Fire – 85 Harrow Court Stevenage 2nd February 2005

Report for the Coroner: by ***Paul GRIMWOOD***
11th December2006
Discussion on Points of Disagreement between the Experts

These notes are for the purpose of offering some direction, in relation to areas of disagreement remaining between the expert opinions presented in the report by Paul Grimwood, following the meeting at the Old Court House, Hatfield that took place 7th & 8th December 2006.

In attendance – Graham Noakes; Paul Stanbridge; Paul Grimwood (for FBU); Roger Day; Pete Marshall (for HFRS); Paul Scott (Faber Maunsell representing Stevenage Borough Council) (Joint agreement that his attendance was not required on 8th December).

Reasons for Disagreement or Differences of Opinion (Paul Grimwood)

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There may be some difference of opinion relating to conclusions drawn from the BRE test fire reconstruction and subsequent computer models. By their own acknowledgement, there are several factors such as wind speed, wind direction, confirmed stack effects, interior surface fire loadings and ventilation parameters that were unknown to them in relation to the real fire that occurred in flat 85.These factors will directly influence levels of maximum burn rate (kg/s) and peak fire intensity (MW) as reached by the fire during the abnormal rapid development. The importance of both maximum burn rate (kg/s) and peak fire intensity (MW) is seen by their relevance to the amount of flow-rate (LPM) needed to suppress such a fire safely and effectively prior to the decay stages being reached. Furthermore, the percentage of heating efficiency within the compartment is directly influenced by the amount of air being forced in through ventilation openings and therefore wind speed and directional data is of great relevance when attempting to estimate fire-fighting flow-rate requirements. Furthermore, the BRE computer model of the flat fire itself bears no resemblance whatsoever to the surrounding circumstances that occurred on the morning of the fire at 85 Harrow Court and appears in direct conflict with the HFRS Fire Investigation report, which aligns more closely to my own conclusions. (BRE were not invited to attend for discussion in these areas).

The BRE report describes a fire test reconstruction and various computer models as representative of a flat fire, similar to that which occurred at 85 Harrow Court. It is acknowledged by BRE in several areas of their report that the accuracy of any conclusions drawn from such tests or computer models are strictly dependent upon realistic input data. There are several factors such as wind speed, wind direction, confirmed stack effects, interior surface fire loadings and ventilation parameters that were unknown at the time to them in relation to the real fire that occurred in flat 85. It is suggested therefore that these areas are critical to the estimations of fire load involvement; speed of fire development, heating efficiency and maximum burn rate reached during the fire and these factors should be closely examined, as they are directly relevant to the amount of water needed to safely and effectively suppress the fire prior to its decay stage; for example, whilst attempting to stabilise conditions in flat 85 to allow rapid entry and recovery of missing or trapped fire-fighters.

1.1 The BRE use a correlation between room temperature and heat release rates given in BS 7974 to suggest a steady state heat release rate of 3.5MW.

1.2 Grimwood uses the FIRESYS model that presents a standard design fire load mass (includes wall & surface innings) inline with a calculated ventilation area to provide a **minimum** rate of burning (0.9kg/s) and level of peak fire intensity (13.2MW) throughout the flat without taking the gusting wind factor into account, which would increase the heating efficiency within the compartment beyond levels normally experienced.

1.3 It is proposed that the BRE data, in terms of fire intensity (3.5MW), is more representative of a single room (bedroom) fire at the time of flashover (as seen in the attached FIRESYS model for comparison – Appendix One).

1.4 It is further proposed that the FIRESYS data, in terms of fire intensity (13.2MW), is more representative of total fire involvement throughout the entire flat (as seen in the attached FIRESYS model for comparison – Appendix Two) – ***NOTE Appendix Two should REPLACE the FIRESYS data presented in error in the Grimwood report as the original document was only tendered in draft format.***

1.5 There appears confusion, following discussion with Roger Day of HFRS, and it is therefore proposed for clarification, that the 46 second burn off of fire gases during total 'flat' involvement suggested by Grimwood, is not the same event discussed on p13 of the HFRS report where it is suggested a 60 second development of fire occurred during the transition from small fire to total 'room' involvement in the bedroom.

