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## ***Interactive comment on “Robust optimization methodologies for water supply systems design” by J. Marques et al.***

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This paper presents an approach for optimizing design of water distribution system considering abnormal conditions such as pipe bursts and fire flows. The design optimization model is formulated to minimize the pipe and pump capital cost such that the pipe diameters and pump head are optimized to satisfy the constraints of desired nodal pressures and admissible nodal pressures. A simple system is used as case study to demonstrate the optimized design solutions without and with pump station, which is added to handle abnormal operation scenarios. The overall approach presents a good conceptual framework for water distribution system design optimization under both normal and abnormal conditions.

It is reviewer’s opinion that the research work can be further improved in addressing a

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number of aspects as follows.

1. Authors assume that adding pump station is the design option for handling abnormal conditions. This may be a valid assumption for some systems, but the options should thoroughly evaluated for the final design. For instance, with the added pump station, energy cost can be neglected due to the occasional operation in a short period of time, however, associated overhead for maintaining the pump stations may not be negligible when many pump stations are required as contingency infrastructure for a large system, which is likely the case in real water system. A life cycle cost analysis needs to be conducted to compare the cost of adding pump station as contingency facility.

2. It is true that large pipe diameter required for handling abnormal conditions is not favorable under normal condition. However, large pipes should not be excluded as competitive solution. Instead, the water quality responses, such as water age, should be used to evaluate the design alternatives so that the solution can be further optimized for truly robust design.

3. According to the design optimization model presented in the paper, a demand satisfaction constraint is formulated and applied in such a way that the demand is totally met when the nodal pressure is equal or greater than the desired pressure, and the no demand or consumption is supplied when the pressure is lower than the admissible pressure. It is not explicitly stated if a pressure dependent demand (PDD) analysis is used for hydraulic simulation although PDD analysis should be applied to quantify the actual supply under abnormal or pressure deficient conditions (Wu et al. 2009).

4. In related to the note above, authors' assumption that no demand is met when the pressure is lower than the admissible pressure does not seem to be a valid, although it will depend on how much the admissible pressure is specified for the nodes. In practical system, the demand or actual amount of the supplied water decreases as the pressure decreases, it is zero supply when pressure is zero. When admissible pressure, as authors prescribed, is greater than zero, there should be some demand that can be

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met or supplied. In the case study, authors specified the admissible pressures of 30 m, 25 m and 10 m for various scenarios. With the specified admissible pressure, there will be quite significant amount of water that can be supplied throughout the network.

Finally, the paper is well structured and adequately written for publication although there is always room for improvement. The reviewer would like to congratulate the authors for publishing their work and their contribution to the research forefront of water supply system design optimization.

#### Reference

Wu, Z. Y., Walski, T., Wang, R.H. Boulder, D., Yang, S. Y. (2009) "Extended Global Gradient Algorithm for Pressure Dependent Demand Analysis of Water Distribution Systems", ASCE Journal of Water Resources Planning and Management., Vol.135, No.1, pp13-22.

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