101D and FPAA101H, have been developed which rationalised water supply and design requirements so as to reduce installation cost compared to AS 2118.1 sprinkler systems. For buildings over 25m effective height or buildings less than 25m effective height, applying the CV3 AS 2118.1 sprinkler system is still required. This means anyone using a DTS pathway for compliance for these types of buildings will need to install a fire sprinkler system. As part of these requirements, two new types of fire sprinkler systems have been included, as well as concessions for other fire safety features on account of the additional protection afforded by the fire sprinkler systems. (This was not introduced to directly address cladding fires).
3. Fire safety Verification Method. A new non-mandatory Fire Safety Verification Method (VM) will be introduced, with a delayed adoption date from 1 May 2020. The new VM, a voluntary tool under a Performance Solution pathway, provides for a documented process in the design of fire safety Performance Solutions and is based on the International Fire Engineering Guidelines (IFEG)[9]. (This was not introduced to directly address cladding fires).

PATHWAYS TO COMPLIANCE FOR EXTERNAL WALL FIRE PERFORMANCE IN AUSTRALIA

Figure 2 summarises the current NCC pathways to compliance for fire performance of external wall systems in Australia.

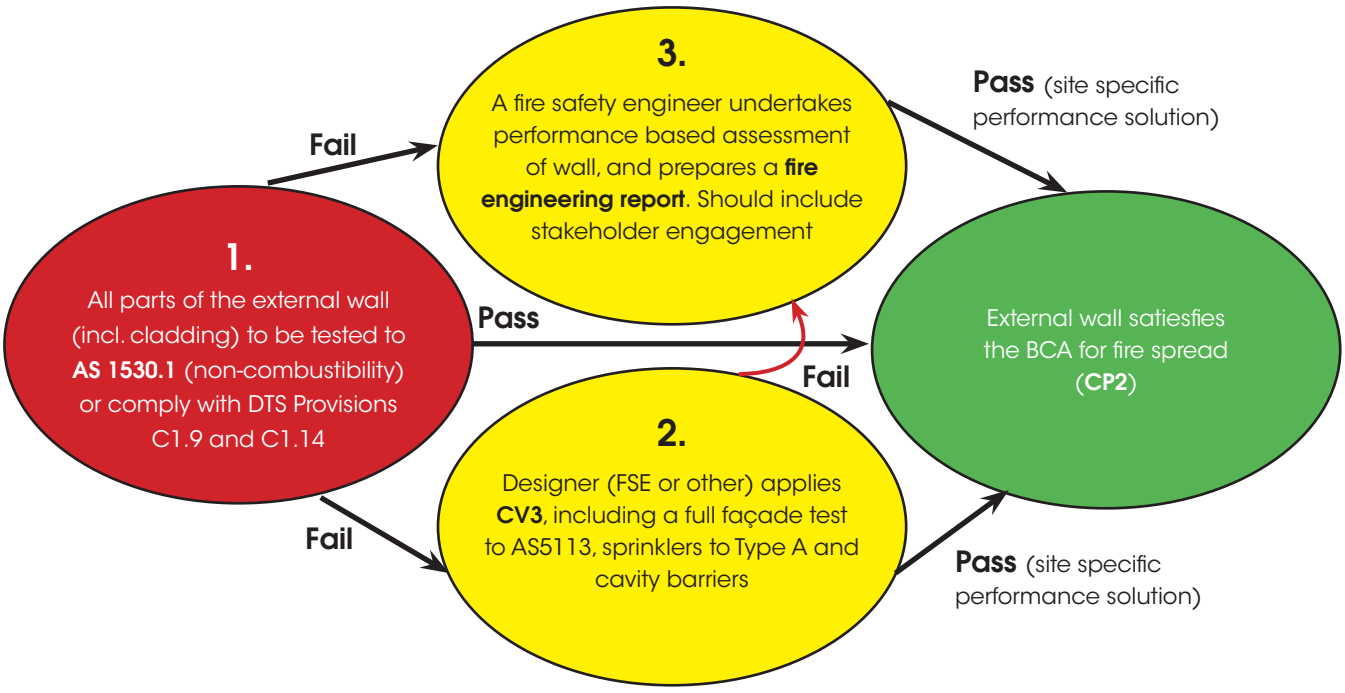


Figure 2: NCC compliance pathways possible for an external wall system relating to external wall reaction to fire (does not cover fire resistance requirements)

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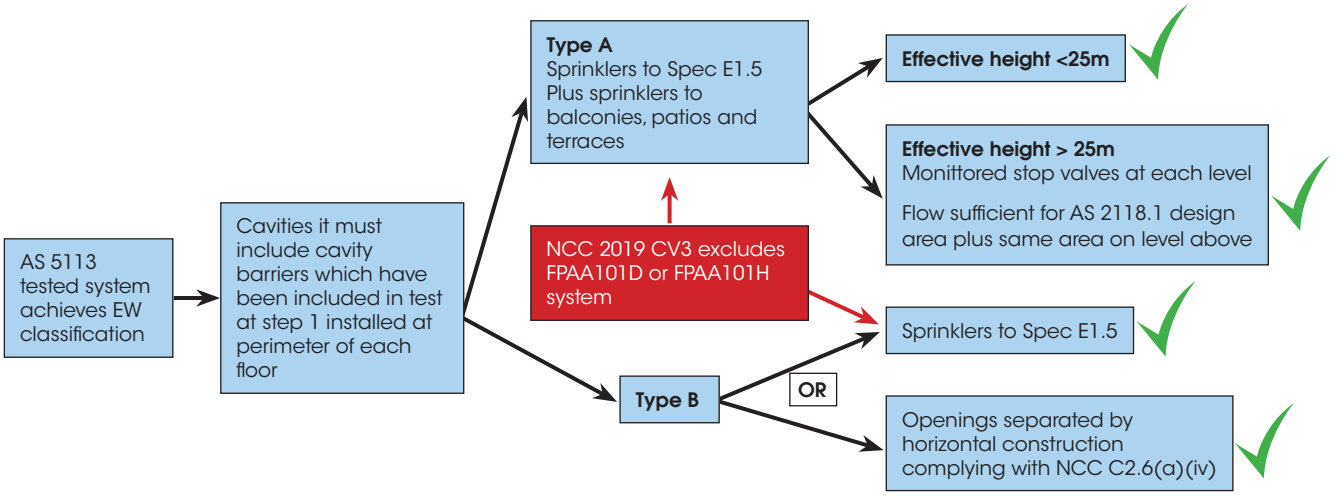


Figure 3: Summary of NCC CV3 requirements

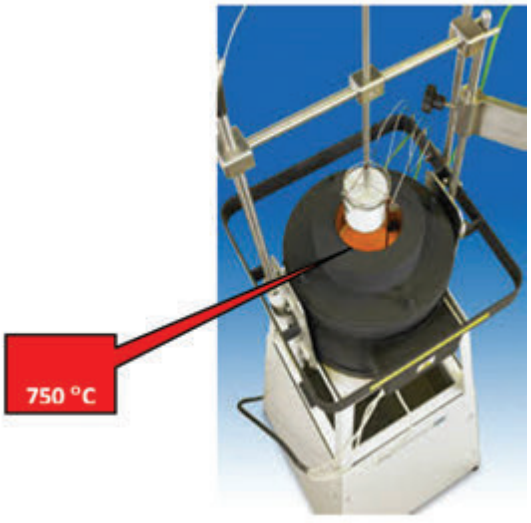
VERIFICATION METHOD CV3

Verification Method CV3 states that compliance with **CP2** to avoid the spread of fire via the *external wall* of a building is verified when the requirements summarised in the following flow diagram are satisfied.

AS 1530.1 COMBUSTIBILITY TEST

In AS 1530.1, small specimens are exposed to a temperature of 750°C within a small conical tube furnace. Criteria for non-combustibility are typically:

- The mean duration of sustained flaming (flaming longer than 5 s), is other than zero.
- The mean furnace thermocouple temperature rise exceeds 50°C.
- The mean specimen surface thermocouple temperature rise exceeds 50°C.



AS5113 FIRE PROPAGATION TESTING AND CLASSIFICATION OF EXTERNAL WALLS OF BUILDINGS

AS 5113 was first published in 2016 and provided a full scale façade fire test and classification standard based on BS 8414 or ISO 13785.2. In practice, only BS8414 method is currently being applied in Australia. The standards were selected after a review of the many different test methods[10]. The standard acceptance criteria are based upon BR135 with significant changes. This test method is not applied as NCC DTS but is applied to provide suitable evidence required for performance solutions.

In practice, most external wall systems tested to this standard rarely meet all the acceptance criteria. For example, falling debris criteria may be typically exceeded (e.g. melting of aluminum or spalling of concrete) even when criteria relating to vertical fire spread are not. Such tests may still be applied as evidence for performance solutions.

The following diagrams summarise the key features and acceptance criteria of AS 5113 applying BS 8414.

- Wing wall detail.
- Timber crib.
  - In combustion chamber.
  - Directly at base of façade.
  - Crib 1.5m wide x 1m deep x 1m high.
  - Crib mean mass ~400kg (±~80kg).
  - Crib Peak HRR =3±0.5MW.
- Extent of flame immersion and heat flux to external wall is greater than for ISO 13785-2.
- Critical temperatures measured at 5m above opening.

Figure 4: Key features of AS5113 applying BS 8414

CLASSIFICATION CRITERIA	CRITERIA LIMIT	DESCRIPTION
5.4.5(a) T_{w5m}	≤600°C	Temperatures 5m above the opening measured 50mm from the exposed specimen face shall not exceed 600°C for a continuous period greater than 30s.
5.4.5(b) $T_{cavity5m}$ 5.4.5(b) $T_{layer5m}$	≤250°C	Temperatures at the mid-depth of each combustible layer or any cavity 5m above the opening shall not exceed 250°C for a continuous period of greater than 30s.
5.4.5(c) $T_{Unexposedside0.9m}$	≤180K rise	Where the system is attached to a wall that is not required to have an FRL of –/30/30 or 30/30/30 or more, the temperature on the unexposed face of the specimen 900mm above the opening shall not exceed a 180K rise.

