

REPORT

Survey of Rework Practices in the UK Electronics Assembly Industry

M Wickham and C P Hunt

January 1998

January 1998

SURVEY OF REWORK PRACTICES
IN THE UK ELECTRONICS
ASSEMBLY INDUSTRY

M Wickham and C P Hunt
Centre for Materials Measurement and Technology
National Physical Laboratory
Teddington
Middlesex
United Kingdom
TW11 0LW

ABSTRACT

A survey of the rework practices of the UK electronic assembly industry has been undertaken. Rework of electronics components in the UK was found to be dominated by the use of soldering irons. Many companies did not control tip temperatures, rework times, background heating or the number of rework operations which could be undertaken on any one component. Few companies followed the recommendations of component manufacturers aimed at preventing damage to thermally sensitive components. It was found that those companies which did control rework temperatures, did reduce rework temperatures for SM components. In general rework temperatures were much higher than those recommended by component manufacturers. A great deal of cleaning was undertaken after rework with most companies doing some form of local cleaning. Most companies reused components if only on an occasional basis.

© Crown copyright 1998
Reproduced by permission of the Controller, HMSO

ISSN 1361-4061

National Physical Laboratory
Teddington, Middlesex TW11 0LW, UK

Extracts from this report may be reproduced provided the source is acknowledged.

Approved on behalf of Managing Director, NPL, by Dr C Lea,
Head, Centre for Materials Measurement and Technology

CONTENTS

	Page
1 INTRODUCTION	1
2 SURVEY RESULTS AND DISCUSSION	1
2.1 Market Sectors of Companies Completing Survey	1
2.2 Tools Used for Rework	2
2.3 Package Styles of Components Reworked	3
2.4 Rework On Individual Component Types	3
2.4.1 Through-hole Rework	3
2.4.2 Rework of Chip (C's, R's etc.) Components	4
2.4.3 Rework of SOT Components	5
2.4.4 Rework of MELF & SOD Components	6
2.4.5 Rework of SOIC & TSOP Components	6
2.4.6 Rework of PLCC Components	7
2.4.7 Rework of QFP Components	8
2.4.8 Rework of BGA Components	9
2.4.9 Rework of LCCC Components	9
2.5 Solder Types Used in Rework	10
2.6 Solder Alloys Used in Rework	10
2.7 Use of Cleaning After Rework	11
2.8 Reusing components that have been previously removed	11
2.9 Use of background heating	13
2.10 Control of tool tip temperature on soldering irons	13
2.11 Control of rework with soldering irons	14
2.12 Control of SM rework with hot gas pencils	16
3 CONCLUSIONS	17
APPENDIX - Survey Questionnaire	18

1 INTRODUCTION

The National Physical Laboratory is about to embark on a major research programme to investigate the effect of rework on the reliability of soldered assemblies. To better understand the practices that industry uses to rework components, the NPL conducted a survey, the results of which form the basis for this report. The survey covers both through-hole (TH) and surface mount (SM) rework and covered the following types of tools :

Standard soldering and desoldering irons : These are conventional soldering irons. They use an electrical heater to warm an iron core which is thermally connected to tip. The energy from the core is rapidly transferred to the tip when it is cooled. These irons normally have a power rating of greater than 35W (for less than 35W see miniature soldering irons) and many have variable temperature control. Desoldering irons usually have an integral method for removing solder from the joint. Modified tips may be used to solder and de-solder multi-pin devices.

Heated tip soldering irons : Irons which have a tip heated internally rather than using heat stored in an iron core within the shaft of the iron. Manufacturers include Metcal and Pace Sensatemp. Typically these irons do not have a power rating. Modified tips may be used to solder and de-solder multi-pin devices.

Miniature soldering irons : Similar to standard soldering irons but with a lower power rating, smaller thermal mass and a finer tip. Typical power ratings are between 18 and 25W. Some versions are temperature controlled.

Heated Tweezers : Tools which incorporate two heated tips which are joined by a hinged mechanism so that the tips can be clamped around both ends of the component to be reworked.

Hot air pencils : Small hand-held tools which emit a narrow stream of heated air. Usually a single nozzle less than 5mm in diameter is used. For larger diameter nozzles see next section.

Hot air hand tools : Larger hand-held systems which resemble modified paint strippers or heat guns. These often use nozzles especially shaped to individual component types.

