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HEALTH & SAFETY LABORATORY

Hand Soldering - Summary of Information

HSL/2006/58

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EXECUTIVE SUMMARY

Objectives

This report was compiled following a request from Andrew Garrod of CHSD 3, Bootle for background information on soldering for an HSE project on rosin-cored solder fume. This project only covers hand soldering and not activities such as wave soldering, plumbing flux, investment casting waxes, hot melt glues, resins, sealing waxes or rosin manufacture.

Main Findings

A wide range of cored solder wires are available from a large number of suppliers.

The various solder wire products can be divided into a relatively small number of groups based on their metal (lead-based or lead-free) and flux (rosin-based, modified rosin, water soluble or rosin-free) composition.

In the past lead-based solders have dominated the market, but this is set to change with the implementation of EC RoHS (Restriction on use of Hazardous Substances) and WEEE (Waste Electrical and Electronic Equipment) directives.

A variety of rosin-free solder products is available, but, for various reasons, the take-up of these products is still relatively low.

Confusion still exists over the definition of “rosin-free”, in particular as to whether fluxes based on “modified rosin” and which may still generate airborne resin acids when heated, should really be regarded as “rosin-free”.

The move to rosin-free products is subject to many of the same concerns as the move to lead-free, namely quality, durability, etc.

Scrutiny of most of the MSDS obtained for rosin-free solders has shown that they contain little or no information on either the compounds present in the flux or those likely to be generated on heating. This lack of product safety information makes a proper risk assessment difficult and provides a major disincentive to their use.

Despite some potentially harmful properties, many of the components identified in the few rosin-free products examined at HSL do not have occupational exposure limits. In addition, there is little or no occupational exposure information related to the use of such products.

There are no set methods for monitoring of fume generated by rosin-free products (other than MDHS 83 to confirm that no resin acids are present in the fume).

Recommendations

If proper risk asssessments are to be undertaken, the standard of product safety information for many solder wire products needs to be improved, particularly in the cases of those products containing rosin-free fluxes.

1 INTRODUCTION

This report was compiled following a request from Andrew Garrod of CHSD 3, Bootle for background information on soldering for an HSE project on rosin-cored solder fume. This project only covers hand soldering and not activities such as wave soldering, plumbing flux, investment casting waxes, hot melt glues, resins, sealing waxes or rosin manufacture.

The report provides a summary of information covering the following issues:-

- Who supplies solder into the UK market, and how is the market moving.
- What solders do they supply (including lead-free solders).
- Which of these claim to be rosin-free, and which really are rosin-free.
- Is it possible to acquire safety current safety data sheets for subsequent scrutiny/analysis.
- Can a ‘mendacity tool’ be created for HSE inspectors, to detect when an employer is trying to deceive HSE about the practicability of substitution.

2 SUPPLIERS

A wide range of different cored solder wires can be obtained from a large number of suppliers.

A search of the Internet located in excess of a hundred products, a figure which rapidly multiplies when all the combinations of metal and flux composition and/or content are taken into account.

A brief summary of the various products and companies located is contained in Annex 1. This list probably covers most of the major suppliers, but it is certainly **not** an exhaustive lists of all possible suppliers of solder wire products.

3 SOLDER PRODUCTS

Cored solder wires, as used in most hand soldering, comprises an alloy wire containing one or more flux cores. During soldering the metal wire is melted to join other metal surfaces whilst the flux reacts with, and removes, compounds from the surface of the joint, to improve the flow of the solder and prevent oxidation. The soldering process generates solder flux fume, the composition of which is dependent on the flux type present. Solder flux fume may also be generated from flux residues during desoldering or recycling operations. Although there is a huge number of products available, the majority of cored solder wires fall into one of the following groups.

3.1 TIN/LEAD SOLDERS

These are the traditional solder wires and generally have a metal content of around 60% tin and 40% lead. These solders generally contain a flux core comprised of one of the following:-

3.1.1 Rosin-Based flux

These are the classic rosin (colophony) solders, typically containing between 1 and 3% w/w of rosin-based flux. This type of flux tends to have a distinct yellow coloration and to leave a hard residue on the work piece after soldering. This residue can be left in situ and hence these products are often referred to as “No Clean”solders. The resin acid components present are generally those containing either two (abietic/pimaric and isomers) or three (dehydroabietic) carbon-carbon double bonds. Fume generated during heating of rosin cored solders forms the basis of current exposure limits. Activators, typically halides, are often added to the flux. These activators increase the reactive properties (or activity) of the flux. This allows soldering of more difficult metals or, alternatively, to reduce the amount of flux in the solder. Activated fluxes can be divided into the following sub-groups according to their degree of activation:-

- **RMA** – Rosin (Mildly Activated);
- **RA** – Rosin (Activated);
- **RSA** – Rosin (Super Activated).