1.6 It is clear from burn patterns that existed on the exterior building walls following the fire at Harrow Court that the direction of fire travel was from the NW wall to the NE wall, where an abnormal burn off of fire gases occurred outside the flat. This demonstrates a *forced draught fire* that was driven through the flat with some rapid intensification of the heating efficiency. This intensification of heating was caused by high velocity airflows entering the NW facing wall housing the bedroom window. Such an effect would cause temperatures inside the flat to far exceed those that may routinely be experienced in a normal post-flashover bedroom fire.

1.7 These abnormally high velocity airflows and associated temperatures are not accounted for in either the BRE or FIRESYS data as presented (BRE use an inappropriate wind speed and direction). As most compartment fires are only able to burn to around 50% efficiency at best, due to available ventilation factors, the data presented from FIRESYS in Appendix Two is calculated on this basis.

In the situation of a forced draught fire where large amounts of air are not simply drawn in by the fire but rather forced in by a gusting wind (for example), then the burning (heating) efficiency of the interior fire is increased beyond 50%. It is not possible to reliably calculate the exact conditions experienced in flat 85 at the time the rapid fire phenomena occurred, although efforts have been made to do so using the FIRESYS model. For example, a 60% heating efficiency demonstrates a fire-fighting water requirement of 360 LPM (compared to 300 LPM at 50%); or 420 LPM at 70% heating efficiency. It is safe to say that the estimated fire-fighting flow-rate requirements far exceeded those needed to suppress a 13.2MW compartment fire burning at 50% efficiency, during the actual periods of peak heating intensity. The water requirements needed to deal with the rapidly developing and abnormal fire development throughout flat 85 may be extrapolated by using fire suppression formula. In using Grimwood's empirically derived Tactical Flow-rate formula for example (Area m^2 x 6 or 65x6) it can be seen that a minimum flow-rate of 390 LPM is needed. The theoretical FIRESYS data suggests a minimum flow-rate of 3-400 LPM depending on the estimated heating efficiency factor built into the model. There are many well established flow-rate formulas used around the world and these all result in even higher flow demands in this situation. None of these calculated flow-rates account for the higher temperatures caused by the forced draught fire that occurred throughout the flat and are therefore clearly under-estimated in terms of the flow-rate needed. The *performance of the hose-line and nozzle* used by Ffrs Dudley & Dredge in their attempts to assist and recover their colleagues therefore comes into question.

1.8 Such abnormally high intensification of the fire's heating efficiency can be seen, for example, through areas of partial but complete destruction apparent in the two bodies located in the main bedroom. Such levels of complete burning are rarely experienced under normal conditions presented in a compartment fire.

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Appendix 4

FIRESYS

Fire Safety Engineering Programme 8-E

Version No. 2003.mbp

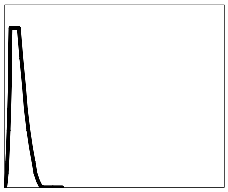
Programme Title **UNIVERSAL FIRE MODEL**

Project Title **GRIMWOOD - APPENDIX ONE** Project Ref. 101-020205

Firecell **Flat 85, HARROW COURT, SILAM ROAD, STEVENAGE**

THIS IS A DOUBLE T^2 MODEL THAT MAY BE EITHER VENTILATION OR FUEL SURFACE CONTROLLED MODEL

Fuel Type		=	Residential Normal		
Ambient Heat of Combustion	H'n	=	15 MJ/kg		
FLED	ef	=	500 MJ/m^2		
Firecell Width	W	=	2.800 m		
Firecell Depth	D	=	4.200 m		
Firecell Height	H	=	2.300 m		
Effective Opening Width	w	=	2.500 m		
Effective Opening Height	h	=	1.000 m		
Fire Growth Coefficient (to reach 1MW)	t*g	=	300 s	=	5.0 min
Fire Decay Constant (to reach 1 MW)	t*d	=	1200 s	=	20.0 min