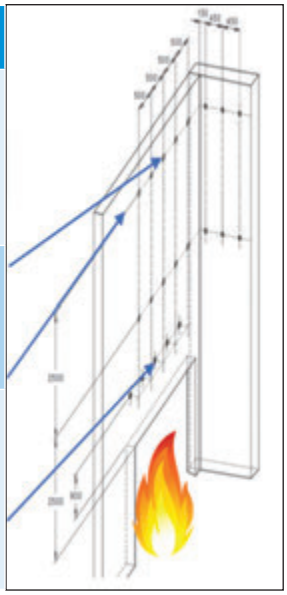


Figure 5: Temperature acceptance criteria for AS 5113 applying BS 8414

CLASSIFICATION CRITERIA	CRITERIA LIMIT	DESCRIPTION
5.4.5(d) Flaming 5.4.5(d) Opening	No Flaming No Openings	Where the system is attached to a wall not required to have a fire resistance of –/30/30, 30/30/30 or more, flaming or the occurence of openings in the unexposed face of the specimen above the opening shall not occur.
5.4.5(e) Spread	No Spread beyond Specimen	Flame spread beyond the confines of the specimen in any direction, as determined during the post-test examination, shall not occur. The examination shall include flame damage such as melting, charring but not smoke discolouration of staining of the surface, any intermediate layers and the cavity. Confines of specimen= • 2.4m horizontally on main test wall • 1.2m horizontally on wing wall • 6m vertically above top of combustion chamber opening

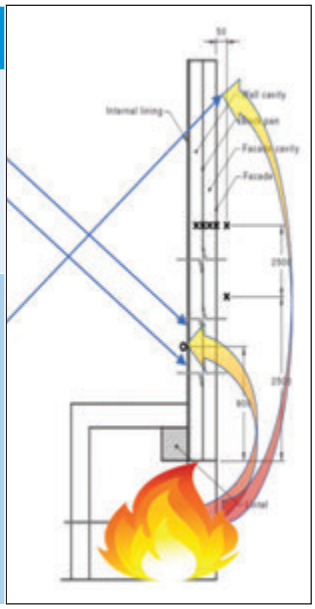


Figure 6: Fire spread and opening acceptance criteria for AS 5113 applying BS 8414

CLASSIFICATION CRITERIA	CRITERIA LIMIT	DESCRIPTION
5.4.5(f) Debris Flaming	≤20s	Continous flaming on the ground for more than 20s from any debris or molten material from the specimen shall not occur
5.4.5(g) Debris mass	≤2kg	The total mass of debris falling in front of the specimen shall not exceed 2kg. The mass shall be measured after the end of the test.

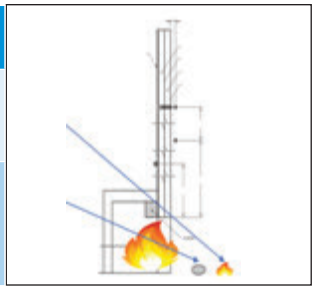


Figure 7: Debris acceptance criteria for AS 5113 applying BS 8414

STATE REGULATORY CHANGE AND RISK ASSESSMENT TOOLS

Most states have brought in new legislation regarding non-conforming products and combustible cladding. The Victorian Building Authority implements an audit process applying a Risk Assessment Tool (RAT), an approach similar to the NFPA EFFECT™ tool which has been developed by the Victorian Cladding taskforce and is applied during the audit and review process of the buildings.

The Engineers Australia Society of Fire Safety has published Society of Fire Safety Practice Guide Façade/External Wall Fire Safety Design 2019[11]. Several other guides have been published by the ABCB[12], CSIRO[13] and other state regulators.

CONCLUSION

The recent wall cladding fires triggered systemic reviews of regulation in many countries. The Hackitt report opening was severe "…the regulatory system (UK) covering high-rise and complex buildings was not fit for purpose …" we have seen further evidence confirming the deep flaws in the current system. Review in Australia was less stern; however major flaws were identified.

Many countries have made changes to building Acts, Regulations and Codes. Australia has amended fire test methods and regulation to address combustible cladding applied to new buildings. Investigation procedures for existing buildings and audits and risk assessment tools have been developed. These are steps towards remediation of the issues. Issues relating to consistency of requirements for combustible cladding between the different states within Australia and other countries remains a challenge.

These steps in improving and clarifying regulations and tests are the first step in enhancing fire safety of façade systems. However, ensuring compliance with regulations is a challenge.

Internationally, the trend is toward large scale tests (in addition to material tests) which represents the majority fire scenarios and ensures assessment of full scale and component interactions. Tests should be applicable to all wall system types and the field of application clear.

Buildings identified as having a risk of fire spread due to non-compliant cladding, can have the risk reduced as shown in response to the NEO200 building via interim rectification and fire service pre-planning.

Ongoing maintenance and confirmation of compliance throughout the life of a building is critical to ensure that fire safety systems, both active and passive, provide an acceptable level of life safety. External cladding systems are in place for decades, prone to alteration and damage from intentional works, accidental damage, weathering and ageing.

REMARKS FROM BUILDING SERVICES TECHNICAL DIVISION, IEM

Despite the current lack of legislation in Malaysia on external claddings in fire safety, the Malaysian fire authority (BOMBA) has already taken a proactive approach to implement the BS 8414 fire test requirement for designs of new buildings with external cladding system higher than 18m. The fire tests for such external claddings system is currently being carried out by SIRIM Malaysia at its test lab centre in Rasa, Kuala Kubu Baru, Selangor. To cope with the market demand, SIRIM Malaysia will have two test labs for this BS 8414 fire test in the near future. ■

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CONGRATULATIONS

*Congratulations to **Laksamana Muda Datuk Ir. Mohd Shaiful Adli Chung bin Abdullah** on being awarded the Darjah Pangkuan Seri Melaka (D.P.S.M) during the Anugerah Darjah, Bintang & Pingat Kebesaran Negeri Melaka 2019, held in conjunction with **Tun Dr Mohd Khalil Yaakob's** 81st birthday celebration on 12 October 2019.*

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IoT IN FIRE MANAGEMENT

by Ir. Vekneswaran T. Arasappan

With the advent of digital technology, the automation and data exchange initiatives that began in the manufacturing industry have turned into a full-blown revolution that cuts across sectors from agriculture, mining and construction to transportation, communication, utilities, finance, insurance, healthcare and real estate. The rate of the transformation is unprecedented, and it is now known as the 4th Industrial Revolution (4IR).

Driven by technology, Industry 4.0 increasingly employs automation, while accelerating mechanisation, with more robotics taking over routine and labour-intensive tasks. Digitalisation is rife, depending heavily on computers and software for almost everything, culminating in the widespread use of apps and digital devices across all workstreams. The advent of cyber-physical systems enabled by the Internet of Things (IoT) and cloud computing, is making phenomenal changes to the landscape, never before seen in the history of the world.

For the building services sector, Industry 4.0 is the next step in its gradual evolution. The key lies in how the various mechanical and electrical systems associated with a building can function in their inter-relations to provide a much higher level of service.

PURPOSE OF BUILDINGS

About a million years ago, man started moving into caves, primarily to seek shelter from harsh weather and wild animals as well as to have space for communal purposes. The discovery of fire kept man warm, provided protection from wild animals and enabled cooking activities.

Today, Wikipedia describes buildings as serving societal needs, "primarily as shelter from weather, security, living space, privacy, to store belongings, and to comfortably live and work". In today's context, electricity takes the place of fire as an enabler.

Whether it's caves or buildings, man's needs have remained pretty much the same. This is encapsulated in Abraham Maslow's hierarchy of needs (see diagram 1).

Today's buildings fulfil man's physiological needs by providing shelter with comfortable indoor weather and an environment controlled by the air-conditioning and lighting systems.

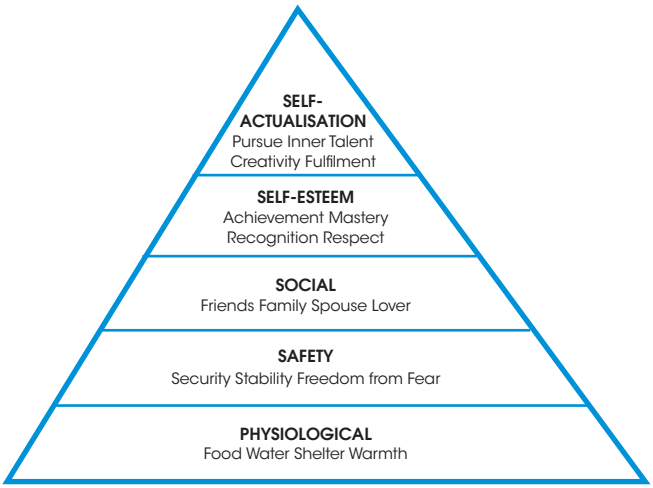


Diagram 1: Source: Maslow, A. Motivation and Personality (2nd ed.) Harper & Row, 1970

Safety and security are provided by the fire detection and prevention systems with CCTV and card access for auto doors/gates.

The telephony, network and the lift systems enables communication and connectivity within the social community for collaborative activities.

The technology in buildings today has evolved tremendously in the last few decades. Continuous learning and continuous improvements with each construction project, have resulted in buildings that are engineering feats today. However, the purpose remains the same: To serve man's needs.

These needs have also become significantly complex over the years. Given the current trend of "personalisation" and a focus on customer experience, an air-conditioning service may evolve into providing comfort-as-a-service and, instead of a fire-fighting system, it may be safety-as-a-service while cleaning services could become hygiene-as-a-service. Thus, a building-as-a-service, will take building services to another level altogether.

