Title	Research Report 340: Computer model for design and validation of deluge systems for protection against fire.
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Executive Summary	A project has been undertaken to develop a computer model as part of improved guidance for the design and evaluation of water deluge systems for the protection of liquefied petroleum gas (LPG) tanks against fire. The current guidelines for the design of water deluge systems are based on meeting a single, overall water application rate value for the whole tank i.e. 9.8 dm3 m-2 min-1. A wide range of combinations of water deluge design parameters are permissible under the current guidelines, producing a wide range of water distribution patterns, while meeting the overall water application rate requirement. However, it has been demonstrated that the water distribution across the tank surface is often highly irregular; the degree of irregularity depending on the particular combination of water deluge design parameters used. In the case of highly uneven water distributions, regions of low water coverage and consequently poor fire protection were found. Basing the design of water deluge systems on a single, overall water application value is therefore inappropriate. There is a need for improved guidance on the combinations of water deluge parameters that should be permitted to ensure adequate protection against fire, taking into account the expected water distribution on the tank surface. The combination of water deluge parameters producing the best water coverage varies from case to case, depending on the range of water deluge design parameters available e.g. for an existing water deluge system, and the level of protection required. A model has therefore been developed to predict the combination of water deluge parameters required to produce the optimum water coverage for any given horizontal (LPG) tank and water deluge system. The model is validated for the cylindrical section of such vessels and is capable of extension to the hemi-spherical/toroidal tank ends, as well as spherical and vertical cylindrical vessels. However, further study would be required to obtain experimental data to enable model evaluation of the prediction of the water coverage in such circumstances. A standardised method of measuring the water coverage on the tank surface involving the collection of water at a range of locations across the surface has been devised. The rate of water collection per unit width of the collection vessel was selected as the most appropriate parameter for characterising the water flow across the tank surface, and has been termed the “surface water flow rate”. The developed model consists of a number of empirical relationships between surface water flow rate distributions and the water deluge parameter settings and operating conditions producing each distribution. By interpolation of these relationships, surface water flow rate distributions can be predicted for any intermediate combination of deluge design and operating parameters. Prior to the start of the current project, the model was only applicable to 3 and 4-row water deluge systems and 1.2 and 2.2 m diameter tanks. However, the model has now been extended by the acquisition of additional empirical relationships to include: (i) 5-row water deluge systems; (ii) 3.0 m diameter tanks. The model has been incorporated into a Visual Basic (VB) software code, which provides a user-friendly, front-end interface, facilitating application of the model to the optimization and evaluation of deluge designs. Validation of the model has been carried out by comparing predicted and measured surface water flow rate values at a range of locations for a 3.0 m diameter tank. An

	average percentage difference between predicted and measured values of 7.0% was demonstrated.
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