

**COMMITTEE OF EXPERTS ON THE TRANSPORT OF
DANGEROUS GOODS AND ON THE GLOBALLY
HARMONIZED SYSTEM OF CLASSIFICATION
AND LABELLING OF CHEMICALS**

Sub-Committee of Experts on the
Transport of Dangerous Goods

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**PROPOSALS OF AMENDMENTS TO THE RECOMMENDATIONS
ON THE TRANSPORT OF DANGEROUS GOODS**

Model Regulations on the Transport of Dangerous Goods

Note 2 to 2.1.3.5.5 Firework classification

Transmitted by the expert from the United Kingdom

Annex to document ST/SG/AC.10/C.3/2006/84

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Test C.1: Time/pressure test as described in 'Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria', fourth revised edition.

Detailed below are the results of time/pressure tests carried out at the Health and Safety Laboratory (HSL) on pyrotechnic compositions and units.

The results are divided into groups of interest:

- Flash and black powder
- Whistles
- Sparklers
- Stars

The remaining tables detail the results in order of fastest rise time, followed by all of the raw data.

Flash and black powder:

Composition						Sample Mass (g)	Min rise time (ms)	Average rise time (ms)	SD
Name	Contains	Weight ratio	Physical form	Article name					
AB	Flash 1	Flash powder from EXSN 1473/1		powdered	WP9 unsticked rocket	0.5	0.64	0.78	0.14
R	BP/Flash 1	HKF BP / Flash from EXSN 1473/1	50/50	mixture	HKF/Flash 1	0.5	0.85	1.37	0.61
Q	BP/Flash 1	HKF BP / Flash from EXSN 1473/1	60/40	mixture	HKF/Flash 1	0.5	0.93	1.40	0.41
P	BP/Flash 1	HKF BP / Flash from EXSN 1473/1	80/20	mixture	HKF/Flash 1	0.5	1.78	2.11	0.52
W	BP	Black powder		granular	HKF	0.5	3.76	5.10	1.18
D	BP lift	Black powder		granular	WP9 150mm star burst shell	1.0	4.27	5.19	1.13
F	BP Burst	Black powder/husks		husked	WP9 150mm star burst shell	1.0	4.85	6.25	1.34
C	BP lift	Black powder		granular	WP9 150mm star burst shell	0.5	7.42	8.51	0.95
V	Flash 2	Barium nitrate/aluminium powder	70/30	<250µm powder	Ba(NO ₃) ₂ :Al	0.5	7.87	11.18	3.35
E	BP Burst	Black powder/husks		husked	WP9 150mm star burst shell	0.5	8.26	9.90	1.56

- Henry Krank Fine black powder has smaller granules than the black powder lift charge from the WP9 150mm shell.
- Flash 1 composition: 45% potassium perchlorate, 22% magnalium, 11% sulphur, 22% aluminium
- BP lift composition: 65% potassium perchlorate, 6% potassium nitrate, 19% carbon, 10% phenolic resin
- BP burst composition: 8.3% rice husk, 91.7% black powder (73% potassium perchlorate, 14% sulphur, 13% carbon)

Whistle:

Composition						Sample Mass (g)	Min rise time (ms)	Average rise time (ms)	SD
Name	Contains	Weight ratio	Physical form	Article name					
AC	Whistle 2	Whistle composition from 'Screamer'		<500µm powder	EXSN1645 Festival box	0.5	1.74	1.96	0.21
B	Whistle 1	Potassium perchlorate/potassium benzoate	70/30	<250µm powder	Homemade	1.0	4.16	4.62	0.41
AR	Whistle	Whistle pellet from 'mini cuckoo'		whole pellet in plastic case	EXSN1645 Festival box	~0.8*	7.64	13.37	6.26
A	Whistle 1	Potassium perchlorate/potassium benzoate	70/30	<250µm powder	Homemade	0.5	7.93	9.34	1.37

*individual units not weighed, assumed to be the same.