3.1.2 Modified Rosin Fluxes

Modified rosin solders also typically contain between 1 and 3% of flux. Like rosin based products, they are often described as “No Clean” solders, with the main difference being that the residue left behind by modified rosin fluxes is generally colourless. and this is often cited as the main reason for using these products. Analysis of modified rosin fluxes at HSL have shown that they generally contains resin acid components which, compared to those unmodified rosin fluxes, have undergone a hydrogenation/dehydrogenation. This form of chemical modification is often referred to as disproportionation and results in resin acids with zero (tetrahydro- acids), one (dihydro- acids) or three (dehydro- acids) carbon-carbon double bonds.

Experience has shown that solders containing modified rosin flux may, on occasion be described as “rosin-free”. However, like traditional rosin cored solders, these products generate fume containing resin acids on heating, albeit with a quite different resin acid composition. Consequently, it might be considered misleading to think of these products as “rosin-free”. Like

traditional rosin-based fluxes, modified rosin fluxes may also contain additional chemical activators, again typically halides, to increase their effectiveness.

3.1.3 Water Soluble Fluxes

The fluxes used in this group of solders tend to be rather more active than traditional rosin-based alternatives and, as the name suggests, are water soluble. This additional activity means that this groups of products are generally used to solder joints on "difficult" or poor quality surfaces. However, their more active nature also means that any residue remaining after soldering must be removed in order to prevent degradation or other long-term damage to the work-piece. This is the main reason for making the flux water soluble as any residue can be removed by simply rinsing the work-piece with water after soldering. The need for cleaning after soldering means that these solders are not generally used unless absolutely necessary. As well as the additional production time involved, water is obviously not an ideal solvent for electrical equipment and there is also the issue of disposal of the residue contaminated water.

An information search indicated that water soluble fluxes can be based on rosin derivatives or be rosin-free and based on other organic acids or materials such as polyethylene glycol (PEG). Consequently, the fume generated from water soluble fluxes may contain components other than resin acids. For example, one such product tested at HSL was found to generate significant amounts of formaldehyde.

3.1.4 Rosin-Free Fluxes

The strict definition of these products are those which contain fluxes with no colophony content whatsoever (although as mentioned above some modified rosin products have, on occasion, also been described as "rosin-free"). Analysis of a number of these products at HSL has identified mono- and di- carboxylic acids as major components in the fume generated on heating this type of solder. Consequently, the rosin based UK occupational exposure limit for solder flux fume cannot be applied to these products. However, it should be noted that a number of the dicarboxylic acids, whilst not currently subject to UK occupational exposure limits, are described as irritants or even, as in the case of adipic (hexanedioic) acid, potential sensitisers. Therefore, despite being "rosin-free", fume generated from some or all of these products must be regarded as potentially harmful.

Whilst these products are intended as direct replacements for traditional rosin-based solders, take-up is still relatively low. The main reason for this is probably maintaining product quality. Manufacturers tend to have used the same rosin-based products for years and are confident that using these products will achieve required levels product specification without the need for additional research and development costs. In addition, whilst analysis carried out at HSL has shown that fume produced by these products still contains some potentially harmful compounds, most of the relevant material safety data sheets (MSDS) provide little or no indication on what these compounds are. Indeed, most MSDS do not even appear to identify the material present in the bulk flux material, merely stating the metal content of the solder and recommending the continued use of fume extraction. Consequently, it is very difficult for users to perform a proper risk assessment, and this, combined with the fact that use of fume extraction is still recommended, provides another reason not to change.