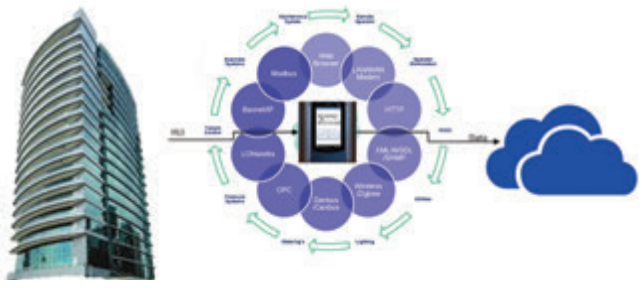
Imagine a building with ambient intelligence that enables it to recognise an approaching tenant, whether by way of long-range RFID, bluetooth low energy or even facial recognition through video analytics. The building is then able to "greet the tenant" by playing preferred music or displaying the tenant's name on an electronic signage. The auto-gate automatically opens while the lift is signalled down to the lobby. When the tenant enters the lift, the floor button alights by itself and the lift automatically goes to the correct floor. Stepping into the floor lobby, the auto door is activated to open while the room air-conditioning and lighting switches turn on to the preferred setting. And perhaps a message is sent to deliver the beverage of choice to the tenant.

The coming together of all the systems in the building to serve the tenant's needs gives the impression of a building that is alive, one that is conscious of the needs of its occupants. This idea isn't too far-fetched, given that vehicles are going autonomous. 4IR has undoubtedly accelerated the evolution towards smart buildings and enabled building-as-a-service to become a reality.

TECHNOLOGY IN BUILDINGS TODAY

The 4IR has brought on a radical paradigm shift to the world of engineering, starting the age of digitalisation in almost every industry. The advances have culminated in an ecosystem of IoT, which is described by Wikipedia as a system of interrelated computing devices, mechanical and digital machines, objects, animals or people provided with Unique Identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

Already, most buildings have some form of Building Management System (BMS) or Building Automation System (BAS), which enables the monitoring and control of the building remotely. Most of the time, this is limited to the power supply, air-conditioning and lighting systems. IoT takes this one step further by connecting these systems as well as other disparate systems (fire-fighting systems, lift, CCTV, and card access systems in the building) to the internet, literally putting the entire building online.



Source: UEM Edgenta

When a digital power meter goes online, it can send up to 30-40 pieces of information per second, depending on the model and make. The same goes for an air-conditioning chiller, which can send up to 150 parameters per second. Data extracted from these and various other systems is streamed over the internet and into the cloud (see diagram). This data then needs to be interpreted and in the cloud, the data is structured and aggregated for the purpose of data analytics.

Data in the cloud is analysed using the various algorithms available, to produce business and operational insights. Some of the more complex algorithms include anomaly detection and machine learning. Anomaly detection studies data on unusual events that's not consistent with the streaming data. The fault detection is then investigated to identify the root cause for immediate rectification. Machine learning on the other hand, analyses historical data to predict possible future outcomes so that potential failures can be detected and avoided altogether. Real-time streaming and analytics of data enables the reduction of time-based preventive maintenance works and encourages more condition-based and predictive maintenance works.

Source: UEM Edgenta

One important aspect of analytics is the visualisation of the data and insights on a dashboard (see picture above). The dashboard is accessible on a computer, tablet or mobile device and it can be accessed anytime and anywhere in the world via an internet connection. Its capabilities are not limited to monitoring but also includes control as well, depending on the authorisation level. All these and more can be done in the cloud.

Cloud computing, the enabling engine for IoT, allows for interaction of data between different systems such as using the card access system data to control the air-conditioning and lighting systems based on the detected presence of occupants. A rule-based engine can be built on the cloud and programmed to monitor all the sensors in the buildings with a call to action when the readings exceed the threshold. Building operation rules can be written to enable simple functions such as switching on the air-conditioning or switching off the lights automatically. Programming the rule-based engine to instruct a building to generate its own

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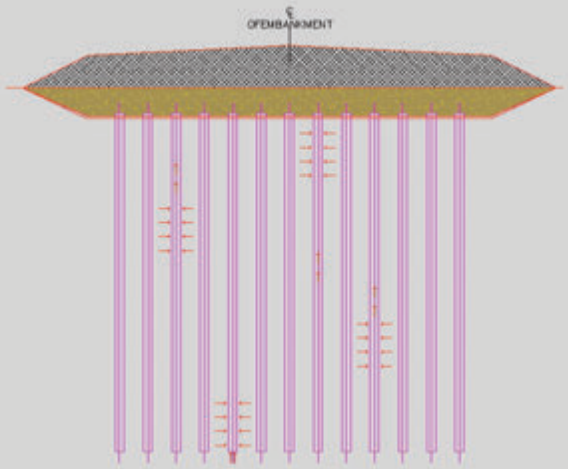

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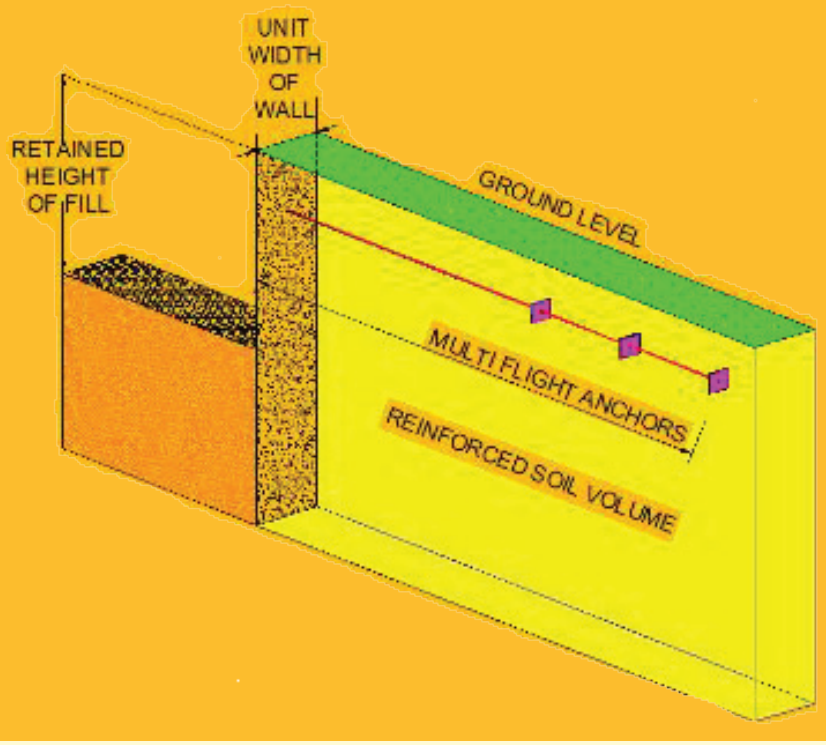

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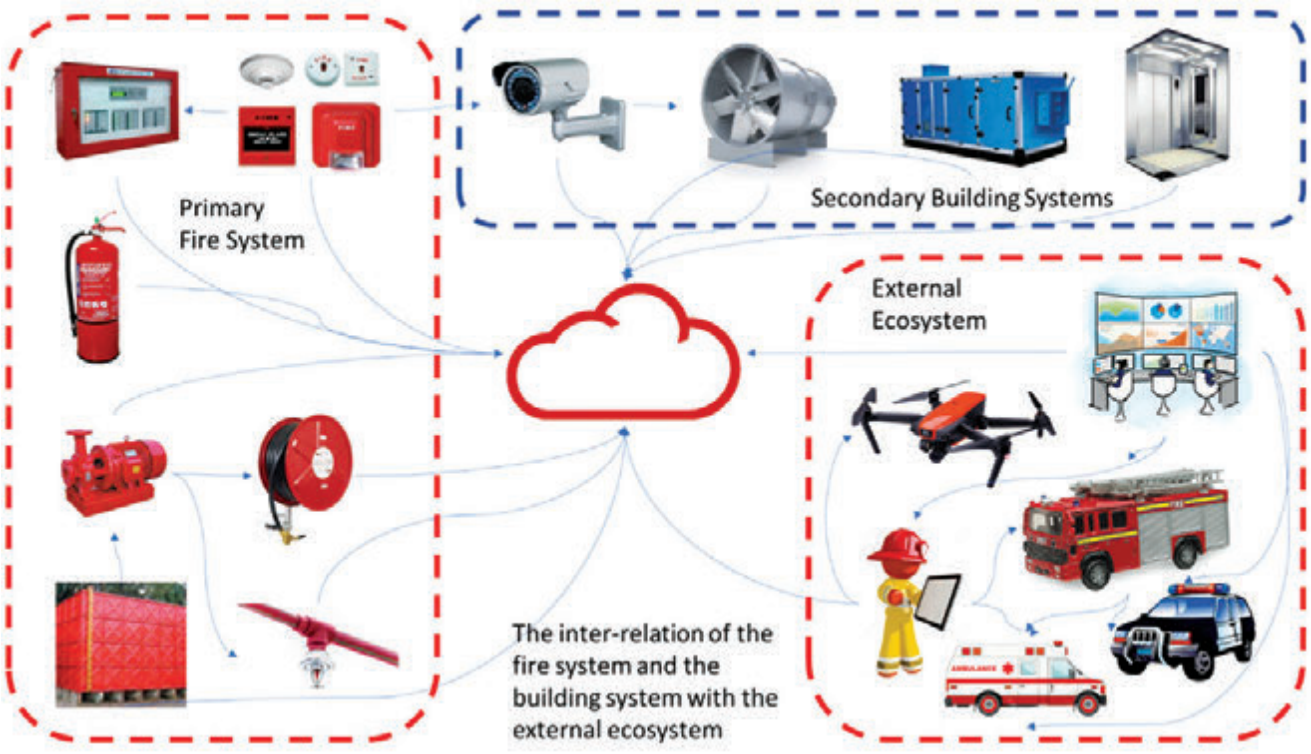

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work orders and to assign it to the respective technicians can bring it one-step closer to building artificial intelligence.