Sparklers:

Composition						Sample Mass (g)	Min rise time (ms)	Average rise time (ms)	SD
Name	Contains	Weight ratio	Physical form	Article name					
AE	Blue sp.	Blue Sparkler		powdered	Coloured sparklers	0.5	9.25	15.47	5.39
AD	Red sp.	Red sparkler		powdered	Coloured sparklers	0.5	16.09	26.11	12.66
AA	Gold Sp.	Gold sparkler		<500µm powder	Large gold sparkler	5.0	16.51	17.12	0.86
Z	Gold Sp.	Gold sparkler		<500µm powder	Large gold sparkler	4.0	19.56	20.44	1.12
Y	Gold Sp.	Gold sparkler		<500µm powder	Large gold sparkler	3.0	32.47	36.36	3.47
X	Gold Sp.	Gold sparkler		<500µm powder	Large gold sparkler	2.0	48.89	62.84	22.91
U	Gold Sp.	Gold sparkler		<500µm powder	Large gold sparkler	1.0	71.20	170.83	139.45
T	Gold Sp.	Gold sparkler		<500µm powder	Large gold sparkler	0.5	509.30	509.30	-*

*only one repeat went over 2060bar

Stars:

Composition					Sample Mass (g)	Min rise time (ms)	Average rise time (ms)	SD	
Name	Contains	Weight ratio	Physical form	Article name					
AN	Star	Silver bee pellets (ground)		powdered	5" silver bee shell	0.5	2.27	3.72	2.19
AL	Star	Silver bee pellets		whole	5" silver bee shell	6.5	6.73	6.73	N/A
AG	Star	Red stars, ground		powdered	25 shots cakes' RCC	0.5	9.56	16.34	8.56
AP	Star	Green star, ground		powdered	25 shots cakes' RCC	0.5	9.83	10.43	0.86
AJ	Star	Blue stars, ground		powdered	25 shots cakes' RCC	0.5	17.29	20.18	3.18
AM	Star	Silver bee pellets (partial)		partial pellet	5" silver bee shell	1.0	20.09	24.30	4.26
AF	Star	Red stars, whole		whole	25 shots cakes' RCC	1.5	23.72	31.90	11.93
AI	Star	Blue stars, whole		whole	25 shots cakes' RCC	1.5	23.97	36.43	10.89
AO	Star	Green stars, whole		whole	25 shots cakes' RCC	1.4	25.84	48.22	38.60

- Stars taken from a Roman Candle Combination (RCC) firework.
- Stars were cylindrical, length 16mm, diameter 9mm
- Stars were pressed, and contained a colour, gold flitter and crackle.

Results, fastest rise time first:

Composition						Sample Mass (g)	Min rise time (ms)	Average rise time (ms)	SD
Name	Contains	Weight ratio	Physical form	Article name					
AB	Flash 1	Flash powder from EXSN 1473/1		powdered	WP9 unsticked rocket	0.5	0.64	0.78	0.14
R	BP/Flash 1	HKF BP / Flash from EXSN 1473/1	50/50	mixture	HKF/Flash 1	0.5	0.85	1.37	0.61
Q	BP/Flash 1	HKF BP / Flash from EXSN 1473/1	60/40	mixture	HKF/Flash 1	0.5	0.93	1.40	0.41
N	Waterfall 1	Waterfall composition		powdered	WP9 connected waterfall	1.0	1.53	2.04	0.46
AC	Whistle 2	Whistle composition from 'Screamer'		<500µm powder	EXSN1645 Festival box	0.5	1.74	1.96	0.21
P	BP/Flash 1	HKF BP / Flash from EXSN 1473/1	80/20	mixture	HKF/Flash 1	0.5	1.78	2.11	0.52
M	Waterfall 1	Waterfall composition		powdered	WP9 connected waterfall	0.5	2.03	4.90	2.59
AN	Star	Silver bee pellets (ground)		powdered	5" silver bee shell	0.5	2.27	3.72	2.19
W	BP	Black powder		granular	HKF	0.5	3.76	5.10	1.18
B	Whistle 1	Potassium perchlorate/potassium benzoate	70/30	<250µm powder	Homemade	1.0	4.16	4.62	0.41
D	BP Lift	Black powder		granular	WP9 150mm star burst shell	1.0	4.27	5.19	1.13
F	BP Burst	Black powder/husks		husked	WP9 150mm star burst shell	1.0	4.85	6.25	1.34
AL	Star	Silver bee pellets		whole	5" silver bee shell	6.5	6.73	6.73	
K	Star	Green peony stars		crushed	Green peony shell	1.1	6.88	7.78	1.19
C	BP lift	Black powder		granular	WP9 150mm star burst shell	0.5	7.42	8.51	0.95
AK	Tracer	Blue trace		powdered	25 shots cakes' RCC	0.5	7.82	10.27	2.24
AR	Whistle	Whistle pellet from 'mini cuckoo'		whole pellet in plastic case	EXSN1645 Festival box	~0.8	7.84	13.37	8.26
V	Flash 2	Barium nitrate/aluminium powder	70/30	<250µm powder	Ba(NO3)2:Al	0.5	7.87	11.18	3.35
A	Whistle 1	Potassium perchlorate/potassium benzoate	70/30	<250µm powder	Homemade	0.5	7.93	9.34	1.37
E	BP Burst	Black powder/husks		husked	WP9 150mm star burst shell	0.5	8.26	9.90	1.56
L	Star	Green peony stars		crushed	Green peony shell	0.5	8.39	9.63	1.88
AE	Blue sp.	Blue Sparkler		powdered	Coloured sparklers	0.5	9.25	15.47	5.39
AG	Star	Red stars, ground		powdered	25 shots cakes' RCC	0.5	9.56	16.34	8.56