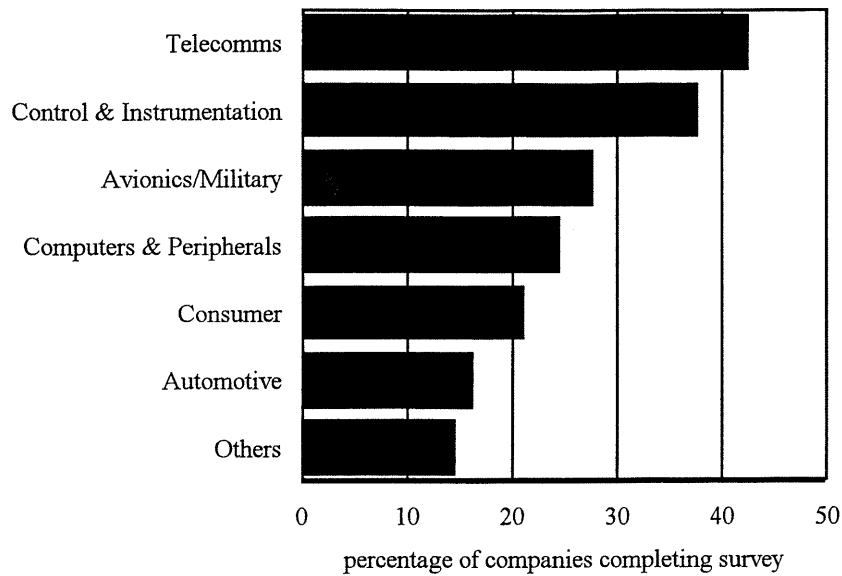
Hot gas rework equipment : Larger still, bench top models with interchangeable nozzles. These machines may have optical systems to assist the operator in aligning components with the substrate. Primarily designed for multi-pin surface mount devices.

Infrared rework equipment : Bench top equipment which heats the component to be reworked by an infrared source. This is usually either a focused IR. lamp or a set of heated wire elements.

2 SURVEY RESULTS AND DISCUSSION

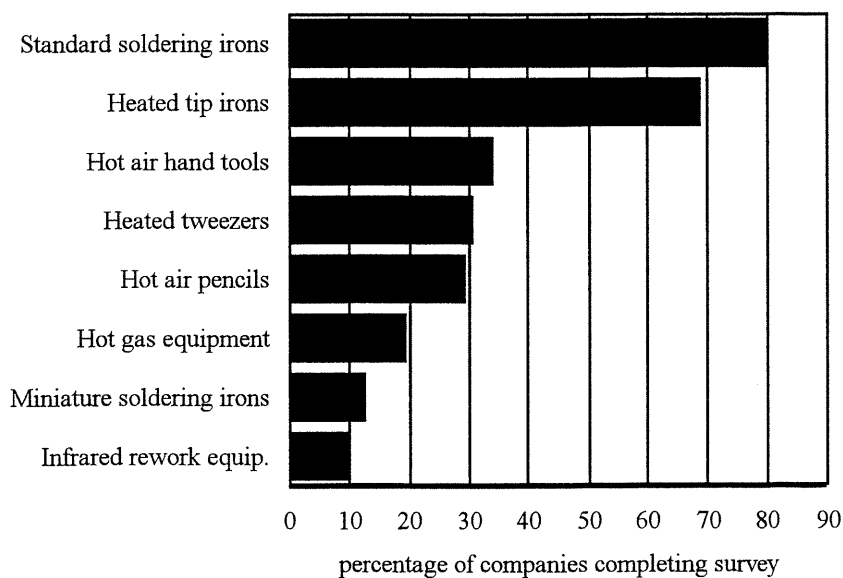
2.1 Market Sectors of Companies Completing Survey

In total, usable replies were received from 61 different companies. The market sectors of the industry in which the companies were involved can be seen in Figure 1. The total replies add up to more than 100% as a number of companies were active in more than one market sector.

Figure 1 : Market Sectors of Companies Completing Survey

2.2 Tools Used for Rework

Rework of electronic components, both TH & SM, is dominated by soldering irons (Figure 2). Conventional soldering irons, which use a heated metal slug in the barrel of the iron to transfer heat to the tip were the most popular being used by over 80% of companies. But newer soldering iron designs incorporating direct tip heating without using large metal heat reservoirs were almost as popular at nearly 70% of replies. The other tools used were mainly surface mount rework tools such as hot air hand tools, hot gas equipment and infra-red rework equipment used mainly for higher pin count packages and heated tweezers, hot air pencils and miniature soldering irons used predominantly on passives or discretes or in the case of the latter two, rework of individual joints on larger packages.