The main risk is cybersecurity, so network security must be addressed with a virtual private network with the necessary firewalls, anti-virus and anti-spyware. Information security must be protected by cryptography and user authentication while application security must be enhanced by session management and input parameter validation. Disaster recovery will require risk assessment along with the back-up storage. Cybersecurity concerns must have a concrete plan and implementation.

The application of IoT in buildings in Malaysia is still in its infancy. It is mostly a manufacturer-driven market and new products are getting more and more sophisticated in terms of technology. New buildings will be inherently designed to use more digital applications while the retrofit of older buildings is subject to the owner's appetite for smart buildings. Nevertheless, the rapid advancements in technology will definitely be a driving force for smarter buildings in Malaysia within the next decade or two.

IMPLICATIONS OF IoT IN FIRE MANAGEMENT

Safety has always been a priority requirement in building design and construction. Technology is increasingly being used to enhance the safety of occupants and these include newer fire detection and prevention systems.

A conventional fire detection system refers to smoke and heat detectors connected to the fire alarm panel and fire alarm notification system while fire prevention systems include the standard fire extinguishers, hose reel systems and sprinklers. The influence of technology on these systems can be categorised into the advancement of each system on its own, the inter-relation of these systems with other building systems and the interaction of these systems with the external ecosystem (see diagram above).

Firstly, on its own, each system can be enhanced by applying IoT technology on the various components. The most basic, primary fire-fighting equipment is the fire extinguisher. Most buildings and facilities have fire extinguishers located at various spots according to Bomba guidelines and building requirements. These need to be checked periodically to ensure they are in good, working condition.

With IoT, new fire extinguishers can be fitted with a digital pressure gauge, which will send a signal should the pressure in the canister drop, so that immediate rectification or replacement is done. An electronic tether can hold the fire extinguisher in place and trip a circuit when it is removed from its position or tampered with. A proximity sensor can even be installed to ensure that nothing blocks the fire extinguisher and that it is accessible when needed. When the fire extinguisher is used, it will immediately trigger sensors to send an alarm via a network that connects all, to alert authorised personnel in real-time to take immediate action or make an emergency call.

Similarly, hose reels can also be fitted with sensors to detect tamper or use. Water flow sensors and digital pressure gauges on the sprinkler pipeline will provide

relevant information on the integrity and readiness of the system. The same applies to the water tanks; Sensors can be installed to ensure the required water capacity is available and to trigger an alarm if it's not. Pumps can be connected online and programmed to run at intervals and to self-check various parameters to determine if everything is operating at optimum level. If an anomaly is detected, the system can trigger an alarm to the relevant personnel who can then remotely operate the pump or check it in person.

All these systems will be connected to the same network as the smoke and heat detectors and fire alarm panels. These will enable the management, operations and maintenance of such critical systems in real-time and ensure a high degree of uptime. Since all these systems are connected and always online, any failure can be immediately detected in real-time and rectifications carried out swiftly.

Secondly, independent fire-fighting systems can be programmed to work with other systems in the building. For example, a trigger on any of the smoke or heat detectors will activate the CCTV to focus on that direction and allow video analytics to determine if there is smoke or a fire. If so, the system can automatically activate sprinklers or the fire suppression system remotely. At the same time, the smoke spill system can be activated, the air-conditioning/ventilation system shut down, the power supply to certain areas switched off and lifts called to the ground floor. An alarm can be sent to the relevant authorities/personnel and an alert to the building occupants via siren, signages or even a pre-recorded message on the PA system.

IoT connects all these devices via the wired or wireless network and sends data to the cloud whereby algorithms such as machine learning, anomaly detection, predictive analytics and video analytics are deployed to analyse the event and call for action. The action is governed by a rule-based engine built on the cloud, which then sends a command to the actuator to react accordingly, based on the analysed information. The ability of the system to perform all these functions is known as artificial intelligence.

Thirdly, the interaction of the building with the external ecosystem can be a game changer for Bomba as it will be able to monitor all connected facilities and respond in real-time in an emergency. A connected building will be able to provide critical mapping information to enable firefighters to easily navigate to the building as well as identify the location of the triggered alarm. Access to such information will enable them to pre-plan their rescue entry plan en route to the scene.

At the scene, information from the lift system will be useful in helping firemen manoeuvre their way into the building or to use the lifts to rescue occupants. Connected systems such as the card access system will provide vital information such as the number of people in the building and the last known location of those trapped inside. Firefighters can also access the CCTV system to "see" the danger zone and remotely control the smart building fire suppression system to activate directed extinguishing at specific areas.

In future, firefighters will communicate and use sensors to track the movement of rescue personnel in a burning building and fire engines will be wi-fi hotspots for operating digital devices used in rescue operations. All information can be shared with various rescue agencies, including police personnel, first responders, ambulance services and hospitals.

In time, robots and drones fitted with cameras can be remotely controlled to aid in fire extinguishing or to deliver face masks, blankets or oxygen canisters to trapped victims. However, advances in technology come with a caution; cybersecurity issues must be addressed while fire standards, guidelines and regulations must keep up with technology changes accordingly.

CONCLUSION

With the 4IR, there has been tremendous advancement in IoT, sensors and digital applications. As fire safety cannot be compromised, technology is constantly being applied to improve the ability to detect and prevent fires as well as manage emergencies. In Malaysia, it is important that stakeholders come together to set the base standard for technology requirements in fire detection and prevention systems. This will then be an impetus for the widespread adoption of more technologically advanced fire-fighting systems within the local building industry. ■

Author's Biodata

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UPCOMING ACTIVITIES

2-Day Seminar on "High Performance Chiller Plant"

Date	: 17 – 18 January 2020 (Friday – Saturday)
Time	: 9.00 a.m. – 5.30 p.m.
Venue	: Wisma IEM
Approved CPD	: Applying
Speaker	: Mr. Yow Kuan Yee

1-Day Course on "Project Risk Management"

Date	: 19 February 2020 (Wednesday)
Time	: 9.00 a.m. – 5.30 p.m.
Venue	: Wisma IEM
Approved CPD	: 6.5
Speaker	: Ir. Faizal Abdullah Sanusi

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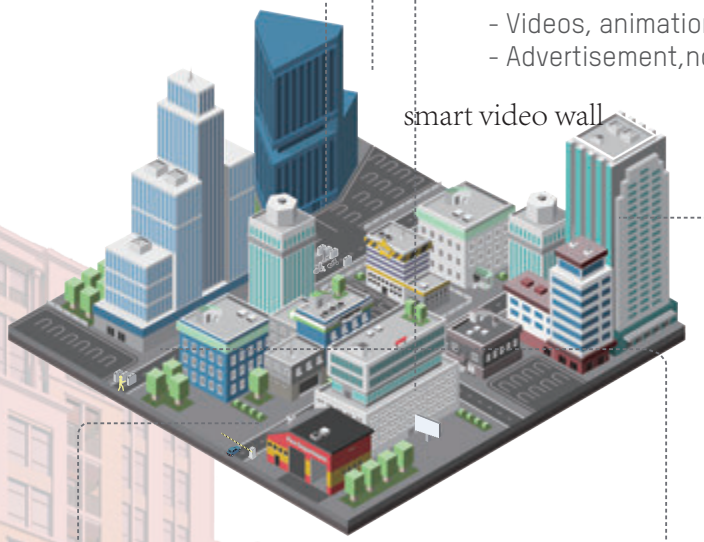

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WORLD TUNNEL CONGRESS 2020: AN EXTRAORDINARY EVENT


by Ir. Dr Ooi Teik Aun


Ir. Khoo Chee Min


Ir. Dr Wang Hong Kok

With the recent handing over of the ITA-AITES flag to Malaysia, the annual World Tunnel Congress (WTC), a global gathering of the greatest tunnelling minds and experts, will next convene on our home ground in 2020 [1].

On 20 June 2017, it was breaking news when The Institution of Engineers, Malaysia (IEM) came into the limelight with The Star headline, "Malaysia Wins Bid To Host World Tunnel Congress In 2020" [2]. Bidding for the prestigious event is held three years in advance. The 2 rounds of voting took place at the 43rd ITA-AITES (International Tunnelling & Underground Space Association) General Assembly in Bergen, Norway, where Malaysia beat two other contenders, Australia and India, for the honour. The minutiae were reported by the principal author in *JURUTERA*, September 2017 [3].

Ir. Dr Ooi Teik Aun's dream to host the World Tunnel Congress dated back to the WTC2012 in Bangkok. In *JURUTERA*, June 2017 [4], the co-authors published an article titled "Aspiring to Organise World Tunnel Congress 2020: A Vision". With the support and dedication of all IEM members, this dream has now been realised. However, it comes with high expectations and great challenges.

Ir. Dr Ooi Teik Aun (right), Ir. David Lai Kong Phooi (left) and Anna Ceppaluni (Honorary Consul of Malaysia, second from right) receiving the ITA-AITES flag from Andrea Pigorini (Italian Tunnelling Society, SIG President, Italy)

Here, we will attempt to review the background, development of WTC2020 and share the expectations and challenges of organising this world class event.

ITA-AITES & WORLD TUNNEL CONGRESS (WTC)

Founded in 1974, the International Tunnelling & Underground Space Association (ITA-AITES) is the leading international organisation promoting the use of tunnels and underground space through knowledge sharing and application of technology. Presently, ITA-AITES has 78 Member Nations and 266 corporate or individual Affiliate Members. The Tunnelling & Underground Space Technical Division (TUSTD) of IEM was endorsed as the 50th Member Nation of ITA-AITES at the General Assembly in Durban in May 2000. TUSTD was inaugurated on 28 February 2000 with the encouragement of ITA-AITES.