3.2 LEAD-FREE SOLDERS

As the name suggests, lead free solders contain a metal alloy containing no lead. Typically, the alloys used in this type of product contain a high proportion of tin (often greater than 90% of the

total metal content) with the remainder being mainly a mixture of silver and/or copper. These products are being phased in on environmental grounds as direct replacement products for the various tin/lead based products. In Europe, this replacement of lead containing products has come about as part of EC Directive 2002/95/EC on the Restriction of use of certain Hazardous Substances (RoHS) in Electical and Electronic Equipment (EEE), and, indirectly, from EC Directive 2002/96/EC on Waste from Electrical and Electronic Equipment (WEEE). The RoHS legislation will be enforced, with some exemptions, throughout the European Community from 1st July 2006. With regard to lead based solders, the exemptions are listed in the directive are as follows:-

- Lead in high melting temperature solders (ie tin-lead solders containing more than 85% lead) - this exemption has been introduced to allow the use of lead in solders for specific applications (such as chip manufacture) for which suitable lead-free alternatives have not yet been identified;

- Lead in solders for servers, storage and storage array systems (exempt until 2010) – this exemption has been introduced to allow the use of lead in high reliability applications for which suitable lead-free alternatives have not yet been identified;

- Lead in solders for network infrastructure equipment for switching, signalling, transmission as well as network management for telecommunication – once again, this exemption has been introduced to allow the use of lead in high reliability applications for which suitable lead-free alternatives have not yet been identified.

As can be seen, the scope of these exemptions is potentially quite broad, but basically revolves around the question of reliability of lead-free solders. The main appeal of these exemptions are that they provide a delay allowing supply chains to be fully converted, or to redesign or replace equipment. However, as the use, and manufacture, of lead-free solders becomes the norm, it seems likely that the use of these exemptions will decline, partly because new lead-free products will become available, but also because the availability of leaded solder products will decline. The WEEE directive, and other environmental and health concerns, are also likely to result in pressure from end users to switch to “greener” lead-free products.

Reports produced by the DTI and others indicate that alloys based on tin, silver and copper (SnAgCu) probably offer the best alternative to lead-based solders, with equivalent levels of reliability. However, other tin-based alloys containing antimony, bismuth and zinc have also been developed and are favoured by different industries. Besides the choice of solder alloy, other issues when switching to lead-free products include:-

- Availability of lead-free components;

- Reliability data;

- Rework and repair issues;

- Visual appearance of joints – leading to higher levels of rejection;

- Compatibility of materials, components, equipment and processes with higher soldering temperatures.

Various reports by the DTI states that whilst the wetting performance of lead-free solders is not as good as lead-based products, but the difference is not critical and also depends on flux type. As may be seen in the product list in Annex 1, lead-free solders are available with a very similar selection of rosin-based, modified rosin, water soluble and rosin-free flux cores.

The melting points of lead-free solders tends to be slightly higher (typically around 220°C) than lead-based products (typically around 180°C), with a consequent increase in actual soldering temperatures. This has the potential for generation of higher levels of fume, as previous development work at HSL with rosin-based solders has shown a direct relationship between soldering iron temperature and fume concentration (see Figure 1). In practice however, this difference may not be as great as expected, as existing lead-based solders are often heated to temperatures in excess of the recommended soldering temperature.

