Hot Issues in Fire Engineering

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Concerns on the Low Heat Release Rates Estimated for Design Fires in Fire Engineering Approach

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Consequent to so many big building fires in Hong Kong with one happened recently at Fa Yuen Street [1] in end November, 2011, there are deep concerns [2] on providing building fire safety in projects going through Fire Engineering Approach (FEA) or performance-based design (PBD). There are problems that the fire safety provisions did not comply with the prescriptive codes, such as partitions without fire resistance, storage of large quantities of combustible goods and extended travel distance. In most of the FEA/PBD projects [3], fire hazard assessment was focused only on evacuating people trapped inside the building. Very few FEA/PBD reports appeared in the past two decades talked about impact to firefighting and protecting firemen. The hard job of fighting against the big fires is left to the firemen!

As raised openly in a recent conference in Singapore [4], most of the FEA/PBD projects are only for reducing the construction cost. There are now many challenges on firefighting procedures not following guidelines [5]. This leads to concerns on how FEA/PBD would affect firefighting strategy, rescue strategy, intervention of fire service systems, and most importantly, potential health and safety impact on firemen. Note that toxic gases are not included in smoke assessment [6-9], but only heat and at most, carbon monoxide concentration deduced from free computing software without professional liability. Even so, a very low design fire less than 5 MW used to be estimated and adopted in many FEA/PBD projects.

Heat release rate [10] is the most important parameter affecting the course of a fire in hazard assessment in FEA/PBD while determining the fire safety provisions. Using a low design fire much less than the real incident [1] is very dangerous. Full sprinkler protection was not provided in many public places such as crowded subway station platforms [11] and large airport terminals [12]. Note that any disturbance in the burning process would increase the heat release rate, giving a fire much bigger than the design fire [13]. Firemen then have to fight against the big fires, if happened. However, there was no special consideration in FEA/PBD reports on evaluating the impact on firefighting strategy, rescue strategy, and health and safety of firemen under a big fire. These were only briefly discussed even in overseas PBD design guides with due reference to occupational safety and health practices not specifically worked out for fighting big fires [e.g. 14]. FEA/PBD design with assumed low heat release rates would give a much less hazardous environment, very different from those in real fires experienced by firemen [1]. Further, firemen might presume fighting fires in buildings with fire safety provisions complied with the code. Extending the travel distance, for example, would require longer operating time of portable breathing apparatus.

Fire load was surveyed by different research groups in the past 25 years in factory buildings, retail shops, karaokes, higher education institutes, residential buildings and shopping malls. Local residential buildings are observed to store much more combustibles [15] than the upper limit imposed by the codes [16]. It is very easy to get heat release rates higher than the low design value of only 5 MW assumed in many FEA/PBD reports, once adequate ventilation is provided due to whatever reason.

Data on heat release rate for local combustible products are not available. Estimations were based on very crude assumptions under low radiative heat fluxes in most of the FEA/PBD projects. Most of these calculations [e.g. 17] were not supported by systematic full-scale burning tests. Some calculations were even wrong in just taking overseas combustibles to be the same as local ones, and assumed that the average heat release rate is the peak heat release rate. Correct calculation on the design fire is necessary for implementing the new generation of building fire safety codes [18] in view of the big post-flashover fires encountered [1,5,19]. Methods of estimating low probable heat release rates by burning those combustibles were just reviewed [20.] The trick of getting low heat release rates was pointed out. Further, it is difficult to model [21] the consequence of a big fire scenario realistically with Computational Fluid Dynamics (CFD). That is why some fire consultants even said that the Available Safe Egress Time (ASET) predicted by CFD is independent on the design fire higher than a certain value!

Therefore, the following immediate actions are recommended on FEA/PBD submissions:

- Existing buildings:

  All FEA/PBD on fire safety provisions for existing projects assuming such low heat release rates must be reviewed again, with impact to firefighting and protecting firemen included. Appropriate fire safety management with more security guards assigned in those places [2] should be implemented to ensure that the amount of combustibles is kept low. The heat release rate of burning the stored combustibles might be low, say kept below 5 MW if the guards are properly trained. When there are difficulties in keeping low fire load density to match with the assumed low design fire, additional passive building designs and workable active fire protection systems should be provided. For example, large airport terminals and crowded deep underground subway stations likely to store more combustibles might give rise to big fires. These places must be fully protected by appropriate fire suppression systems and smoke management systems. Firemen should be warned that they might be going to a more hazardous environment for fighting against the big fire and rescue occupants. They must take appropriate precautions with suitable training, and be provided with additional firefighting equipment.

- New projects:

  Heat release rates estimated in new projects must be vigorously justified by full-scale burning tests on acceptable scenarios to ensure appropriate fire safety can be provided. An additional section on the effect on firefighting must be included in the FEA/PBD report. Firemen must be informed to ensure that they can take appropriate actions in firefighting. FEA/PBD projects only for reducing cost should not be allowed [4]. A cost analysis report on fire safety provisions in those places with difficulties to comply with fire code should be submitted to demonstrate that the objective of PBD is not for cost reduction. FEA/PBD should only be implemented when there are no fire safety codes.

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