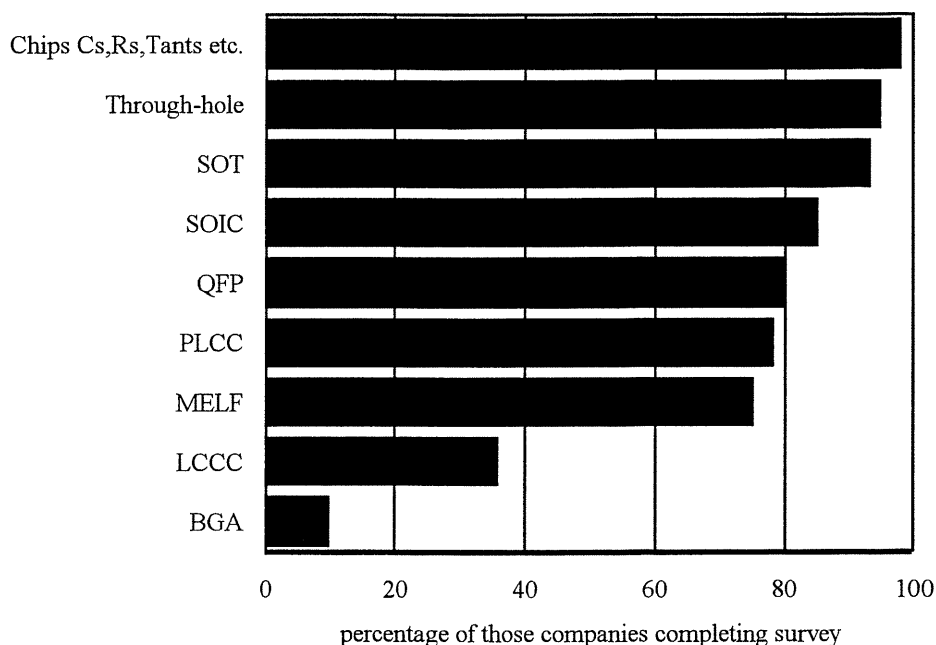
Figure 2 : Tools Used For Rework

2.3 Package Styles of Components Reworked

The responses to this question (Figure 3) clearly indicated the mixed technology nature of the industry today. Only 5% of respondents did not rework TH components. All respondents did some form of SM rework. Perhaps this should not be taken as true representation of the industry as a whole, as the group sampled, through their association with the Soldering Science and Technology Club, were more likely to utilise SM technology than on average. Respondents utilised MELF components less frequently than chip or SOT devices. Quad flat packs (QFPs) were the favoured multipin package just ahead of PLCCs. Ball grid arrays (BGAs) were reworked by less than 10% of the survey.

Leadless ceramic chip carriers (LCCC) were reworked by over 35% of replies. This must be considered higher than would be expected, probably due to the number of companies (around 30%) replying that were involved in high reliability electronics such as avionics.

Figure 3 : Package Styles of Components Reworked

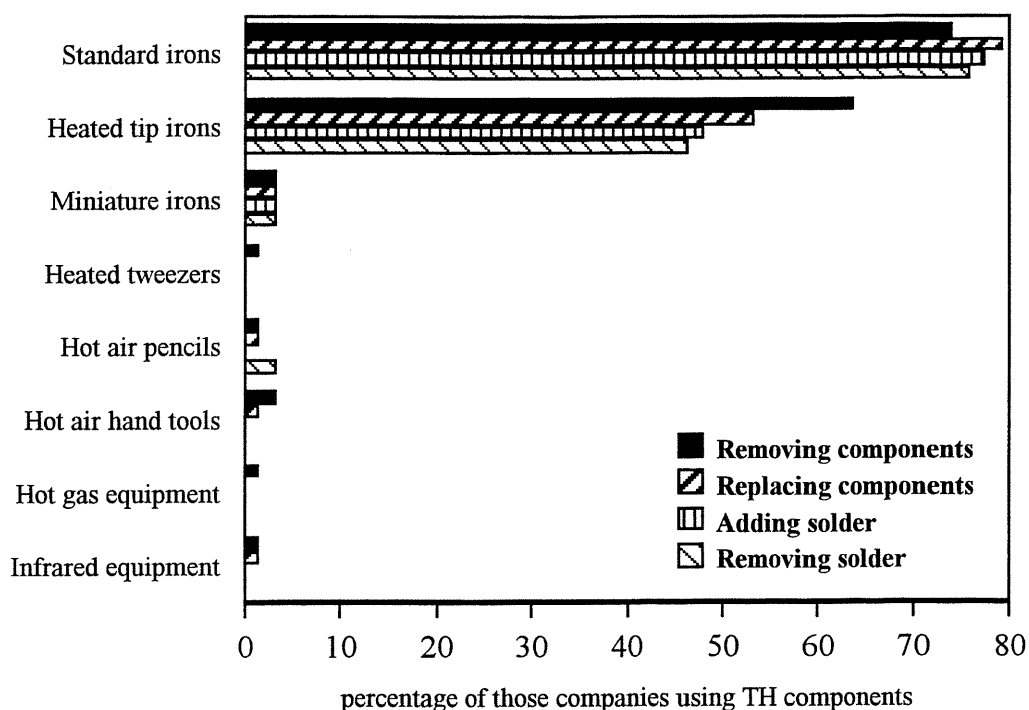


2.4 Rework On Individual Component Types

The survey requested respondents to indicate which tools were used on which components for each of four types of rework. The four types of rework surveyed were removing components, replacing components, adding solder and removing solder.

2.4.1 Through-hole Rework

The rework of conventional through-hole components was found to be completely dominated by soldering irons as (Figure 4). Standard irons were slightly more popular than the heated tip irons, with both types being used extensively for all four types of rework activity. The other tool options, being mainly intended for SM work, were little used for any of the TH rework operations.