*NOTE User judgement is needed for selecting values of t*g and t*d. As a general rule t*d = 4 times t*g.*

Design Fire Load Mass	M	=	392 kg		
Design Fire Load Energy	E	=	5,880 MJ		
Energy at FC/VC Crossover Point	Etp	=	3,257 MJ		
Fire is Fuel or Ventilation Controlled		=	Ventilation Controlled		
Firecell Area	Af	=	12 m^2		
Opening Area	Av	=	2.5 m^2		
Opening Ratio	Av/Af	=	0.21 -		
Ventilation Factor	Fv	=	2.5 m^2.5		
Internal Surface Area 2	At2	=	53 m^2		
Opening Factor 2	Fo2	=	0.047 m^1.5		
Pyrolisis Coefficient	kp	=	0.093 kg/s.m^2.!		
Maximum Burn Rate	Rmax	=	0.2 kg/s		
Maximum Fire Intensity	Qmax	=	3.5 MW	=	0.297 MW/m^2

Growth Phase Duration	tg	=	560 s	=	9.3 min	=	16 %
Steady Phase Duration	ts	=	752 s	=	12.5 min	=	21 %
Decay Phase Duration	td	=	2,241 s	=	37.4 min	=	63 %
Total Fire Duration	t	=	3,553 s	=	59.2 min	=	100 %
Energy Released in Growth Phase	Eg	=	651 MJ	=	43 kg	=	11 %
Energy Released in Steady Phase	Es	=	2,623 MJ	=	175 kg	=	45 %
Energy Released in Decay Phase	Ed	=	2,605 MJ	=	174 kg	=	44 %
Total Energy Released	E	=	5,880 MJ	=	392 kg	=	100 %

BFD Time Temperature Curve

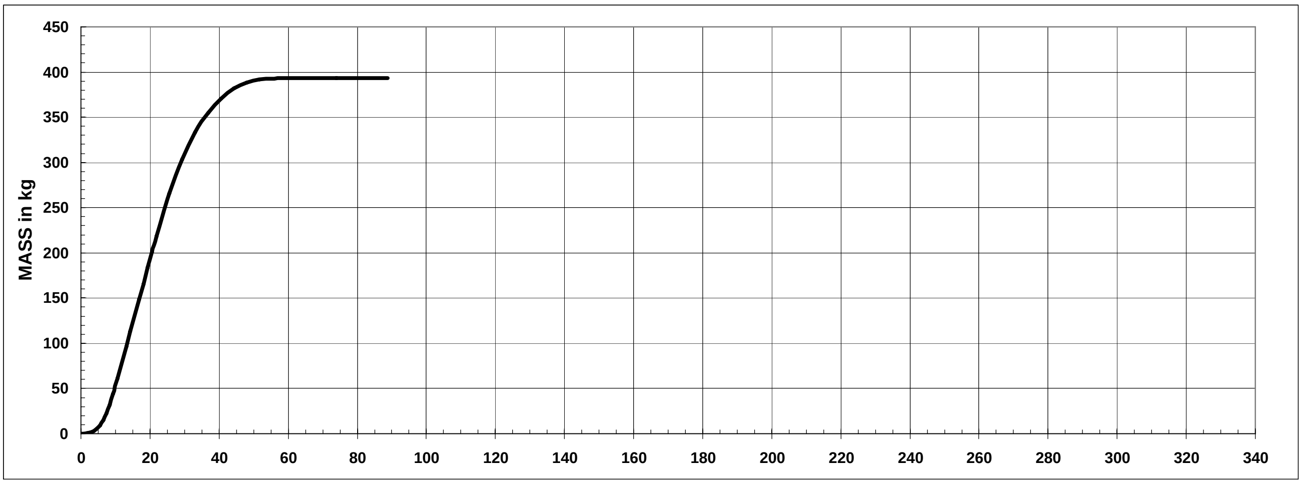
				Guides
Peak Temperature	Tp	=	872 C	956
Peak Time	tp	=	21.9 min	
Shape Parameter	sc	=	0.7 -	3.4