Each year, ITA-AITES holds both its General Assembly meeting and the World Tunnel Congress in a different Member Nation. WTC is the world's leading tunnelling congress, with the largest number of tunnelling professionals. It offers an ideal platform to encourage industry learning and growth with its extensive reach and influence across the globe. Refer to map (see Figure 1) for the host countries of past WTCs.

WHY BID FOR WTC2020?

With its team of dedicated members, IEM TUSTD had worked very hard over the last 20 years to promote Malaysia in the tunnelling world. *JURUTERA* Bulletin, in its July 2018 issue championed by TUSTD, dedicated the theme to "The rise of tunnelling in Malaysia through advances in innovations and technologies."

Over the years, it was TUSTD's aim to showcase our nation's achievements in tunnel technology such as the Variable Density Tunnel Boring Machine (VD TBM) which was invented to overcome the sinkhole and blowout problems

Ed.	Year	Host Country	City	Ed.	Year	Host Country	City	Ed.	Year	Host Country	City
In.	1974	Norway	Oslo	16th	1990	China P.R.	Chengdu	32nd	2006	Republic of Korea	Seoul
1st	1975	Germany	Munich	17th	1991	United Kingdom	London	33rd	2007	Czech Republic	Prague
2nd	1976	United Kingdom	London	18th	1992	Mexico	Acapulco	34th	2008	India	Agra
3rd	1977	Sweden	Stockholm	19th	1993	Netherlands	Amsterdam	35th	2009	Hungary	Budapest
4th	1978	Japan	Tokyo	20th	1994	Egypt	Cairo	36th	2010	Canada	Vancouver, BC
5th	1979	U.S.A.	Atlanta, GA	21st	1995	Germany	Stuttgart	37th	2011	Finland	Helsinki
6th	1980	Belgium	Brussels	22nd	1996	U.S.A.	Washington, DC	38th	2012	Thailand	Bangkok
7th	1981	France	Nice	23rd	1997	Austria	Vienna	39th	2013	Switzerland	Geneva
8th	1982	United Kingdom	Brighton, Sussex	24th	1998	Brazil	Sao Paulo	40th	2014	Brazil	Foz Do Iguacu
9th	1983	Poland	Warsaw	25th	1999	Norway	Oslo	41st	2015	Croatia	Dubrovnik
10th	1984	Venezuela	Caracas	26th	2000	South Africa	Durban	42nd	2016	U.S.A.	San Francisco, CA
11th	1985	Czech Republic	Prague	27th	2001	Italy	Milan	43rd	2017	Norway	Bergen
12th	1986	Italy	Florence	28th	2002	Australia	Sydney, NSW	44th	2018	United Arab E.	Dubai
13th	1987	Australia	Melbourne, VIC	29th	2003	Netherlands	Amsterdam	45th	2019	Italy	Naples
14th	1988	Spain	Madrid	30th	2004	Singapore	Singapore	46th	2020	Malaysia	Kuala Lumpur
15th	1989	Canada	Toronto, ON	31st	2005	Turkey	Istanbul				

Figure 1: Host countries of past World Tunnel Congresses

encountered in the SMART project when tunnelling through the KL Limestone Formation [5]. This machine, a first-of-its-kind in the world, was jointly developed by MMC-Gamuda and Herrenknecht, a German TBM manufacturer.

Our industry was ready to join the ranks of the world league in tunnelling [6], so it was no surprise when IEM submitted a bid to host the ITA-AITES World Tunnel Congress 2020 in Malaysia.

"When we judge by the progress in the use of underground space in Malaysia, the progress has been remarkable. This is an indication of the fact that Malaysian professionals have not only learnt from their trainings, but most importantly, have developed their own expertise to come up with ingenious underground solutions to their problems," said Prof. Tarcisio B. Celestino, the immediate Past President of ITA-AITES.

Evidently, WTC2020 brings enormous benefits to our professional community and country. Benefits to the professional community include networking with colleagues, state-of-the-art information, business exchanges and co-operations, business opportunities and maximising attendance from members of the local profession due to the low cost of attendance as compared with offshore congresses.

Interest is also generated among delegates about both the host country and city, often for the first time and they will be keen to learn about the geographic location, climate, attractions, cultures, cuisine and people. While delegates attend congresses with the aim of networking and increasing their knowledge and skills, they are also attracted by the appeal of the destination. The benefits to both the city and country are accompanying tours which boost local incomes, an increase in tax revenues from commerce (shops, restaurants, hotels etc.), an increase in GDP for the country, an increase in the number of tourists and word-of-mouth marketing when delegates tell friends back home about their favourable experiences in the city and country. [7]

DECADE OF GROUNDWORK

"In line with IEM's mission to create a platform towards nation building and striving to enhance society's consciousness on science and technology, hosting WTC2020 and ITA-AITES general assembly will be

conducive to the attainment of its objectives," said Ir. Dr Ooi, organising chairman of WTC2020 [2].

IEM has had vast event organising experiences since the 1970s, having successfully organised international conferences, workshops, seminars and other training programmes. In 2006, IEM TUSTD organised the first International Conference and Exhibition on Tunnelling & Underground Space (ICETUS2006) to coincide with the opening of the SMART Tunnel. In 2011, it organised ICETUS2011 in conjunction with the launch of Interstate Pahang-Selangor Raw Water Transfer project. More recently, it organised ICETUS2015 to coincide with the substantial completion of KVMRT-SBK Line.

In 2010, Ir. Dr Ooi attended WTC2010 in Vancouver where the first Asian ITA-AITES President, Prof. In-Mo Lee from Korea, was elected. IEM TUSTD was the kingmaker. In 2012, he attended WTC2012 in Bangkok and presented a Malaysia tunnelling report; feelers were sent out to bid for WTC2016. However, Prof. In-Mo Lee's advice was to not contest as America was interested. Then Ir. Dr Ooi attended WTC2016 in San Francisco and expressed IEM TUSTD's intention to bid for WTC2020. Upon his return, the IEM WTC2020 Bidding Committee was set up under TUSTD and the hard work began.

The actual work started years before the pre-bid conference was held, from the moment IEM informed the governmental institution, MyCEB, about its intention. A chain reaction was created as everyone involved focused on the goal: To win the bid for the city and the country.

In January 2017, IEM TUSTD submitted the official bid to the ITA-AITES executive council. In April 2017, prior to the 43rd ITA-AITES General Assembly in Bergen, IEM had organised the first Southeast Asian Conference and Exhibition in Tunnelling & Underground Space (SEACETUS). ITA-AITES Member Nations in Southeast Asia and other parts of the world were actively solicited for their support and their vote for Malaysia.

The efforts by the committee members to promote IEM prior to the General Assembly in Bergen was instrumental in winning the bid. They participated in various activities and conferences overseas with promotions in San Francisco (April, 2016) by Ir. Dr Ooi Teik Aun, in Singapore (Nov, 2016) by Ir. Khoo Chee Min, in Dubai (Feb, 2017) by Ir. Frankie Cheah and Ir. Dr Rini Asnida Abdullah, in Myanmar (March, 2017) by Ir. Ong Sang Woh and in Croatia (May, 2017) by Ir. Neo Boon Kheng and Ir. Syed R. Hussain.

POST-AWARD EXPECTATIONS

For the first time, IEM will be hosting such a prestigious world-class event. From planning the agenda to choosing the speakers and rolling out a promotional campaign, there are several challenges that need to be considered. Since 2017, IEM had started preparation works to ensure WTC2020 will be a success story for Malaysia!

An executive organising committee (EOC) was formed under the supervision and leadership of Ir. Dr Ooi, the organising chairman. It comprised experienced members of TUSTD, other volunteers from IEM and the dedicated staff members of IEM Training Centre/Academy. An advisory board was formed along the lines of WTC2020 & ITA-AITES General Assembly through invitation from EOC and its members consisted of the ITA-AITES Executive Council and International Advisory Committee and National Advisory Committee to achieve a high standard of preparedness so as to ensure the programme for WTC2020, Kuala Lumpur, would be fulfilled. The event is fully managed by IEM Training Centre Sdn. Bhd. and IEM Academy Sdn. Bhd.

It is our obligation to meet the requirements set out in the ITA-AITES By-Laws in organising the World Tunnel Congress 2020, to provide good quality contents for lecture sessions and to make it a memorable congress for delegates coming from all corners of the world. The EOC made its presence at the WTC & ITA-AITES General Assembly yearly prior to WTC2020, to secure maximum sponsorship, delegates boosting and event promotion to increase event reach with international mindfulness.

In order to deliver a successful WTC2020 in Kuala Lumpur, the organising committee continued its efforts to organise SEASET2018 and PSCTUS2019 to boost the impact on local attendance and to ramp up registration of local delegates for the event. A regional young member tunnelling symposium is in the pipeline for the first quarter of 2020, prior to WTC2020.

Now is also the right time for the EOC to demonstrate and deliver the importance of the bid subject, the number of delegates expected, the benefits the congress will bring and what this represents in financial terms to the local economy, the number of people who will be involved in the process and, last but not least, the opportunity to show the world how wonderful our country, city and people are!

For benchmarking and based on recent past WTCs, the target is 1,500-2,000 delegates (See Figure 2 on next page). The recently-concluded WTC2019 in Naples, Italy, saw an impressive turnout of 2,700 delegates though the event was planned for only 1,600, based on the WTC2017 turnout in Bergen, Norway.

At the close of submission of abstracts on 30 June 2019, a total of 638 abstracts covering a wide range of topics had been received from all over the world. In terms of exhibition, 70% of the 200 exhibition booths have been taken up by various industry players, both locally and internationally.

"The 7-day event is expected to generate an economic impact of close to RM21 million from more than 1,500 delegates," said Datuk Zulkefli Hj. Sharif, CEO of MyCEB [8].