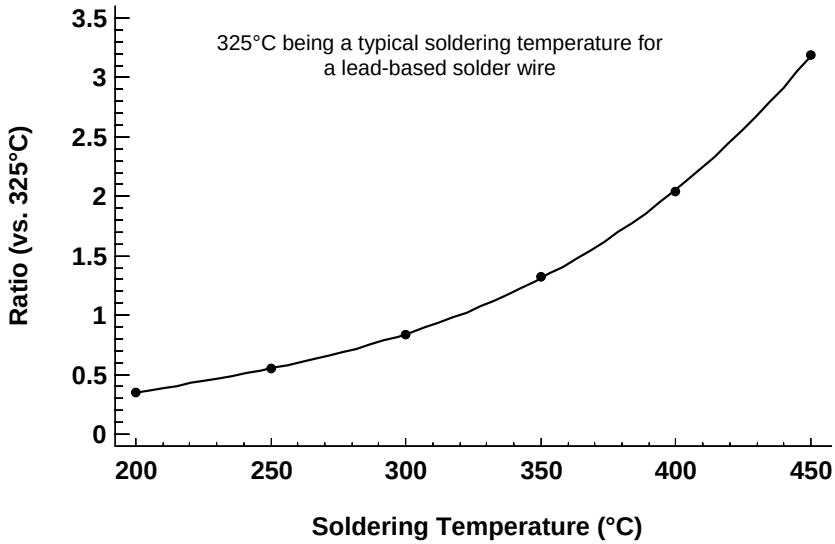

Figure 1: Effect of Soldering Temperature on Amount of Fume Produced

4 SUMMARY

- There is a large number of potential suppliers of solder products in the UK (and an even larger number of products).
- Despite the large number of individual products, solder wires can be divided into a relatively small number of groups based on their metal (lead-based or lead-free) and flux (rosin-based, modified rosin, water soluble or rosin-free) composition.
- In the past lead-based solders have dominated the market, but this is set to change with the implementation of EC RoHS and WEEE directives.
- The RoHS legislation, requiring the removal of lead from new EEE put on the market, will be enforced, with some exemptions, throughout the European Community from 1st July 2006.
- There are various exemptions to the legislation, some with a time limit, which will mean that the use of lead solders continues beyond the implementation date. However, pressures from various sources, particularly end users, mean that the use of these exemptions is likely to decline markedly over time.
- The WEEE legislation covers disposal and recycling of EEE.
- A variety of rosin-free solder products is available, but, for various reasons, the take-up of rosin-based products is still relatively low.
- Confusion still exists over the definition of "rosin-free", in particular as to whether fluxes based on "modified rosin" and which may still generate airborne resin acids when heated, should really be regarded as "rosin-free".
- The move to rosin-free products is subject to many of the same concerns as the move to lead-free, namely quality, durability, etc.
- Scrutiny of most of the MSDS obtained for rosin-free solders has shown that they contain little or no information on either the compounds present in the flux or those likely to be generated on heating. This lack of product safety information makes a proper risk assessment difficult and provides a major disincentive to their use.
- A small number of the rosin-free products have been analysed at HSL. These analyses have shown the presence of a variety of components, some of which, such as adipic acid, may also have sensitising properties.
- Despite some potentially harmful properties, many of the components identified in the few rosin-free products examined at HSL do not have UK occupational exposure limits. In addition, there is little or no occupational exposure information related to the use of such products.
- There are no set methods for monitoring of fume generated by rosin-free products (other than MDHS 83 to confirm that no resin acids are present in the fume).
- Overall, the lack of product safety information for rosin-free products provides many potential users with a good reason to continue using rosin-based products, their argument being basically one of *"better the devil you know"*.

5 REFERENCES

In addition to the references shown below, the websites for the various solder suppliers listed in Annex 1 are a good source of additional background information, including technical an material safety data sheets for many of the solder products.

RoHS Directive 2002/95/EC
27 January 2003
Restriction of the use of certain hazardous substances in electrical and electronic equipment.

WEEE Directive 2002/96/EC
27 January 2003
Waste electrical and electronic equipment (WEEE)

Amendment Directive 2003/108/EC
8 December 2003
Amending Directive 2002/96/EC on electrical and electronic equipment (WEEE)

Solder fume and you
INDG 248
HSE Books

Controlling health risks from rosin (colophony) based solder fluxes
INDG 249L
HSE Books

MDHS 83 (1997)
Resin acids in rosin (colophony) solder flux fume
Laboratory method using gas chromatography

I Pengelly et al. (1994)
Investigation into the composition of solder fume
Ann Occup Hyg, **38**, No. 5, 753-763

I Pengelly et al. (1994)
Development of a method for measuring exposure to resin acids in solder fume
Ann Occup Hyg, **38**, No. 5, 765 – 776

I Pengelly (1999)
Fume from reduced colophony solder
HSL Project report OMS/99/19

NPL
Lead-free literature
www.npl.co.uk

NPL
Lead-free links (details of solder suppliers)
www.npl.co.uk

B Richards (NPL)
Lead-free legislation
www.npl.co.uk

B Richards (NPL)
The reality of lead-free soldering
www.npl.co.uk

B Richards (NPL)
Lead-free soldering – world's apart?
www.npl.co.uk

DTI Report (1999)
B Richards et al.
An analysis of the current status of lead-free soldering
www.npl.co.uk