Figure 4 : Rework of Through-hole Components

2.4.2 Rework of Chip (C's, R's etc.) Components

The rework of SM chip passive components was also dominated by the use of soldering irons as shown in Figure 5. Heated tip irons were used by slightly more companies than standard soldering irons. Both iron types were used extensively for all four types of rework operations. A slight preference of companies for heated tip irons was probably due to the sensitivity of multilayer ceramic chip capacitors to thermal shock. Rapid changes in body temperature of these components can cause microcracks to form between layers within the capacitor. These are often undetectable at final inspection, but when the components are stressed in the field, these microcracks can propagate causing field failure. The heated tip irons, with their directly heated tips, are believed to submit such components to less thermal shock.

A similar thinking may account for the usage by around 10% of companies completing the survey, of miniature soldering irons. If soldering irons must be used to rework chip capacitors, some component manufacturers recommend the use of such miniature irons because of the lower thermal shock they can produce. Heated tweezers were used by about a quarter of companies, primarily to remove chip components, because the single hand "clamping, heating and removal" operation of these tools makes for easy chip removal. They are a clumsy tool for adding or removing soldering, as both chip joints are caused to reflow and therefore it was unsurprising that no respondents used them for this task.

Both hot air pencils and hand tools were used by around 10-20% of respondents mainly for removal and replacement of components, where both joints need to be reflowed simultaneously. These tools were less popular for adding or removing solder from chip components even though **they are the preferred rework tool** recommended by some multilayer ceramic chip capacitors manufacturers, because they are less likely to cause thermal shock damage. The more sophisticated hot gas equipment is used by a few companies (less than 10%) for removing and replacing chip components but not for adding or removing

components. These would be expensive tools to use for all four. Infrared rework equipment was only used by one respondent for all four types of rework.

Figure 5 : Rework of Chip Components

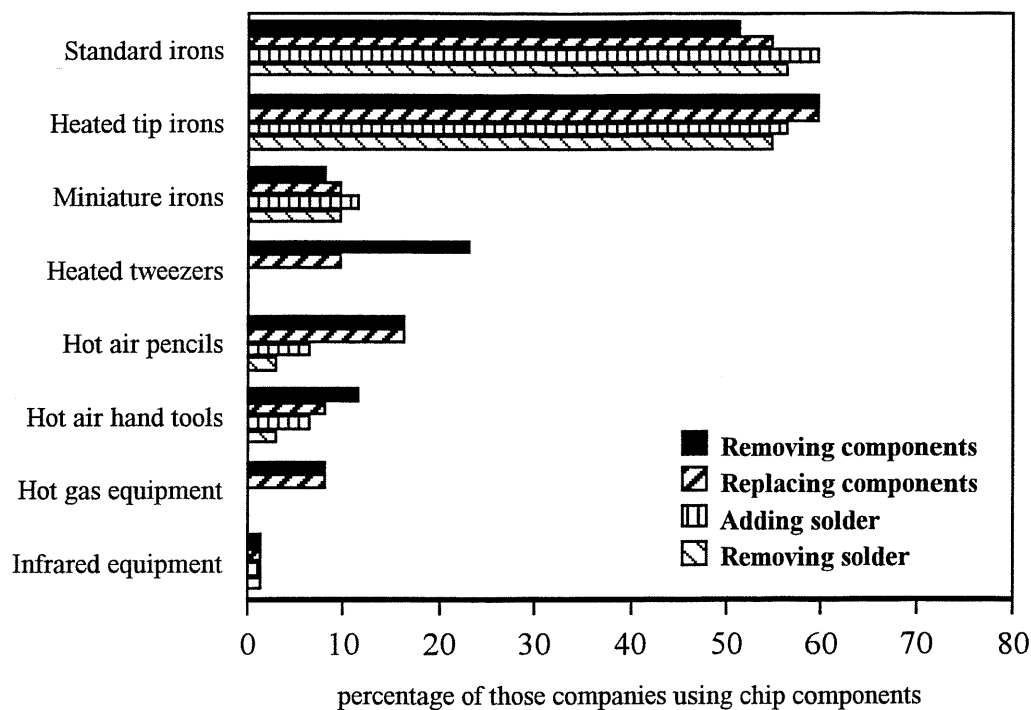
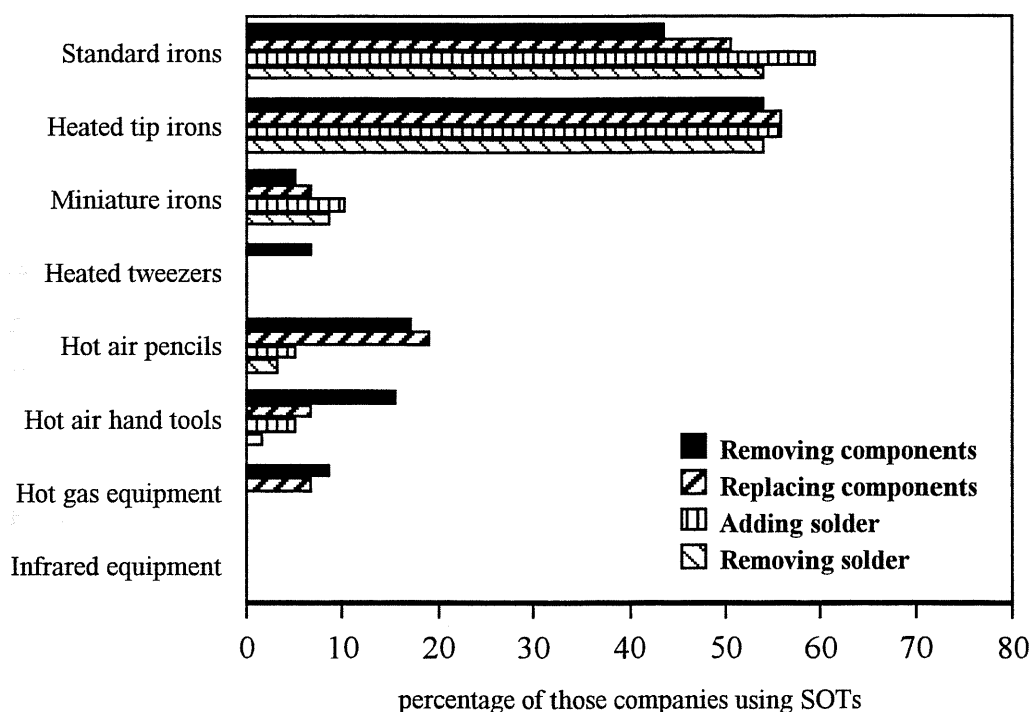


