QUALITY ASSURANCE IN COMMERCIAL WIND TUNNEL TESTING

J.C.K. CHEUNG and W.H. MELBOURNE

Department of Mechanical Engineering
Monash University, Clayton, Vic 3168

1. SUMMARY

Increasing interest in the quality of wind tunnel facilities and the setting up of a subcommittee in Australian Wind Engineering Society to produce a Quality Manual have generated an urgent need for ideas on implementing Quality Assurance, especially in commercial wind tunnel test. This paper, whilst not directly describing quality manuals, is the authors view of Quality Assurance with respect to wind tunnel testing. A lot more is covered in relevant literatures [1, 2], but this is just a first attempt to summarize the basics of such a broad and rather nebulous subject.

2. INTRODUCTION

Early in 1988, the Australian Wind Engineering Society had set up an enquiry into the assessment of wind tunnel facilities to satisfy quality assurance aspects of commercial wind tunnel testing, initially with environmental studies in particular. In 1989, a subcommittee was organised to produce a working document on quality assurance assessment of wind tunnel testing. Later in 1990, an attempt was made to present such a document in a form of the Manual of Practice for Wind Tunnel Testing. Due to the very large coverage of all aspects and types of wind tunnel testing, the drafting of such a manual can be encyclopedic and can include a lot of in-house regular routines which may also be not conformable in different wind tunnel facilities. Cheung [3] proposed such a document to be a concise Quality Manual which concerns the quality system for assurance, but does not include quality control and procedures. The Quality Manual details only what has to be done. The Quality Procedures for describing how to achieve such quality of performance, are to be produced separately by each of the wind tunnel facilities to maintain flexibility and confidentiality.

The concern for quality has continued on and on despite our limited ability to define quality, to assess accurately the quality of wind tunnel testing, and to effect the organisational changes needed to assure for quality. This paper attempts to

document the development of quality assurance in wind tunnel testing and tries to stimulate more ideas on quality in the services from the Wind Engineering profession.

3. QUALITY AND ITS DEFINITION

In ASTM standard, quality is defined as the totality of features and characteristics of a product on service that bear on its ability to satisfy specified needs. In brief, as in AS1057, it is the fitness for purposes. Certainly, it depends on the perspective of the definer who focuses on his own needs or purposes. Clients may judge quality of wind tunnel testing by the ability of the consultants to identify wind problems, if any, and to provide solutions within their feasibility in time. Wind tunnel professionals may judge quality by the modelling accuracy and the measurement reliability. Administrators may judge quality by their wind tunnel's ability to perform the greatest numbers of tests at the lowest possible cost and with the highest possible credibility.

Taking a hypothetical case as an example, a client comes to a wind tunnel with a request for an environmental wind speed study to determine likely wind conditions at a corner at the base of a proposed tall building with a wide concave facade facing the strong south wind direction on top of an escarpment. The consultant, upon examination of the supplied drawings, finds that the wind problem may occur not only at the corners, but also on the opposite pavement where the wind flow induced down from the building facade would be deflected across the street. Also, there is an open shopping arcade in the middle of the proposed building, which is subject to high mean wind flow due to the pressure difference across the building and high turbulent gusty wind caused by separated flow off the edge of the escarpment. The client states that he is more concerned about the wind conditions within the proposed building boundary and just wants to solve any wind problem at the corner with a report to obtain a building permit in four weeks time. The wind tunnel testing is commissioned and the wind tunnel model is accurately made with all details inside the arcade to similate adequate flow passage. Just before the testing begins, the client sends in a new set of drawings which, perhaps taking the consultant's point, change the open shopping arcade into an enclosed restaurant. The tests have proceeded with the model arcade blocked in. Although fortunately there is not much addition in model-making time, the model-maker is frustrated by the loss of his effort in putting all those details inside the arcade in vain. During the wind tunnel testing, it has been shown that a small wind-break planter at the corner can effectively deflect the induced wind flow upward into the wake region of the building and ameliorate the high wind conditions at the corner to within the recommended criterion for comfort for walking in public access-ways. Despite the lack of the client's interest in the opposite pavement area, the wind tunnel operator demonstrates that the unacceptably high wind conditions across the street can only be mitigated with a canopy around the building to deflect the wind flow

induced down from the concave facade at a higher level before reaching the ground. The client accepts the proposal of the wind-break planters/trees at street level but stresses that any structural canopy would contradict the whole architectural concept of the proposed building. He also starts to worry about the modelling accuracy, the measuring technique, the validity of blockage correction and even the adequacy of applying the recommended criterion to the opposite pavement area where there is a loading dock not to be used regularly for pedestrian access. Eventually, substantiated with further wind tunnel tests, the consultant recommends a solution with extensive wind-break trees like a forest canopy at the base of the building. Although the client manages to obtain his building permit in time, he is frustrated by his inability to get landscaping suggestions just at the building corners of which he has come to ask for. The wind tunnel professional is frustrated by the failure to adopt the structural canopy because the wind break trees may be difficult to grow in the dry elevated land shaded by the building and under frequent high wind conditions. The administrator, meanwhile, is concerned about the loss of potential clientele, which reflects upon the use of resources.

The definition of quality therefore encompasses not only the physical capability of modelling in a wind tunnel, but also the act of carrying out such in a cost effective manner. It must also take into account the values and purposes of the professionals, the clients and the institutions.

4. QUALITY ASSESSMENT

Since the values and purposes of even a particular professional, a particular client and a particular wind tunnel facility may vary for different tests, what is high quality in one job can be unacceptable in another. Therefore, a definitive assessment of quality must be based on a knowledge of all the particulars in each job. Such assessments are of course time consuming and tend to be unreliable unless assessed by someone extremely competent. Therefore, some sort of explicit requirements have to be formulated for assessment to represent at least an acceptable standard. At one extreme, these requirements represent what leading experts, based on the best technological evidence, consider to be the best practice. At the other extreme, they may be derived from the average practice of most wind tunnel facilities. The degree of compliance to these Quality Requirements then becomes a rough measure of quality. However, these requirements, even with lots of special cases, cannot easily take into account the variability among different tests. Therefore, a definitive assessment of quality for any given test cannot totally rely on the compliance with the Quality Requirements which are meant to apply to the average test. It is still necessary to subject each test to a judgement by expert professionals who are given all the relevant facts.

5. QUALITY ASSURANCE

Quality assurance may be seen as a cycle of activities [4]: to observe practice, to compare practice with expectations and to implement change in practice or change in expectations. The first stage is then repeated to see if this change would produce the desired effect for better quality. Either to observe the physical capability of modelling or the act of performing the testing, or to determine expectations from the pre-formulated requirements for a given job, or to implement change requires an expert professional close within the wind tunnel facility.

6. CONCLUSION

Quality assurance for commercial wind tunnel testing can only be achieved when it represents the aims of all parties involved: the clients, the professionals and the institutions. The professionals consist of a team of integrated effort from the consultants, the model-makers, the wind tunnel operators and all other personnel involved from the first contact with the client to the final consultation. Only with the encouragement from the Wind Engineering Society and the management of wind tunnel facilities can quality be assured to the client's satisfaction.

7. REFERENCES

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[4] Shaw, C.D., "Introducing quality assurance', King's Fund College Project Paper No.64, July 1986.