IEM is proud to be carrying the Jalur Gemilang when it hosts WTC2020 on 15-21 May 2020 at the Kuala Lumpur Convention Centre. As branding plays a key part, the theme for WTC2020, "Innovation Sustainable Underground Serving Global Connectivity", has been conscientiously and aptly chosen to timely reflect the innovation achievements of ITA-AITES in promoting the use of tunnels and underground

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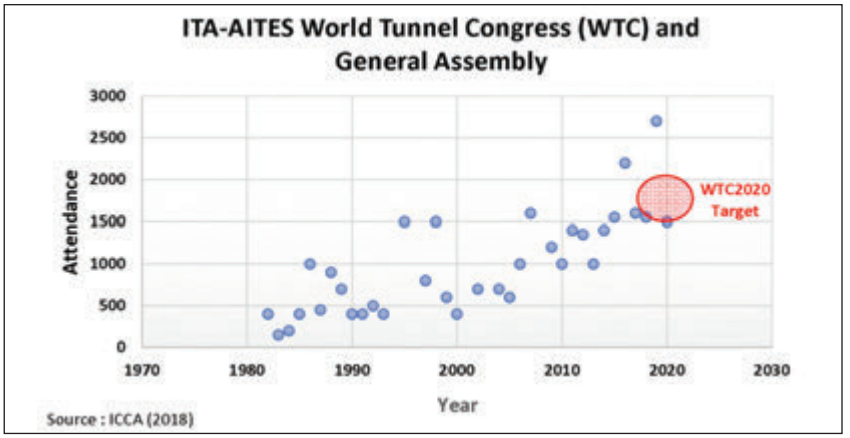

Figure 2: Number of delegates who attended past WTCs

space for the benefit of the people, environment and sustainable development for the past 5 decades.

It is more than a slogan for ITA-AITES and its Member Nations. It is a challenge and commitment to contribute to sustainable development. It is our great honour to share with the global tunnelling fraternity our country's success story in innovative tunnelling and underground solutions. The encouragement of the innovation and sustainable development in the organisation of WTC, and the technical presentations, is a key theme. We will be delighted if we can spark the interest of a whole new generation in the work and achievements of ITA-AITES. ■

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Authors' Biodata

A pioneer in geotechnical engineering, **Ir. Dr Ooi Teik Aun** is Director of IEM Training Centre Sdn. Bhd. and IEM Academy Sdn. Bhd., practising Consulting Engineer, Arbitrator and an Adjudicator. He is the Organising Chairman of World Tunnel Congress (WTC) 2020 and Executive Council Member of the International Tunnelling & Underground Space Association (ITA).

Ir. Khoo Chee Min is currently serving as Chairman of IEM Tunnelling & Underground Space Technical Division (TUSTD) and Deputy Organising Chairman of World Tunnel Congress (WTC) 2020.

Ir. Dr Wang Hong Kok is Vice President, IEM (2019/2021) and principal lecturer at TAR University College.

TROJAN HORSE OF CANAKKALE

Ir. Lau Tai Onn

Ir. Lau Tai Onn *a retired Civil & Structural Engineer. He is the secretary of IEM's Standing Committee on Information & Publications (since 2007).*

On the seafront of Canakkale (an ancient city of Troy), in north-west Turkey, stands The Trojan Horse, a tourist attraction that I recently visited on November 1, 2019. The Trojan Horse is part of the story of the Trojan War between the Achaeans (Greeks) and the Trojans, as narrated by ancient Greek poet Homer in his two epic poems, The Iliad and The Odyssey.

After a fruitless 10-year siege, the Greeks constructed a huge hollow wooden horse (the horse being the emblem of Troy), hid an elite force inside and pretended to sail away. The Trojans pulled the horse into their city as a victory trophy. That night the Greek warriors crept out of the horse and opened the gates for the rest of the Greek army to enter and destroy the city of Troy, thus ending the war.

Today, a Trojan Horse metaphorically refers to tricky subversion introduced from the outside; it is also the name of a malicious online programme that tricks users into downloading it so to damage the programming or to steal personal information.

Though the Canakkale Trojan Horse is made of iron struts and fibreglass, it looks as if it is made of scraps of wood from Greek ships and there are ropes wrapped around the legs. It is 11.4m tall, weighs 9,979 kg and has been on display in Canakkale, next to Moorabbin Park, since September 15, 2004. It was a gift from Brad Pitt who played the leading role of the Greek warrior Achilles in the 2004 movie, Troy. ■

VISIT TO PUSAT PENYELIDIKAN KEBOMBAAN (FIRE RESEARCH CENTRE)

by Ir. Gary Lim Eng Hwa

On 23 October 2019, Ir. Tan Chew organised a visit to Pusat Penyelidikan Kebombaan (PUSPEK) or Fire Research Centre for 15 participants, including 3 committee members of Building Services Technical Division (BSTD).

Fire Supt. Jasni Ali briefed the visitors on PUSPEK, the first fire research centre in the country. It was opened by the Minister of Housing & Local Government, on 24 October 2014.

There are four research buildings and laboratories on 20 acres of land. Research & Planning Division/PUSPEK is now a division of Fire Rescue Department Malaysia (FRDM).

PUSPEK's vision is to be a centre of excellence on fire research and development and its mission is to implement the research of science, technology and innovation of professional benefits to increase the effectiveness of FRDM and the industry. PUSPEK has formed an Internal Innovation section to encourage all its officers to apply their creativity to matters related to fire prevention and protection. It has developed a few successful innovations, such as an application using detectors to sense LPG gas and to alert the person-in-charge of the building services via a handphone.

PUSPEK has four sections: Operational Research, Rescue Research, Fire Fighting System Research and Fire Behaviour Research.

At the Fire Behaviour Research Centre, fundamental testing of materials like fire doors are done to obtain the performance as required in the related Malaysian standards for example MS1601: Specification For Fire Resistant Doorsets. The Fire Testing Furnace, which is flexible in the setup, can test both horizontal and vertical specimens (see photographs of the internal Fire Testing Furnace).

PUSPEK now handles approvals for building materials and currently, there are 26 categories including the new external cladding system. Related products, especially those tested at foreign testing laboratories, will be randomly tested here before they are approved.

Installed fire doors are tested using the Fire Testing Furnace. This set-up is then mounted to the front of the Fire Testing Furnace to stimulate an actual site installation. ◄

► *Fire Testing Furnace showing the heat probes along the vertical and horizontal planes. On the side is the heat source using gas. The back section is the vision panel while the bottom is the exhaust of the furnace.*

During a Bomba inspection, site samplings collected will be tested and manufacturers of building materials seeking approval for their products, can refer to Garis Panduan Prosedur Perakuan Bahan Binaan & Alat Pepasangan Keselamatan Kebakaran.

Other testing facilities are Fire Suppression Testing Chamber (Total Flooding Suppression Testing), Room Corner Test/Dual-Cone Calorimeter (Fire Sizing/HRR), Halon Bank and Full Range of Fabric Testing. PUSPEK also collaborates with local universities and testing laboratories such as SIRIM which utilise PUSPEK facilities to carry out their research works jointly with any of the 4 sections in PUSPEK. ■

DECOUPLED CHILLED WATER SYSTEM VS. VPF & DAIKIN APPLIED FACTORY VISIT

by Ir. Yong Gee Suan

IEM's Building Services Technical Division and Daikin Applied Sdn. Bhd. organised a one-day seminar on Decoupled Chilled Water System vs. Variable Primary Flow System, which included a visit to the new Daikin Applied Factory in Shah Alam on 8 August 2019.

Daikin Refrigerant Shah Alam Sdn. Bhd. (DRM-SA) is a near-to-market approach (factory built nearer to Asia Oceania countries) by Daikin Industry Limited, Japan, since 2014, to locate factories that not only fulfill the equipment supply in Asia Oceania, but also to provide a better lead time, faster spare part supply and sharing of technical know-how with engineers and customers using the chilled water system.

The Shah Alam factory, spread over 40,283 sq m with a built-up area of 20,665 sq m, is capable of producing at least 500 chillers and 5,000 units of Air Handling Unit (AHU) annually. DRM-SA has also built an international Air Conditioning, Heating & Refrigeration Institute certified test stand that is able to certify the chiller performance base on customer application condition.

The seminar speaker, Dr ZhaoXi Jing, spoke on two popular chilled water systems – primary secondary system and variable primary flow system – and compared their design considerations, benefits and disadvantages.

He also addressed the application consideration, chiller sequencing strategy, flow requirement and control in VPF as well as building low delta temp syndrome.

As the seminar has been well received by leading consulting firms from the industry, Daikin is be planning to organise more such training and workshops in 2020. ■

Visit to Daikin Refrigeration Shah Alam Sdn. Bhd.

VISIT TO TUANKU JA'AFAR POWER STATION, PORT DICKSON

by Ir. Dr Oh Seong Por

On 7 October 2019, The Institution of Engineers, Malaysia, Negeri Sembilan Branch (IEMNS) organised a technical visit to Tuanku Ja'afar Power Station (TJPS) in Port Dickson. Led by IEMNS Chairman Ir. Dr Oh Seong Por, the 54 participants, comprising members from IEMNS, local industries, Technical Association Malaysia (TAM) and students, spent half a day touring the iconic station.

The Tuanku Ja'afar Power Station in Port Dickson

The group arrived at the station at 10 a.m. and was greeted by Ir. Mohd Zaiddy bin Mat Rajali (manager, Customer Service) who introduced the station's top management team members – Enck Zulkifli bin Jaafar Sidek (head of TJPS), Ir. Muhammad Azhari bin Mustaffa (head of Production), Encik Mohd Annuar bin Mohd Yusoff (senior manager, Business & Support) and Ir. Prem Rakesh (staff engineer).

The participants also enjoyed a tea reception before they were ushered to the conference room where Encik Zulkifli gave a brief explanation about the station. He said TJPS was established in 1969 as a conventional thermal power plant that used fuel oil to generate 600MW. In 2000, the plant was rehabilitated in stages and replaced with a combined cycle which fired natural gas supplied by Petronas and was supported by distillate (diesel) as standby fuel.