Figure 6 : Rework of SOT Components



2.4.3 Rework of SOT Components

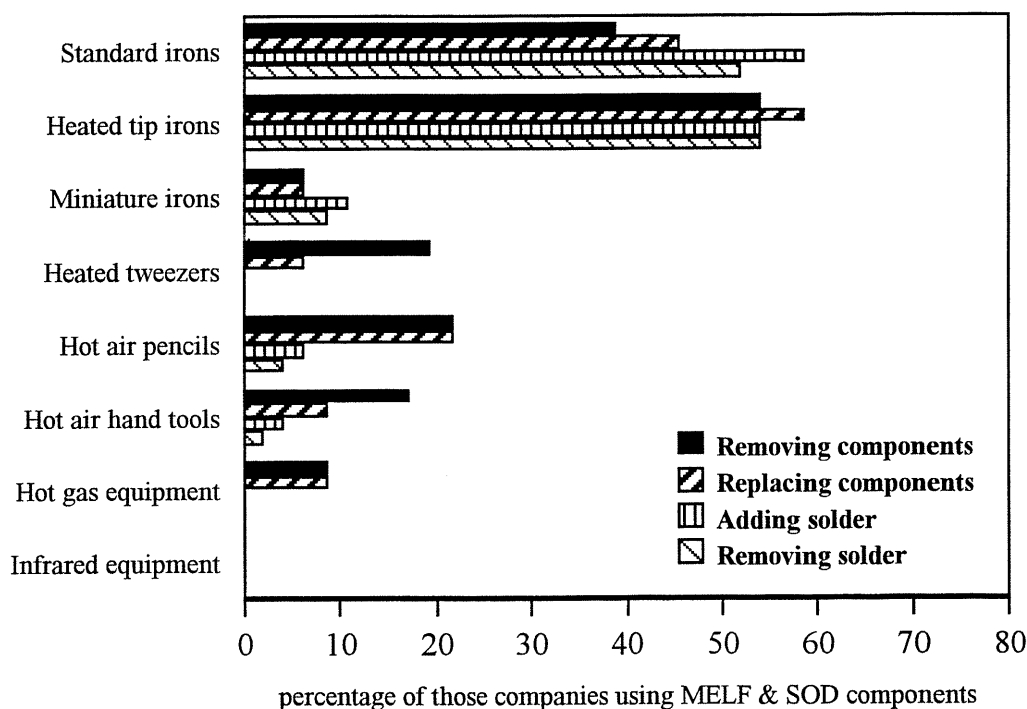
Responses for SOT components (Figure 6) were very similar to those for chip components. Rework was dominated by soldering irons, with heated tip irons being slightly more popular than standard irons. Miniature irons were used by a limited few. Heated tweezers are only

used on SOT components for the removal operation and then by less companies than for chip components. Hot air pencils and hand tools were used slightly more frequently than for chip components. Infrared rework equipment was not used for SOT rework by any of the respondents.