DTI Report (2000)
B Richards (NPL) & K Nimmo (ITRI)
An analysis of the current status of lead-free soldering – Update 2000
www.npl.co.uk

International Program on Chemical Safety (IPCS)
MSDS for individual chemical compounds
www.inchem.org

M Hickman
Prepare to say farewell to an old friend – Proposed changes to regulations on solder
www.leadsdirect.f9.co.uk

OK International
Hand soldering with lead free alloys
www.documents.rs-components.com

6 ANNEX 1: DATABASE OF SOLDER PRODUCTS

Company	Product	Wire	Flux	Flux description	Flux ingredients	Flux (%)	Wire size	Working temp	TDS*	MSDS*	Analysed†
MBO UK	Fluidel 5	Tin/Lead & Pb-free	HC3	Hydrosoluble-Inorganic acid	6.5% amine	-	0.5 - 5 mm	350 - 450°C	✓	×	×
	Fluidel 5	Tin/Lead (60:40)	SR	Organic water soluble; halide-free	-	1.0 - 3.4%	0.3 - 5 mm	370 - 420°C	✓	×	×
	Fluidel 5	Lead free (Sn/Ag/Cu)	S45V	Colophony (& halide) free	Synthetic resin base	1.0 - 3.4%	0.3 - 6 mm	270 - 420°C	✓	×	×
	Fluidel 5	Tin/Lead	S45V	Colophony (& halide) free	Synthetic resin base	1.0 - 3.4%	0.3 - 6 mm	370 - 420°C	✓	×	×
	Fluidel 5	Tin/Lead	CT2	Rosin - mildly activated (RMA)	Rosin (0.4% halide)	1.0 - 3.4%	0.3 - 5 mm	370 - 420°C	✓	×	×
	Fluidel 5	Tin/Lead	RL3	Rosin base	Rosin (0.5% halide)	-	0.5 - 5 mm	265 - 320°C	✓	×	×
	Autofil 'No-clean'	Tin/Lead & Pb-free	No-clean	Rosin/modified rosin	Rosin (0 - 1.1% halide)	-	0.5 - 5 mm	400°C	✓	×	×
Kester	RA 44	Tin/Lead (60:40)	44	Activated rosin	Rosin	3.3%	0.4 - 1.6 mm	-	✓	✓	×
	No-clean 405	Tin/Lead (63:37)	405	Rosin-free low residue	-	1.0 - 2.2%	0.4 - 1.6 mm	600 - 700°F	✓	✓	✓
	No-clean 245	Tin/Lead (63:37)	245	Modified rosin low residue	Modified rosin	1.1 - 3.3%	0.4 - 1.6 mm	-	✓	✓	✓
	285 RMA	Tin/Lead (63:37)	285	Rosin - mildly activated	Rosin	2.2%	0.4 - 1.6 mm	-	✓	✓	×
	331	Tin/Lead (63:37)	331	Organic water soluble	PEG	3.3%	0.4 - 1.6 mm	-	✓	✓	×

* = Technical Data Sheet (TDS) or Material Safety Data Sheet (MSDS) available on internet; † = Flux analysed previously at HSL

ANNEX 1: DATABASE OF SOLDER PRODUCTS (continued)

Company	Product	Wire	Flux	Flux description	Flux ingredients	Flux (%)	Wire size	Working temp	TDS*	MSDS*	Analysed†
Multicore	362	Tin/Lead	362	Rosin based (0.5% halide)	Rosin	3%	-	-	✓	×	×
	366	Tin/Lead	366	Rosin based (1% halide)	Rosin	3%	-	-	✓	×	×
	Hydro-X	Tin/Lead	Hydro-X	Water soluble	-	2%	-	-	✓	×	✓
	400	Tin/Lead	400	Modified rosin (halide-free)	Modified rosin	3%	-	-	✓	×	×
	502	Tin/Lead	502	Modified rosin (0.2% halide)	Modified rosin	3%	-	-	✓	×	×
	505	Tin/Lead	505	Modified rosin (0.5% halide)	Modified rosin	3%	-	-	✓	×	×
	511	Tin/Lead	511	Modified rosin (1.1% halide)	Modified rosin	3%	-	-	✓	×	×
	X-32	Tin/Lead	X-32	Modified rosin (halide-free)	Modified rosin	0.5 - 3%	-	-	✓	✓	×
	X-38	Tin/Lead	X-38	Modified rosin (halide-free)	Modified rosin	0.5 - 1%	-	-	✓	✓	✓
	X-39	Tin/Lead	X-39	Modified rosin (halide-free)	Modified rosin	1%	-	-	✓	✓	✓
	X-42	Tin/Lead	X-42	Modified rosin (<0.5% halide)	Modified rosin	0.5 - 3%	-	-	✓	✓	×
Warton Metals	Omega	Tin/Lead	Omega	Rosin-free	Aliphatic acids/diacids	1 - 3%	0.3 - 3 mm	-	✓	×	✓
	Omega	Lead-free	Omega	Rosin-free	Aliphatic acids/diacids	2 - 3%	0.3 - 3 mm	-	✓	×	×