AP	Star	Green star, ground		powdered	25 shots cakes' RCC	0.5	9.83	10.43	0.88
H	Flash 2	Barium nitrate/aluminium powder	68/32	<250µm powder	Ba(NO ₃) ₂ :Al	1.0	10.16	12.53	3.91
G	Flash 2	Barium nitrate/aluminium powder	68/32	<250µm powder	Ba(NO ₃) ₂ :Al	0.5	11.12	14.72	3.21
AD	Red sp.	Red sparkler		powdered	Coloured sparklers	0.5	16.09	26.11	12.68
AA	Gold Sp.	Gold sparkler		<500µm powder	Large gold sparkler	5.0	16.51	17.12	0.86
AJ	Star	Blue stars, ground		powdered	25 shots cakes' RCC	0.5	17.29	20.18	3.18
Z	Gold Sp.	Gold sparkler		<500µm powder	Large gold sparkler	4.0	19.58	20.44	1.12
AM	Star	Silver bee pellets (partial)		partial pellet	5" silver bee shell	1.0	20.09	24.30	4.26
AH	Tracer	Red trace		powdered	25 shots cakes' RCC	0.5	23.29	28.66	5.16
AF	Star	Red stars, whole		whole	25 shots cakes' RCC	1.5	23.72	31.90	11.93
AI	Star	Blue stars, whole		whole	25 shots cakes' RCC	1.5	23.97	36.43	10.89
AO	Star	Green stars, whole		whole	25 shots cakes' RCC	1.4	25.84	48.22	38.60
S	Fountain	Fountain composition		flake	WP6 fountain	1.0	29.95	36.89	10.32
I	Star	Green peony stars		whole	Green peony shell	1.1	32.16	33.56	2.05
Y	Gold Sp.	Gold sparkler		<500µm powder	Large gold sparkler	3.0	32.47	36.36	3.47
O	Fountain	Fountain composition		flake	WP6 fountain	0.5	44.80	48.45	4.36
X	Gold Sp.	Gold sparkler		<500µm powder	Large gold sparkler	2.0	48.89	62.84	22.91
U	Gold Sp.	Gold sparkler		<500µm powder	Large gold sparkler	1.0	71.20	170.83	139.45
T	Gold Sp.	Gold sparkler		<500µm powder	Large gold sparkler	0.5	509.30	509.30	-

- WP9 connected waterfall composition: 44% potassium perchlorate, 6% sulphur, 44% aluminium (flakes and powder), 4% magnesium and 2% phenolic resin.