2.4.4 Rework of MELF & SOD Components

The picture for rework of SM cylindrical component was again very similar to that for chip and SOT components. Rework of MELF and SOD components was again dominated by soldering irons (Figure 7). Heated tip irons were used by slightly more companies than standard irons. Heated tweezers were used by around 25% of companies for removing the components, and by around 10% of companies for replacing them. Heated tweezers were not used for adding or removing solder. Hot air pencils, hand tools and hot gas rework equipment were used by similar numbers of companies as for the chip and SOT components. Infra-red rework equipment was not used for reworking these component types.

Figure 7 : Rework of MELF & SOD Components



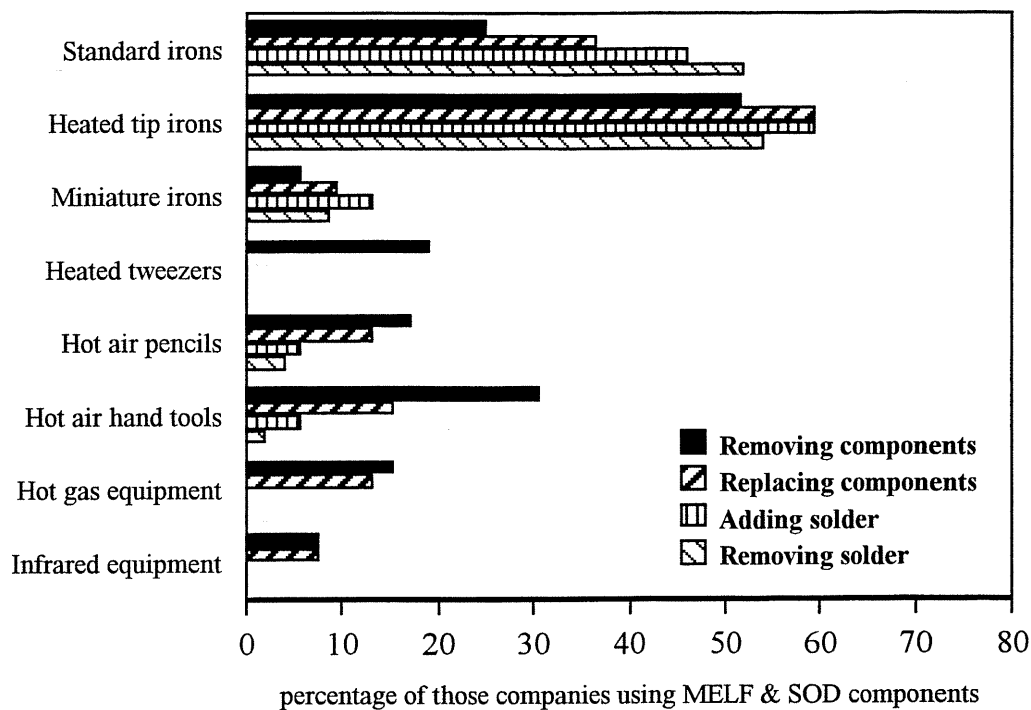
2.4.5 Rework of SOIC & TSOP Components

The types of rework tools used for the higher pin-count packages does change a little from those used for smaller components. The types of tools used for rework of SOIC and TSOP components can be seen in Figure 8. Rework was still dominated by the use of soldering irons, with heated tip irons again proving more popular than standard irons. Indeed, there was a marked reduction in the numbers of companies using standard irons to remove or replace SOIC and TSOP components compared to the results for smaller components. Heated tweezers were used by approximately 20% of companies for removing SOICs and TSOPs but none used them for replacing components.

Usage of hot air pencils was about the same as previously but there was a marked increase in the use of hot air hand tools and hot gas equipment for removing and replacing of components as these tools are well suited to simultaneous reflow of all the leads on a multipin device.