* = Technical Data Sheet (TDS) or Material Safety Data Sheet (MSDS) available on internet; † = Flux analysed previously at HSL

ANNEX 1: DATABASE OF SOLDER PRODUCTS (continued)

Company	Product	Wire	Flux	Flux description	Flux ingredients	Flux (%)	Wire size	Working temp	TDS*	MSDS*	Analysed†
Alpha	FT2002	Tin/Lead	FT-2002	"No-Clean" Rosin (& halide) free	Synthetic rosin-free	1.1 - 2.2%	0.4 - 1.25 mm	-	✓	✓	×
	FT2002	Lead-free	FT-2002	"No-Clean" Rosin (& halide) free	Synthetic rosin-free	2.2 - 3.3%	0.4 - 1.25 mm	-	✓	✓	×
	Fluitin 1532	Tin/Lead	1532	Rosin based (0.8 - 1.1% halide)	Rosin WW	1.1 - 2.2%	0.4 - 1.2 mm	-	✓	✓	×
	Fluitin 1532	Lead-free	1532	Rosin based (0.8 - 1.1% halide)	Rosin WW	2.2 - 3.3%	0.4 - 1.2 mm	-	✓	✓	×
	Fluitin 1535	Tin/Lead & Pb-free	1535	Rosin based (0.3 - 0.5% halide)	Rosin WW	2.2%	-	-	✓	✓	×
	Fluitin AS	Tin/Lead	AS/133	"No-Clean" Rosin (halide-free)	Rosin WW	1.4 - 3.3%	-	-	✓	✓	×
	Pure Core	Tin/Lead	H3C	Organic, water soluble rosin	Rosin derivative	2.2 - 3.3%	0.4 - 1.25 mm	-	✓	✓	×
	Pure Core	Lead-free	H3C	Organic, water soluble rosin	Rosin derivative	3.3%	0.4 - 1.25 mm	-	✓	✓	×
	Reliacore	Tin/Lead & Pb-free	Reliacore 15	Rosin based (RMA)	Rosin	3.3%	0.5 - 1.6 mm	-	✓	✓	×
	SMT	Tin/Lead	SMT	Rosin based (halide-free)	Rosin WW	0.5 - 1.1%	0.4 - 1.2 mm	-	✓	✓	×
	SMT	Lead-free	SMT	Rosin based (halide-free)	Rosin WW	1.1 - 2.2%	0.4 - 1.2 mm	-	✓	✓	×

* = Technical Data Sheet (TDS) or Material Safety Data Sheet (MSDS) available on internet; † = Flux analysed previously at HSL

ANNEX 1: DATABASE OF SOLDER PRODUCTS (continued)