All data:

	Composition				Source		Sample Mass (g)	Rise time from 690-2070kPa (ms)						Min	Average	SD
	Name	Contains	Weight ratio	Physical form	EXSN	Article name		Run a		Run b		Run c				
								Mass (g)	Time (ms)	Mass (g)	Time (ms)	Mass (g)	Time (ms)			
A	Whistle 1	Potassium perchlorate/potassium benzoate	70/30	<250µm powder	NA	Homemade	0.5	0.55	7.93	0.51	9.42	0.47	10.67	7.93	9.34	1.37
B	Whistle 1	Potassium perchlorate/potassium benzoate	70/30	<250µm powder	NA	Homemade	1.0	0.96	4.94	0.97	4.16	0.97	4.77	4.16	4.62	0.41
C	BP lift	Black powder		granular	1473/5	WP9 150mm star burst shell	0.5	0.55	9.14	0.53	7.42	0.54	8.98	7.42	8.51	0.95
D	BP Lift	Black powder		granular	1473/5	WP9 150mm star burst shell	1.0	1.03	4.27	0.95	4.86	0.95	6.45	4.27	5.19	1.13
E	BP Burst	Black powder/husks		husked	1473/5	WP9 150mm star burst shell	0.5	0.52	10.09	0.54	11.36	0.52	8.26	8.26	9.90	1.56
F	BP Burst	Black powder/husks		husked	1473/5	WP9 150mm star burst shell	1.0	0.97	7.53	1	4.85	0.98	6.36	4.85	6.25	1.34
G	Flash 2	Barium nitrate/aluminium powder	68/32	<250µm powder	NA	Ba(NO3)2:Al	0.5	0.48	15.77	0.52	17.27	0.53	11.12	11.12	14.72	3.21
H	Flash 2	Barium nitrate/aluminium powder	68/32	<250µm powder	NA	Ba(NO3)2:Al	1.0	1.03	17.04	0.97	10.16	1.03	10.39	10.16	12.53	3.91
I	Star	Green peony stars		whole	1699/1	Green peony shell	1.1	1.09	32.16	1.1	32.61	1.19	35.92	32.16	33.56	2.05
K	Star	Green peony stars		crushed	1699/1	Green peony shell	1.1	1.05	7.33	1.06	9.13	1.03	6.88	6.88	7.78	1.19
L	Star	Green peony stars		crushed	1699/1	Green peony shell	0.5	0.53	8.71	0.52	11.8	0.51	8.39	8.39	9.63	1.88
M	Waterfall 1	Waterfall composition		powdered	1473/2	WP9 connected waterfall	0.5	0.52	2.03	0.51	7.05	0.52	5.63	2.03	4.90	2.59

N	Waterfall 1	Waterfall composition		powdered	1473/2	WPS connected waterfall	1.0	1.04	2.16	0.98	1.53	1.01	2.42	1.53	2.04	0.46
O	Fountain	Fountain composition		flake	1265	WP6 fountain	0.5	0.51	53.28	0.51	44.8	0.48	47.28	44.80	48.45	4.36
P	BP/Flash 1	HKF BP / Flash from EXSN 1473/1	80/20	mixture	NA	HKF/Flash 1	0.5	0.5	2.71	0.52	1.78	0.49	1.84	1.78	2.11	0.52
Q	BP/Flash 1	HKF BP / Flash from EXSN 1473/1	60/40	mixture	NA	HKF/Flash 1	0.5	0.51	0.9348	0.49	1.57	0.52	1.69	0.93	1.40	0.41
R	BP/Flash 1	HKF BP / Flash from EXSN 1473/1	50/50	mixture	NA	HKF/Flash 1	0.5	0.48	0.8521	0.48	1.23	0.52	2.04	0.85	1.37	0.61
S	Fountain	Fountain composition		flake	1265	WP6 fountain	1.0	1.04	31.96	0.96	29.95	0.99	49.75	29.95	36.89	10.32
T	Gold Sp.	Gold sparkler		<500µm powder	1717/2	Large gold sparkler	0.5	0.5	NR	0.51	NR	0.48	509.3	509.30	509.30	#DIV/0!
U	Gold Sp.	Gold sparkler		<500µm powder	1717/2	Large gold sparkler	1.0	0.98	111.1	0.99	71.2	0.99	330.2	71.20	170.83	139.45
V	Flash 2	Barium nitrate/aluminium powder	70/30	<250µm powder	NA	Ba(NO ₃) ₂ :Al	0.5	0.53	7.87	0.51	11.09	0.49	14.57	7.87	11.18	3.35
W	BP	Black powder		granular	NA	HKF	0.5	0.5	3.76	0.54	5.55	0.48	5.99	3.76	5.10	1.18
X	Gold Sp.	Gold sparkler		<500µm powder	1717/2	Large gold sparkler	2.0	2.02	48.89	2.02	89.28	2.03	50.34	48.89	62.84	22.91
Y	Gold Sp.	Gold sparkler		<500µm powder	1717/2	Large gold sparkler	3.0	3	37.5	2.97	39.12	2.98	32.47	32.47	36.36	3.47
Z	Gold Sp.	Gold sparkler		<500µm powder	1717/2	Large gold sparkler	4.0	4.01	20.03	4.02	21.71	4.01	19.58	19.58	20.44	1.12
AA	Gold Sp.	Gold sparkler		<500µm powder	1717/2	Large gold sparkler	5.0	5.04	17.73	5.05	mistfire	4.99	16.51	16.51	17.12	0.86
AB	Flash 1	Flash powder from EXSN 1473/1		powdered	1473/1	WPS unsticked rocket	0.5	0.5	0.6364	0.51	0.7951	0.49	0.9112	0.64	0.78	0.14