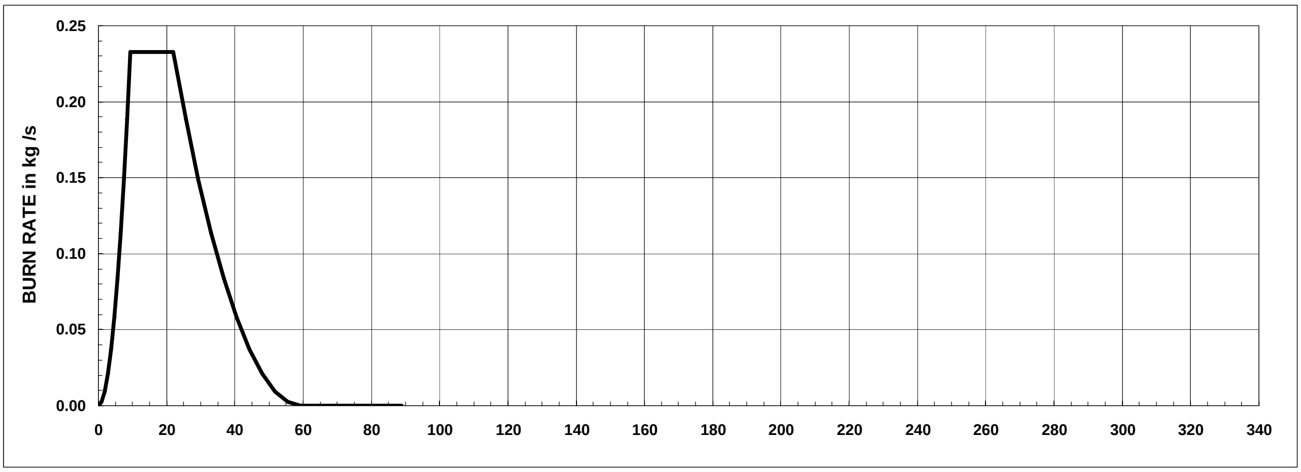
NOTE User judgement is needed for selecting values of Tp and sc.