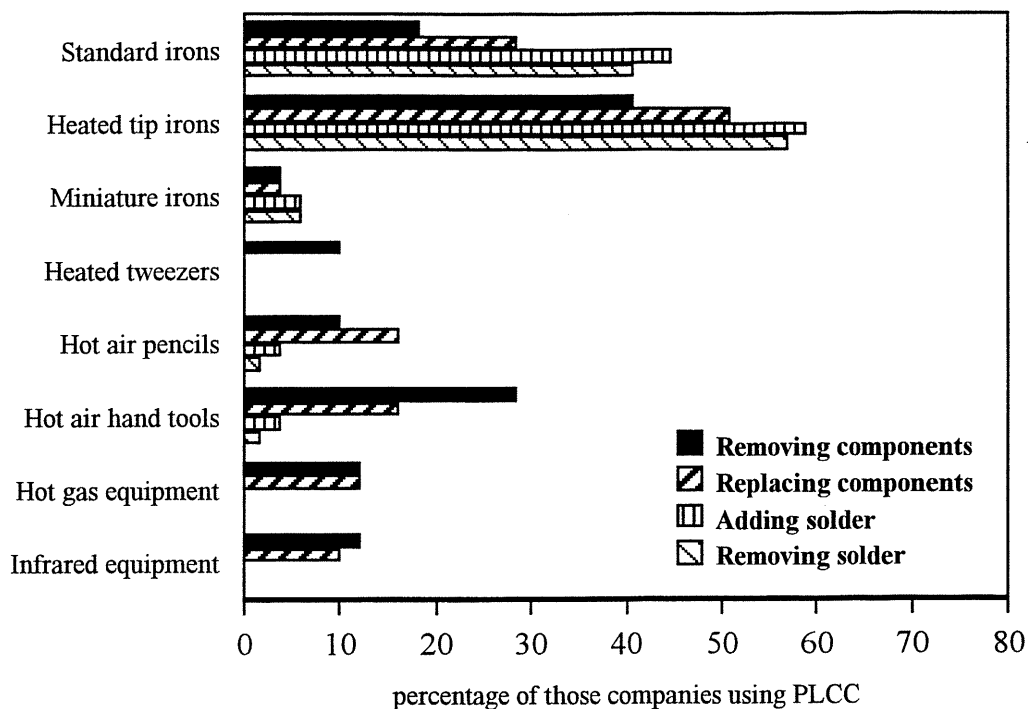
Similar trends were seen in the use of infrared rework equipment although it is still less than 10% of companies that used this type of tool for rework of SOICs and TSOPs.

Figure 8 : Rework of SOIC& TSOP Components



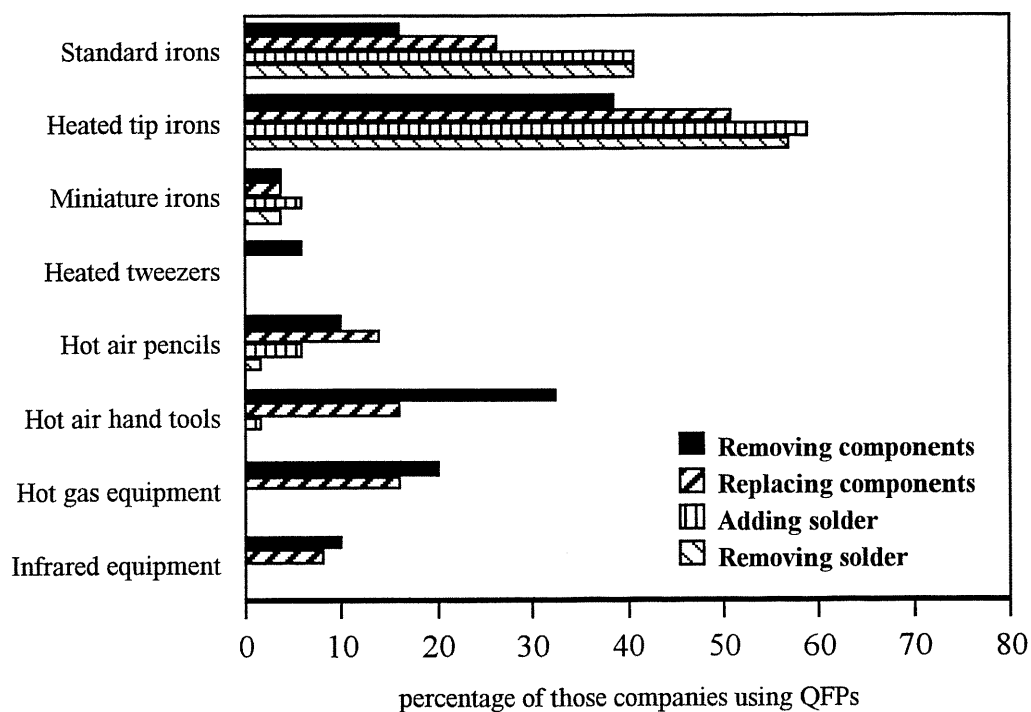
2.4.6 Rework of PLCC Components

The types of tools used for the four sided multi-pin PLCC components differed little from two sided multi-pin components such as SOICs (Figure 9). Rework was still dominated by the use of soldering irons. Again, heated tip irons were more popular than standard irons. Both miniature irons and heated tweezers were used less than for SOIC components. Hot air pencils were used less for removal of components but still used by around 20% of companies for replacing components. Hot air hand tools, hot gas equipment and infra-red equipment were used primarily for removing or replacing PLCCs by about the same number of companies as for SOICs.