The 1st stage (PD1) was commissioned in 2005 and the 2nd stage (PD2) was completed in 2009. The combined power generation design capacity is 1500MW. Encik Zulkifli explained that sea water is pumped into the station and used to cool the condenser of the steam turbine system as well as the closed-circuit cooling of equipment. The sea water passes through the equipment and is discharged back into the sea at higher temperatures of 36-37° Celsius but without disrupting the marine eco-system.

He said the TJPS management places top priority on keeping the workplace safe and on protecting the environment, including managing nitrogen oxide NOx emission at 25ppm which is much lower than the permissible limit set by the Department of Environment.

Then Ir. Prem Rakesh presented the technical aspect of the station (as illustrated in Figure 1).

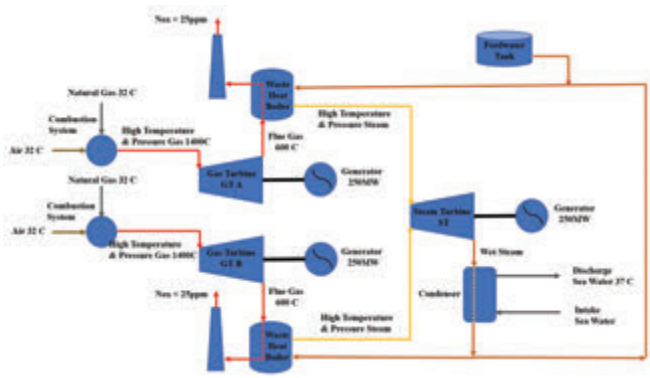

Figure 1: The TJPS Power Generation System

Each PD1 and PD2 has 2 gas turbines (GT A and GT B) and a steam turbine (ST) to turn separate generators. Compressed air and fuel (natural gas) are combusted to produce high temperatures (1400° Celsius) and high pressure gas, sufficient to turn the gas turbine to run the generator. Flue gas that leaves the gar turbine has a huge pressure drop but the temperature is relatively high at 600° Celsius. It is directed to the waste heat recovery boiler to

bring up superheat steam which is used to drive the steam turbine and generator.

In short, there are 2 stages of power generation: The 1st stage uses gas turbines and 2nd stage uses a steam turbine. The gas turbine and steam turbine generator are designed to produce 250MW. Therefore, PD1 and PD2 can generate 750MW each and the total combined power generation of TJPS is 1500MW. The average voltage generated is 15kV and this is stepped up to 275kV before it is supplied to the national grid. Table 1 shows the important assets of PD1 and PD2.

Plant	Asset	Specification	Manufacturer	Year	Current Output
PD1	Gas Turbine GT1A	M701F3, 250MW	Mitsubishi Hitachi Power	13th June 2005	226MW
	Gas Turbine GT1B	M701F3, 250MW	Mitsubishi Hitachi Power	13th June 2005	220MW
	Steam Turbine ST1		Mitsubishi Hitachi Power	13th June 2005	250MW
PD2	Gas Turbine GT2A	9FA3, 250MW	General Electric	24th Jan 2009	222MW
	Gas Turbine GT2B	9FA3, 250MW	General Electric	24th Jan 2009	222MW
	Steam Turbine ST2		Toshiba	24th Jan 2009	250MW

Table 1: Major assets of PD1 and PD2

After the presentation, the participants were divided into two groups to minimise congestion when entering power generation line. They were guided to see in closer detail the important processes and assets that were presented earlier. The first stop was the sea water intake station. Net filter systems are used to prevent fish from being sucked into the cooling system.

The power generation system is a compact integrated type comprising combustion chamber, compressor, gas turbine and generator. The system is monitored around the clock by technicians and engineers inside the central control room. According to Encik Mohd Annuar, the controlling technicians need to be trained constantly to maintain competency. Training is carried out in the simulator at the Excellence Development Centre inside the station.

With improved technology and higher automation, the station can be managed by only 170 personnel. The waste heat recovery system is a gigantic multi-storey steel structure that allows for vertical flue gas flow where heat is transferred to generate superheated steam.

The last stop was the sea water discharge station where we saw the clean water rushing back to the sea, whirling and leaving long trails of white bubbles. Although the station was rehabilitated 15 years ago, the assets and buildings were well maintained and clean with a pleasant environment. Without doubt, this fits the TJPS slogan: "A Great Place Where We Enjoy Working Together".

The participants were then invited to a group photo session with the TJPS management team at the front of the administration building before they departed at 1 p.m. They expressed satisfaction about the visit and left with a good impression of TJPS.

Meanwhile, Ir. Dr Oh Seong Por stayed on to deliver a 2-hour talk on The Route to Professional Engineer to the young engineers of TJPS, in a reciprocal gesture for the warm hospitality shown by TJPS. ■

The TJPS management team and the participants

In the Central Control Room

Ir. Prem Rakesh guiding the participants on a tour of the facilities

In the conference room: Front row (left to right) Ir. Muhammad Azahari bin Mustaffa, Encik Zulkifli bin Jaafar Sidek, Ir. Dr Oh Seong Por and Ir. Mohd Zaiddy bin Mat Rajali

UM WINS FIRST DIGITAL AGTECH HACKATHON

by Ir. Dr David Chuah Joon Huang

A team of year four electrical engineering students from the University of Malaya (UM) won first prize in the 1st Digital Agtech Hackathon in Malaysia. The team members were Cha Zhi Yong, Koay Hong Vin, Ng Tarng Jian and Rahulraj Singh.

The aim of the hackathon, organised by Malaysia Digital Economy Corporation (MDEC), was to develop a chili grading application on the mobile or web platform and then sell it as a business idea. The team with the best chili grading accuracy and business pitch would be declared winner.

With continuous support and advice from Ir. Dr David Chuah Joon Huang, the UM team developed a machine learning model to perform the chili grading. Using graded sample chili data provided by MDEC and various data augmenting algorithms, the team managed to achieve an accuracy of 95%. Coupled with a business idea that would bring the technology to all farmers in the country, the team managed to secure first place and take home the cash prize of RM5,000.

Of the 30 teams participating in the hackathon, 11 teams were from institutions of higher learning while one team was from a secondary school and the rest from external business corporations. ■

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Updated May 2018

RAINBOW ROADS TO ATACAMA DESERT

Ir. Chin Mee Poon

***Ir. Chin Mee Poon** is a retired civil engineer who derives a great deal of joy and satisfaction from travelling to different parts of the globe, capturing fascinating insights of the places and people he encounters and sharing his experiences with others through his photographs and writing.*

Atacama Desert, sandwiched between the Andes mountain range and the Chilean Coast Range, stretches 1,600km over the northern third of Chile. Occupying an area of 105,000 sq km, it is one of the driest places on earth. The greatly varying landscapes, ranging from bizarre moonlike rock formations to palette-like salt lakes and high altitude geyser fields, attract tourists from all over the world and the pre-Columbian adobe village of San Pedro de Atacama is undoubtedly one of the most convenient gateways to the enchanting world of Atacama.

My brother, Mee Sin, and I, together with our wives, hired a car and drove from Salta in north Argentina to San Pedro de Atacama, a distance of 633km. After spending 3 days exploring Atacama Desert, we chose to drive back to Argentina by another route. Both routes were spectacularly beautiful, and I call them the "rainbow roads to Atacama Desert".

It was mid-April 2019, autumn in the southern hemisphere. With Mee Sin at the wheel, we left Salta and went north on the narrow and winding national road RN9 at 9 in the morning. We passed several police checkpoints.

Once on the RN51, however, the views became drastically different. There was no more forest. Instead, barren multi-hued mountains staggered into a kaleidoscope of colours, interspersed with sharp pinnacles that had resulted from eons of erosion. Giant cacti emerged as the dominant vegetation. Stony riverbeds became exposed in the dry season. Llamas, guanacos and donkeys wandered in search of grassy vegetation.

The road from Pumamarca to the border at Paso de Jama and on to San Pedro de Atacama was generally in very good conditions and there were several extremely beautiful salt flats on both sides of the border. Only one had water though and a few flamingos were seen foraging for food in the water.

We joined other tourists at Salinas Grandes, a vast salt flat measuring some 4,700 sq km at an altitude of 4,500m above sea level. The road cut right across the salt flat and the dazzling white plain extended from the road to the distant horizons.

Large and small figurines of camelids carved out of salt were put up for sale at the visitors' centre. Mining of salt was taking place at one corner of the vast salt flat. In the case of the other salt flats, the juxtaposition of phantasmagoric colours made them so atmospheric that they almost appeared to be surreal.

We went through the border control with hardly any hassle and in just half an hour, we were back on the road. Three days later, we visited the otherworldly Valle de la Luna in the morning and then left San Pedro de Atacama for Argentina. We opted for a different route, hoping to see more beautiful scenery on the way, and we were not disappointed.

Heading southeast on Road 23, we had lunch in the village of Socaire. Paso de Sico at the border was 120km away. The road led us through another part of the large Reserva Nacional Los Flamencos, and we crossed the Tropic of Capricorn, marked by a cross-shaped pole and a signboard by the road.

Later we came across several beautiful salt flats and an equally charming salt lake. All these were more than 4,000m above sea level. The air was crisp and the lighting ideal for photography. There was hardly any traffic on the road and we had the whole paradise to ourselves.