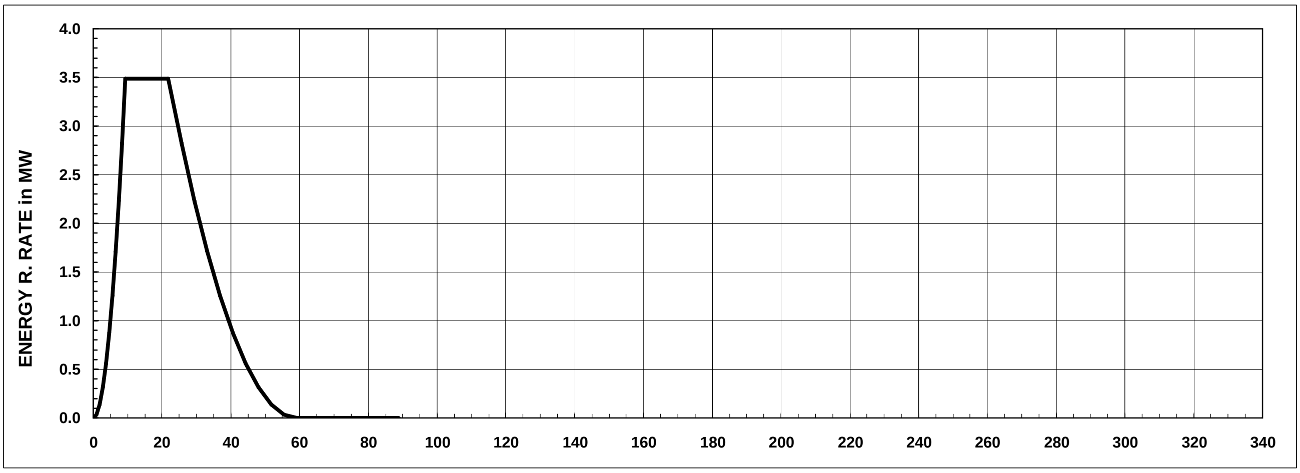
Fire Fighting Water Requirements

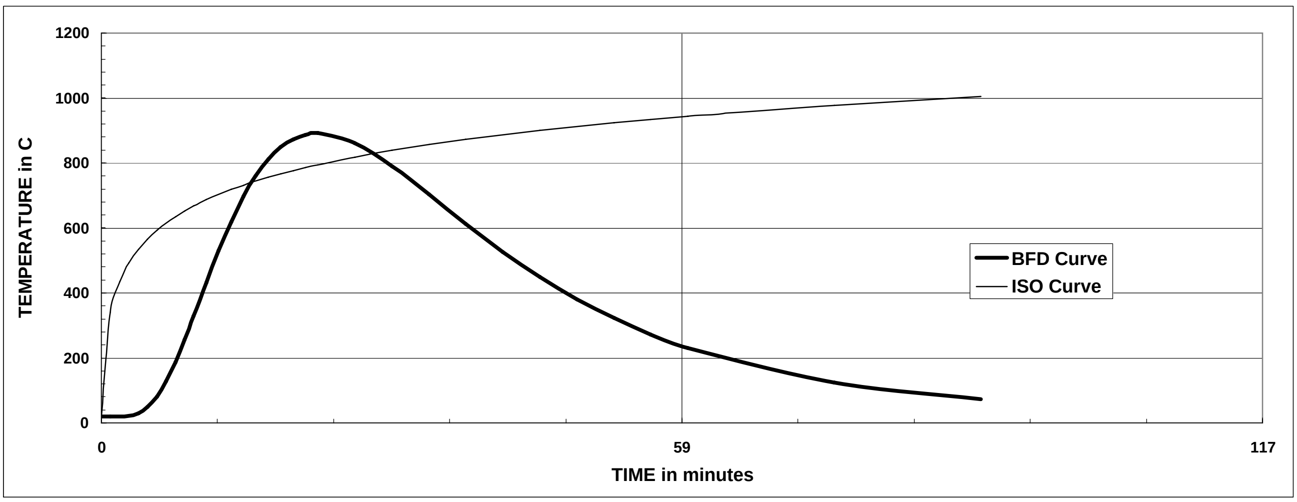
Heating Efficiency Factor	k12	=	0.60 -			0.50
Cooling Efficiency Factor	k13	=	0.50 -			0.50
Minimum Water Flow	F	=	2 l/s	=	0.46 l/s/MW	2.350 l/s/m^2
Theoretical Cooling Intensity at 100 C	Qw	=	4 MW			
Theoretical Cooling Intensity at 600 C	Qw	=	6 MW			
Minimum Flow Duration	tw	=	33 min	=	0.5 hr	
Minimum Water Storage	S	=	3,163 litres	=	0.54 l/MJ	
Average Discharge Density	dd	=	8.2 mm/min			
Average Water Depth over Floor.	wd	=	269 mm	=	269 l/m^2	