Company	Product	Wire	Flux	Flux description	Flux ingredients	Flux (%)	Wire size	Working temp	TDS*	MSDS*	Analysed†
Alpha (continued)	Synalow	Tin/Lead (63:37)	Synalow/113	Rosin based (halide-free)	Rosin	1.1%	0.7 mm	-	✓	✓	×
	Telecore Plus	Tin/Lead	Telecore Plus	"No-Clean" Rosin (halide-free)	Rosin	1.1 - 2.2%	0.4 - 1.25 mm	-	✓	✓	×
	Telecore Plus	Lead-free	Telecore Plus	"No-Clean" Rosin (halide-free)	Rosin	2.2 - 3.3%	0.4 - 1.25 mm	-	✓	✓	×
AIM	OAJ	Tin/Lead	OAJ	Halide activated; water soluble	Rosin derivative?	2%	0.2 - 1.6 mm	650 - 800°F	✓	✓	×
	WS480	Tin/Lead	WS480	Water soluble (halide-free)	-	3%	0.2 - 1.6 mm	650 - 750°F	✓	×	×
	WS482	Lead-free	WS482	Water soluble (halide-free)	Organic amine	2.5%	0.2 - 1.6 mm	650 - 800°F	✓	✓	×
	RMA	Tin/Lead	RMA	Rosin (mildly activated)	Rosin	3%	0.2 - 1.6 mm	650 - 800°F	✓	✓	×
	RA	Tin/Lead	RA	Rosin (activated)	Rosin	3%	0.2 - 1.6 mm	650 - 800°F	✓	✓	×
	RSA	Tin/Lead	RSA-601	Rosin (super activated)	Rosin	3%	0.2 - 1.6 mm	650 - 750°F	✓	×	×
	CF214	Tin/Lead	CF214	"No-Clean" Rosin-free	Rosin-free	1.5%	0.2 - 1.6 mm	650 - 750°F	✓	×	×
	209AX	Tin/Lead	209AX	"No-Clean" synthetic resin	Modified rosin	1 - 3%	0.2 - 1.6 mm	650 - 750°F	✓	×	×
	209AXT	Tin/Lead & Pb-free	209AXT	"No-Clean" synthetic resin	Modified rosin	2%	0.2 - 1.6 mm	650 - 800°F	✓	✓	×

* = Technical Data Sheet (TDS) or Material Safety Data Sheet (MSDS) available on internet; † = Flux analysed previously at HSL

ANNEX 1: DATABASE OF SOLDER PRODUCTS (continued)

Company	Product	Wire	Flux	Flux description	Flux ingredients	Flux (%)	Wire size	Working temp	TDS*	MSDS*	Analysed†
AIM (continued)	210AX	Tin/Lead & Pb-free	210AX	"No-Clean" synthetic resin	Modified rosin	2%	0.2 - 1.6 mm	650 - 800°F	✓	✓	×
	LR-1W	Tin/Lead & Pb-free	LR-1W	"No-Clean" organic acid (halide-free)	C_{1-5} Acids/esters	1.5%	0.2 - 1.6 mm	650 - 800°F	✓	✓	×
	FastCore	Tin/Lead & Pb-free	FastCore	"No-Clean" resin	"Resin"	2.5%	0.2 - 1.6 mm	650 - 800°F	✓	×	×
	Glow Core	Tin/Lead & Pb-free	Glow Core	"No-Clean" resin	Hydrogenated rosin	2.5%	0.2 - 1.6 mm	650 - 800°F	✓	×	×
Almit	KR-15	Tin/Lead	RMA	Rosin (mildly activated)	Rosin	1.6 - 2.6%	-	-	✓	✓	×
	KR-19	Tin/Lead	RMA	Rosin (mildly activated)	Rosin	1.6 - 2.6%	-	-	✓	✓	×
	KR-28	Tin/Lead	RMA	Rosin (mildly activated)	Rosin	1.6 - 2.6%	-	-	✓	✓	×
	HR-19	Tin/Lead	RMA	Rosin (mildly activated)	Rosin	1.6 - 2.6%	-	-	✓	✓	×
	LFM 14	Lead-free	RMA	Rosin (mildly activated)	Rosin	1.6 - 2.6%	-	-	✓	✓	×
	LFM H/R	Lead-free	RMA	Rosin (mildly activated)	Rosin	1.6 - 2.6%	-	-	✓	✓	×
Indium	INDALLOY 241	Lead-free	230	Rosin based	Rosin	1 - 5%	-	-	×	✓	×
	INDALLOY	Tin/Lead	92	"No-Clean" rosin based	Rosin	2 - 3%	-	-	×	✓	×

* = Technical Data Sheet (TDS) or Material Safety Data Sheet (MSDS) available on internet; † = Flux analysed previously at HSL

ANNEX 1: DATABASE OF SOLDER PRODUCTS (continued)