AC	Whistle 2	Whistle composition from 'Screamer'	<500µm powder	NA	EXSN1645 Festival box	0.5	0.52	1.74	0.52	1.99	0.49	2.16	1.74	1.96	0.21
AD	Red sp.	Red sparkler	powdered	1717/1	Coloured sparklers	0.5	0.48	21.88	0.51	16.09	0.49	40.37	16.09	26.11	12.66
AE	Blue sp.	Blue Sparkler	powdered	1717/1	Coloured sparklers	0.5	0.53	9.25	0.57	18.91	0.49	18.24	9.25	15.47	5.39
AF	Star	Red stars, whole	whole		25 shots cakes' RCC	1.5	1.57	45.59	1.49	23.72	1.48	26.38	23.72	31.90	11.93
AG	Star	Red stars, ground	powdered		25 shots cakes' RCC	0.5	0.48	25.96	0.5	13.49	0.55	9.56	9.56	16.34	8.56
AH	Tracer	Red trace	powdered		25 shots cakes' RCC	0.5	0.47	29.13	0.5	23.29	0.5	33.57	23.29	28.66	5.16
AI	Star	Blue stars, whole	whole		25 shots cakes' RCC	1.5	1.35	23.97	1.51	44.13	1.53	41.19	23.97	36.43	10.89
AJ	Star	Blue stars, ground	powdered		25 shots cakes' RCC	0.5	0.47	17.29	0.48	19.67	0.48	23.59	17.29	20.18	3.18
AK	Tracer	Blue trace	powdered		25 shots cakes' RCC	0.5	0.53	12.23	0.5	10.75	0.55	7.82	7.82	10.27	2.24
AL	Star	Silver bee pellets	whole	1699/2/A	5" silver bee shell	6.5	6.52	6.73	-	-	-	-	6.73	6.73	
AM	Star	Silver bee pellets (partial)		1699/2/A	5" silver bee shell	1.0	1.01	24.21	1.01	20.09	1	26.6	20.09	24.30	4.26
AN	Star	Silver bee pellets (ground)	powdered	1699/2/A	5" silver bee shell	0.5	0.52	6.24	0.54	2.64	0.5	2.27	2.27	3.72	2.19
AO	Star	Green stars, whole	whole		25 shots cakes' RCC	1.4	1.33	26.04	1.35	25.84	1.38	92.79	25.84	48.22	36.60
AP	Star	Green star, ground	powdered		25 shots cakes' RCC	0.5	0.5	9.83	0.49	11.44	0.51	10.03	9.83	10.43	0.88
AR	Whistle	Whistle pellet from 'mini cuckoo'	whole pellet in plastic case	1625	EXSN1645 Festival box	~0.8	NM	7.84	NM	9.4	NM	22.86	7.84	13.37	8.26