FIRESYS UNIVERSAL MODEL - 8E









Appendix 4

FIRESYS

Fire Safety Engineering Programme 8-E

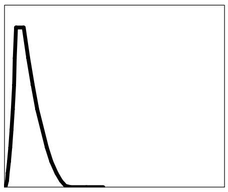
Version No. 2003.mbp

Programme Title

UNIVERSAL FIRE MODEL

Project Title	GRIMWOOD - APPENDIX TWO	Project Ref.	101-020205
Firecell	Flat 85, HARROW COURT, SILAM ROAD, STEVENAGE		

THIS IS A DOUBLE T^2 MODEL THAT MAY BE EITHER VENTILATION OR FUEL SURFACE CONTROLLED MODEL



Fuel Type		=	Residential Normal					
Ambient Heat of Combustion	H'n	=	15 MJ/kg					
FLED	ef	=	500 MJ/m^2					
Firecell Width	W	=	7.500 m					
Firecell Depth	D	=	8.700 m					
Firecell Height	H	=	2.300 m					
Effective Opening Width	w	=	7.500 m					
Effective Opening Height	h	=	1.200 m					
Fire Growth Coefficient (to reach 1MW)	t*g	=	300 s	=	5.0 min			
Fire Decay Constant (to reach 1 MW)	t*d	=	1200 s	=	20.0 min			

*NOTE User judgement is needed for selecting values of t*g and t*d. As a general rule t*d = 4 times t*g.*

Design Fire Load Mass	M	=	2,175 kg					
Design Fire Load Energy	E	=	32,625 MJ					
Energy at FC/VC Crossover Point	Etp	=	23,850 MJ					
Fire is Fuel or Ventilation Controlled		=	Ventilation Controlled					
Firecell Area	Af	=	65 m^2					
Opening Area	Av	=	9.0 m^2					
Opening Ratio	Av/Af	=	0.14 -					
Ventilation Factor	Fv	=	9.9 m^2.5					
Internal Surface Area 2	At2	=	196 m^2					
Opening Factor 2	Fo2	=	0.050 m^1.5					
Pyrolisis Coefficient	kp	=	0.089 kg/s.m^2.!					
Maximum Burn Rate	Rmax	=	0.9 kg/s					
Maximum Fire Intensity	Qmax	=	13.2 MW	=	0.202 MW/m^2			
Growth Phase Duration	tg	=	1,088 s	=	18.1 min	=	18 %	
Steady Phase Duration	ts	=	667 s	=	11.1 min	=	11 %	
Decay Phase Duration	td	=	4,352 s	=	72.5 min	=	71 %	
Total Fire Duration	t	=	6,107 s	=	101.8 min	=	100 %	
Energy Released in Growth Phase	Eg	=	4,770 MJ	=	318 kg	=	15 %	
Energy Released in Steady Phase	Es	=	8,775 MJ	=	585 kg	=	27 %	
Energy Released in Decay Phase	Ed	=	19,080 MJ	=	1272 kg	=	58 %	
Total Energy Released	E	=	32,625 MJ	=	2175 kg	=	100 %	

BFD Time Temperature Curve — Guides

Peak Temperature	Tp	=	872 C	1094
Peak Time	tp	=	29.3 min	
Shape Parameter	sc	=	0.7 -	3.3

NOTE User judgement is needed for selecting values of Tp and sc.

Fire Fighting Water Requirements

Heating Efficiency Factor	k12	=	0.50 -			0.50
Cooling Efficiency Factor	k13	=	0.50 -			0.50
Minimum Water Flow	F	=	5 l/s	=	0.38 l/s/MW	0.353 l/s/m^2
Theoretical Cooling Intensity at 100 C	Qw	=	13 MW			
Theoretical Cooling Intensity at 600 C	Qw	=	18 MW			
Minimum Flow Duration	tw	=	44 min	=	0.7 hr	
Minimum Water Storage	S	=	13,293 litres	=	0.41 l/MJ	
Average Discharge Density	dd	=	4.6 mm/min			
Average Water Depth over Floor.	wd	=	204 mm	=	204 l/m^2	

FIRESYS UNIVERSAL MODEL - 8E