Company	Product	Wire	Flux	Flux description	Flux ingredients	Flux (%)	Wire size	Working temp	TDS*	MSDS*	Analysed†
DKL	EQ-STD	Tin/Lead	RA	Rosin (0.4% halide)	Rosin	2.5%	0.5 - 3 mm	-	✓	×	×
	EQ-LS	Tin/Lead	RA	Rosin (0.4% halide)	Rosin	1.4%	0.5 - 1.2 mm	-	✓	×	×
	SN100C	Lead-free	-	-	-	-	-	-	×	×	×
	SN96SI	Lead-free	-	-	-	-	-	-	×	×	×
RS	M/C 60/40	Sn/Pb	362	Rosin based	Rosin	1 - 5%	0.5 - 1.2 mm	-	×	✓	×
	M/C LMP 362	Sn/Pb/Ag	362	Rosin based	Rosin	1 - 5%	0.5 - 1.2 mm	-	×	✓	×
	M/C Savbit	Sn/Pb/Cu	362	Rosin based	Rosin	1 - 5%	0.7 - 1.2 mm	-	×	✓	✓
	M/C X-39	Sn/Pb	X-39	Modified rosin	Modified rosin	1 - 5%	0.7 - 1.2 mm	-	×	✓	✓
	M/C Hydro-X	Tin/Lead	Hydro-X	Water soluble	-	-	0.7 - 1.2 mm	-	✓	✓	×
	M/C Crystal 400	Sn/Pb	Crystal 400	Modified rosin	Modified rosin	1 - 5%	0.7 - 1.2 mm	-	×	✓	×
	M/C Crystal 511	Sn/Pb	Crystal 511	Modified rosin	Modified rosin	1 - 5%	0.7 - 1.2 mm	-	×	✓	×
	M/C 60EN	Sn/Pb	Ecosol 105	Rosin-free (0.5% halide)	"Carboxylic acid"	-	0.7 - 1.2 mm	340-420°C	✓	✓	✓
	M/C 96SC	Sn/Ag/Cu	Ecosol 105	Rosin-free (0.5% halide)	"Carboxylic acid"	-	0.5 - 1.2 mm	340-420°C	✓	✓	×
	M/C 99C	Sn/Cu (99:1)	362	Rosin based	Rosin	3%	0.5 - 1.2 mm	350-370°C	✓	✓	×

* = Technical Data Sheet (TDS) or Material Safety Data Sheet (MSDS) available on internet; † = Flux analysed previously at HSL

ANNEX 1: DATABASE OF SOLDER PRODUCTS (continued)

Company	Product	Wire	Flux	Flux description	Flux ingredients	Flux (%)	Wire size	Working temp	TDS*	MSDS*	Analysed†
RS (continued)	On-Line 60/40	Sn/Pb	-	Rosin based	Rosin	1 - 5%	-	-	×	✓	✓
	Alpha FT1532	Sn/Pb & Pb-free	FT-1532	Rosin based (0.8 - 1.1% halide)	Rosin	1.1 - 2.2%	0.4 - 2 mm	-	✓	✓	×
	Alpha FT2002	Sn/Pb & Pb-free	FT-2002	Synthetic rosin/halide-free	Rosin-free	1.1 - 2.2%	0.4 - 1.3 mm	-	✓	✓	×
	Alpha HMP	Sn/Pb & Pb-free	RS7MI	Rosin based (1.4 - 1.8% halide)	Rosin	2.2%	1 mm	-	✓	✓	×
	Alpha SMT	Sn/Pb & Pb-free	SMT	Rosin based	Rosin	0.6 - 1.1%	0.4 - 0.75 mm	-	✓	✓	×
Fry	AC92/93/94	Sn/Pb & Pb-free	AC92/93/94	"Organic acid"	NH_4 chloride	< 1%	-	-	×	✓	×
	AC90/96	Sn/Pb & Pb-free	AC90/96	-	NH_4/Zn chloride	1 - 4%	-	-	×	✓	×
	RFC	Sn/Pb/Cu	Rosin	Rosin based	Rosin	1 - 3%	-	-	×	✓	×
	WSFC	Sn/Pb & Pb-free	WSF	Water soluble flux	"Rosin amine"	1 - 4%	-	-	×	✓	×
	NC 53	Lead-free	NC 53	Rosin ester	"Rosin ester"	< 1%	-	-	×	✓	×
	Supercore	Sn/Pb & Pb-free	RA	Rosin based	Rosin	1 - 4%	-	-	×	✓	×

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