Other than the salt flats and lagoons, the road also wound its way in between rocky outcrops of various hues and colours which, together with the distant mountains, occasional groundcover vegetation and the blue sky, formed a patchwork of colossal scale and exceptional beauty that can only be produced by Mother Nature. ■

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57100	TAN KIAN GUAN	BE HONS (TAYLORS) (MECHANICAL, 2009) ME (BATH) (MECHANICAL, 2011)
74100	TEY MING REN	BE HONS (MALAYA) (MECHANICAL, 2013)
85122	ZAINON SHARMILA BINTI SHAMSUDDIN	BE HONS (UTM) (MECHANICAL, 1998) ME (UiTM) (MANAGEMANT ENGINEERING, 2010)
94161	ZUNAIDI BIN IBRAHIM	BE (MIE UNIVERSITY) (MECHANICAL, 1997) ME (MIE UNIVERSITY) (MECHATRONICS, 2003) PhD (MIE UNIVERSITY) (2006)
KEJURUTERAAN MEKATRONIK		
89713	YAM SENG HO	BE HONS (SYDNEY) (MECHATRONICS, 2006)
KEJURUTERAAN PEMBUATAN		
44597	ZULKARNAIN BIN ABDUL LATIFF	BE (BIRMINGHAM) (MANUFACTURING, 1998) MSc (UPM) (MANUFACTURING SYSTEM ENGINEERING, 2015)

PEMINDAHAN KEPADA AHLI (MELALUI PEPERIKSAAN PENILAIAN PROFESIONAL)

No. Ahli	Nama	Kelayakan
KEJURUTERAAN AWAM		
77642	ANG WEE CHUNG	BE HONS (SWINBURNE) (CIVIL, 2011) ME HONS (AUCKLAND) (CONSTRUCTION MANAGEMENT, 2015)
47057	MOHD ZAIDI BIN MOHAMAD SAAD	BE HONS (USM) (CIVIL, 2001)
KEJURUTERAAN ELEKTRIKAL		
53712	MARIAM BINTI MORTAZA	BE HONS (UTM) (ELECTRICAL, 2005) ME (MALAYA) (POWER SYSTEMS, 2017)
KEJURUTERAAN MEKANIKAL		
58659	TAN WAI HONG	BE HONS (UTAR) (MECHANICAL, 2011)
KEJURUTERAAN PETROLEUM		
25432	LEE CHEE MING	BE HONS (UTM) (PETROLEUM, 2002)

PERMOHONAN MENJADI AHLI KORPORAT

Nama	Kelayakan
KEJURUTERAAN AWAM	
ADNAN BIN AHMAD	BE HONS (BRADFORD) (CIVIL & STRUCTURAL, 1996)
AHMAD AZHAN BIN ISMAIL @ SUHAILI	BE HONS (UTM) (CIVIL, 2003)
DURRAH MUNIERAHHANIES AZIZAN	BE HONS (UTM) (CIVIL, 2005)
EKA KUSMAWATI BINTI SUPARMANTO	BE HONS (UTM) (CIVIL, 2005)
HASNAN BIN AB HAMID	BSc HONS (SALFORD) (CIVIL, 1983)
INTAN SALWANI BINTI ABDUL KADIR	BE HONS (UTM) (CIVIL, 2006)
ISMAIL BIN ABUSTAN	BSc (GEORGE WASHINGTON) (CIVIL, 1990) ME (NEW SOUTH WALES) (CIVIL, 1993)
IZWAN BIN JOHARI	BE HONS (USM) (CIVIL, 2004)
KHAIRUL ANWAR BIN ABDUL RAHMAN	BE HONS (UTHM) (CIVIL, 2007)
LOKMAN NUR HAKIM BIN ZAHARI	BE HONS (UiTM) (CIVIL, 2012)
MOHD AZIZI BIN ABDULLAH	BE HONS (UTM) (CIVIL, 2006)
MOHD HAILMEY BIN MUSTAFA	BE HONS (UTHM) (CIVIL, 2008)
MOHD HAIRUL BIN ABU BAKAR	BE HONS (UiTM) (CIVIL, 2009)
MOHD RUSDI BIN ABDULLAH	BE HONS (UTM) (CIVIL, 2002)
MOHD SUFYAN BIN SAUPI	BE HONS (UiTM) (CIVIL, 2010)
MOHD ZAFUAN ARIF BIN KADIM	BE HONS (UTM) (CIVIL, 2003)
MOHD ZAIN BIN ABD RAZAK	ADV. DIPLOMA (UiTM) (CIVIL, 1990)
MUHAMMAD JASNI BIN OTHMAN	BE HONS (UiTM) (CIVIL, 2004)
NAZURAH BINTI SULAIMAN	BE HONS (UTM) (CIVIL, 2009)
NUR INSYIRAHNADIA BT YAAKOP	BE HONS (UiTM) (CIVIL, 2012)
NUR NADZIRAH BINTI ROSLAN	BE HONS (UiTM) (CIVIL, 2013)
NURMAWADDAH BINTI MOHD IDRIS	BE HONS (UiTM) (CIVIL, 2006)
NURUL AINI BINTI MUHAMAD MOKHTAR	BE HONS (UiTM) (CIVIL, 2005)
OLIVER NGABONG ANAK JIMMY	BE HONS (UTM) (CIVIL, 2001) MSc (CURTIN) (PROJECT MANAGEMENT, 2014)
ONG WEE HONG	BE HONS (UPM) (CIVIL, 2008)
RAHAYU BINTI MD DIAH	BE HONS (UTM) (CIVIL, 2005)
RAHMAH BINTI ABDUL HALIM	BE HONS (UM) (CIVIL, 2006)
SHERLYE DONOL	BE HONS (MALAYA) (CIVIL, 2006)
SIM PEI KHIN, JESSICA	BE HONS (SWINBURNE) (CIVIL, 2013)
SITI ALESSA YAHYA	BE HONS (UTM) (CIVIL, 2006)
SITI HAWA BINTI JAAFAR	BE HONS (UiTM) (CIVIL, 2008)
SITI ZATI HANANI BINTI MAHAMOOD	BE HONS (UTM) (CIVIL, 2006)
TAN CHEK SIONG	BE HONS (LONDON) (CIVIL, 2001)
TAY LEE HUI	BE HONS (UTM) (CIVIL, 2005)
KEJURUTERAAN BAHAN	
ZURATUL AIN ABDUL HAMID	BE HONS (USM) (MATERIALS, 2001) MSc (USM) (MATERIALS, 2002) PhD (MELBOURNE) (2011)
KEJURUTERAAN ELEKTRIKAL	
ABDUL MALEK BIN ALI	BE HONS (UTM) (ELECTRICAL, 2015)
AHMAD NASSARUDDIN BIN KAMARUZAMAN	BE HONS (UTM) (INDUSTRIAL POWER, 2006)
AIMI IDZWAN BIN TAJUDIN	BE HONS (UiTM) (ELECTRICAL, 2008) ME (UM) (ENGINEERING, 2012)
AZLY BIN NAFSIN	BE HONS (UMS) (ELECTRICAL & ELECTRONIC, 2001)
HAIRUL NIZAM BIN ZAINAL ABIDIN	BE HONS (UiTM) (ELECTRICAL, 2007)
HALIMATUN BINTI HASHIM	BSc (VIRGINIA POLYTECHNIC INSTITUTE & STATE) (ELECTRICAL, 1998) ME (UNITEN) (ELECTRICAL, 2002)
HUSNA BINTI HUSIN	BE HONS (UNITEN) (ELECTRICAL POWER, 2008)
HUZAINIE SHAFI BIN ABD HALIM	BE HONS (PORTSMOUTH) (ELECTRICAL & ELECTRONIC, 1997) ME (UNITEN) (ELECTRICAL, 2010)
JEYGANES A/L SUPPAN	BE HONS (UNITEN) (ELECTRICAL POWER, 2013)
MAGESWARAN A/L SANTHIRASEGARAN	BE HONS (UTM) (ELECTRICAL, 2014)
MOHD AFIZ BIN MOHD ZOLKEFPELI	BE HONS (UNITEN) (ELECTRICAL & ELECTRONICS, 2009)
MOHD HAFIZ BIN ISHAK	BE HONS (UTM) (ELECTRICAL, 2007) ME (UTM) (ELECTRICAL-POWER, 2015)
MOHD HAFRIZ BIN ISMAIL	BE HONS (UTM) (ELECTRICAL, 2008)
MOHD HAMDAN BIN KAMARUL BAHARAINI	BE HONS (UNITEN) (ELECTRICAL POWER, 2007)
MOHD IQBAL BIN RIDWAN	BSc (KEIO) (ELECTRICAL, 2005)
MOHD RUKHAIRE BIN ABDUL RAHIM	BSc HONS (RENSSELAER POLYTECHNIC) (ELECTRICAL, 2002)
MOHD SHAHRIN BIN ABDULLAH TAWADI	BE HONS (UiTM) (ELECTRICAL, 2006)
MOHD SYAHIBOL FADHILAH BIN MOHD JAMAL	BE HONS (UTM) (ELECTRICAL, 2010)
MOHD ZUHAIRI BIN ZAINAL	BE HONS (UTM) (ELECTRICAL, 2008)
MUHD GADDAFI BIN MUSTAPHA	BE HONS (UKM) (ELECTRONIC, 1998) CONVERSION (UNITEN) (ELECTRICAL, 2011)

Note: *Continuation of the Transfer Graduate, Graduate, Incorporated, Affiliate and Associate would be published in February 2020. For the list of approved "ADMISSION TO THE GRADE OF STUDENT", please refer to IEM web portal at http://www.myiem.org.my.*

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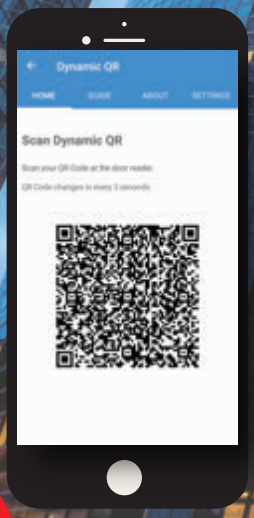

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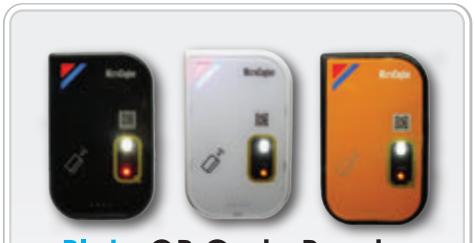

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