bre

DCLG Final Research Report

Effectiveness of sprinklers in residential premises – an evaluation of concealed and recessed pattern sprinkler products

Executive Summary

218113

The authors of this report are employed by BRE. The work reported herein was carried out under a Contract placed by the DCLG. Any views expressed are not necessarily those of the DCLG.

March 2006

Executive Summary

This Executive Summary describes the project “The effectiveness of sprinklers in residential premises – an evaluation of concealed and recessed pattern sprinkler products” commissioned by the Buildings Division of the Office of the Deputy Prime Minister (ODPM) and carried out by BRE. Full details of this study and its findings are given in BRE project report number 218113.

This study is related to a previous one carried out by BRE on behalf of the ODPM on the effectiveness of residential sprinklers. The previous study concentrated on pendent type residential sprinklers and is detailed in BRE project report 204505 (Effectiveness of sprinklers in residential premises) and can be found on the BRE website at www.bre.co.uk/adb.

The overall aim of this current project was to investigate the suitability of concealed and recessed pattern sprinklers for use in residential premises, particularly concerning their effectiveness and maintainability. To achieve this, the project was divided into stages: selection of products, experimental programme, review of maintainability issues and development and evaluation of a new thermal sensitivity test.

This project was guided and reviewed by a Steering Group. Steering Group members included representatives from government regulators, the residential sprinkler industry, housing industry and fire service. They provided general advice and review on aspects of the project methodology and specific advice and information about residential sprinkler products.

Concealed and recessed residential sprinkler products were selected and characterised using water distribution measurements. Stylised fires were then carried out inside a suitable test room to assess the performance of these sprinklers in fire test conditions. A series of twelve fires was conducted, based on the procedures of the fire test for pendent residential sprinklers given in British Standard Draft for Development DD 252 (Components for residential sprinkler systems – specification and test methods, July 2002), recommendations given in British Standard BS 9251 (Sprinkler systems for residential and domestic occupancies – Code of Practice, January 2005) and findings of the previous ODPM study.

The stylised fuel package, intended to simulate furniture and wall linings, was placed inside a simulated residential 'room' with door openings and installed sprinkler heads. The effect of various parameters were investigated: sprinkler model (one pendent, one recessed, four concealed), location of fuel package within sprinkler spray (wall and corner configurations), the effect of frame arm/deflector attachment pins shadow (parallel to the long axis of the test room and pointing towards the fire) and recess distance (manufacturer’s recommended maximum and minimum).

Realistic fires were carried out inside a suitable test room to examine and quantify the effectiveness and performance of selected concealed and pendent sprinkler products, in particular for life safety in the room of fire origin. The results were compared with the findings of the previous ODPM study. A series of ten fires, using fuel arrays representative of domestic and residential premises, was conducted inside a room connected to an adjoining single storey volume by a doorway. Residential sprinklers and smoke alarms were present.

Two fire scenarios, television and table fires, were examined with sprinklers and with the door of the room of fire origin to the hallway open. The television fires were relatively slowly-growing, smoky, shielded, fires and the table fires were rapidly-growing flaming, shielded fires, with the table placed directly beneath the sprinkler. In addition to fire scenario, the other parameters investigated were sprinkler model (one pendent, three concealed) and recess distance (manufacturer’s recommended maximum and minimum). The water flow rate of the single operating sprinkler was either 60 l/min or the manufacturer’s recommended minimum

if greater than 60 l/min, as in the previous ODPM study. Residential sprinkler effectiveness was primarily assessed by measuring their ability to control toxicity, temperature and visibility in a period of 30 minutes from ignition.

A suitable UK test to determine the thermal response category for concealed and recessed residential sprinklers has been specified and developed. The design has been based on DD 252 and experimental work from Factory Mutual Research Corporation, USA and uses a mounting plate and plenum box attached to a heated wind tunnel with appropriate instrumentation. Tests were conducted to investigate the effect of: sprinkler model (one pendent, one recessed, five concealed), frame arm/deflector attachment pins orientation, recess distance, concealer plate retainer lug position, tunnel air temperature and velocity and pressure difference between the tunnel and plenum box. Some tests were conducted with concealed sprinklers to demonstrate the influence of plausible maintainability scenarios. Thermal responses were classified using the specifications of European standard BS EN 12259-1 (Fixed firefighting systems – Components for sprinkler and water spray systems, Part 1 Sprinklers, 1999).

Maintainability issues concerning concealed and recessed residential sprinkler products that might detrimentally affect their performance were reviewed. This involved identifying, gathering and reviewing information on design, installation and maintenance. Information was gathered from BS 9251, anecdotal experience with this type of product installed in real buildings, other studies, visual examination and the experience of the BRE project team members obtained during the course of the experimental work in this project. It should be realised that there may be additional issues of this nature that have not yet been identified.

The main findings of this project are:

- In the realistic experimental fires, the overall performance of concealed sprinklers was similar to the performance of the pendent sprinkler.
- The addition of concealed residential sprinkler protection proved effective in potentially saving lives in the room of fire origin for the television fires, but proved ineffective in potentially saving lives for the table fires.
- Smoke alarms, fitted in the room of fire origin, responded in 31% to 57% of the time required by sprinklers and well before conditions had become life threatening and smoke alarms, fitted in adjacent spaces, responded in 43% to 77% of the time required by sprinklers and well before conditions had become life threatening.
- In the DD 252 stylised fires, the concealed sprinklers met all the acceptance criteria for the majority of cases.
- In one corner stylised fire, the recessed sprinkler at maximum recess distance exceeded one of the DD 252 temperature criteria soon after sprinkler operation, but subsequently controlled the fire.
- In one corner stylised fire, the concealed sprinkler did not meet any of the DD 252 acceptance criteria, because a combination of maximum recess distance and unfavourable alignment of frame arms and concealer plate retainer lug caused an adverse effect on the water distribution at the fire location.
- Parameters that influence recessed and concealed sprinkler water distribution and fire performance characteristics need to be considered and specified in DD 252, if the performances of these sprinklers are to be assessed.
- A suitable thermal sensitivity test for the evaluation of concealed sprinklers has been established for consideration for inclusion in residential sprinkler standards. Some improvements have been identified.
- The pendent sprinkler resulted in a thermal sensitivity rating of quick response under favourable conditions, as required by BS 9251 and DD 252.
- None of the concealed sprinklers examined achieved a thermal sensitivity rating of quick response, even in the most favourable conditions.
- Generally, the concealed sprinklers operated later and at higher temperatures than the pendent sprinkler.

- The issue of whether the thermal sensitivity ratings determined in this study for concealed and recessed residential sprinklers are suitable for life safety applications could be considered by the relevant British Standards committee.
- A number of potential problems that relate to the design, installation and maintenance of concealed sprinklers have been identified.
- Unfavourable frame arm/deflector attachment pins orientation, maximum recess distance and unfavourable concealer plate retainer position and a combination of these can delay the thermal response of concealed sprinklers.
- Maximum recess distance, alignment of the cover plate lugs, and frame arm/deflector attachment pins orientation, proximity to high level obstructions and a combination of these can be detrimental to the water distribution of the concealed sprinkler.
- Water in the concealer plate, blocked vent holes, glued and painted concealer plates can delay the thermal response of concealed sprinklers.

The results of this study will be provided to the relevant British Standards committee for consideration in the development of residential sprinkler standards.