Figure 9 : Rework of PLCC Components

2.4.7 Rework of QFP Components

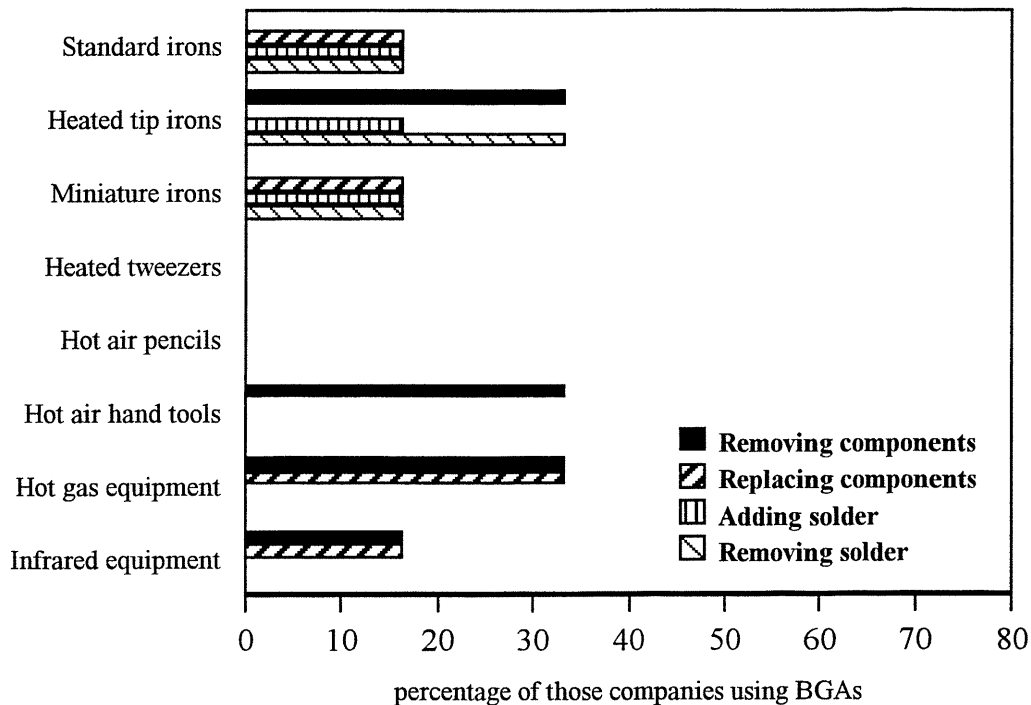
The tools used for rework of QFPs, as shown in Figure 10, was very similar to rework of PLCCs. The only significant difference was a slightly increased use of hot gas equipment.

Figure 10 : Rework of QFP Components

2.4.8 Rework of BGA Components

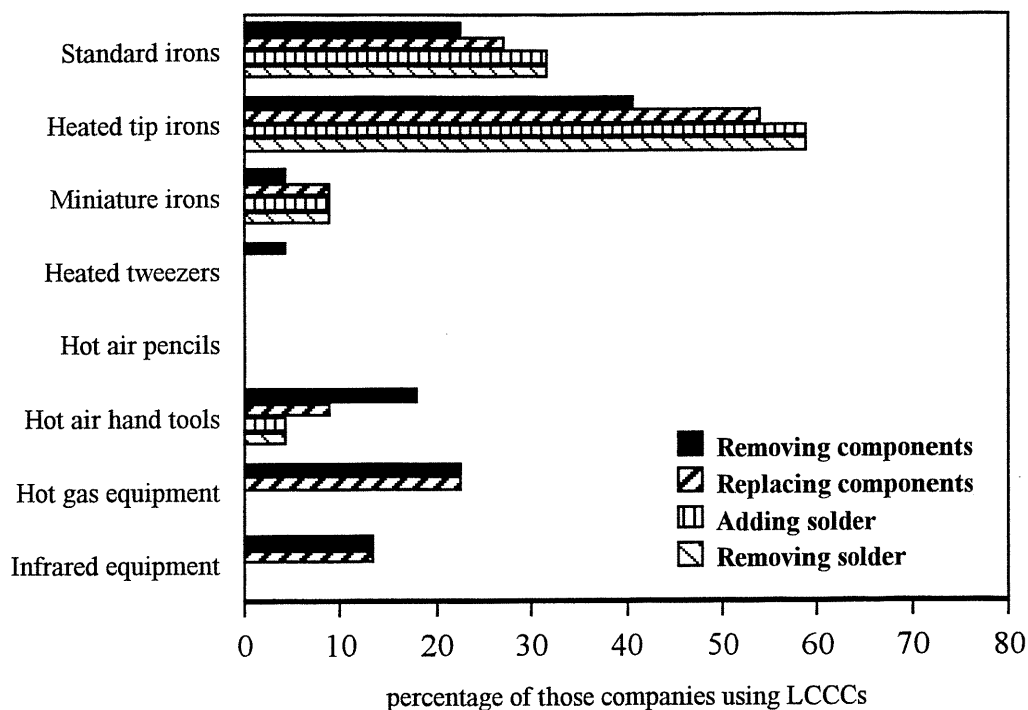
The tools used for the rework of BGA components is shown in Figure 11. It should be noted that these results are based on completed surveys from only six companies. Most users utilised hot air hand tools or hot gas equipment to remove BGAs although one user utilised infra-red rework equipment and surprisingly, several companies used soldering irons. Soldering irons were also used by one company to add or remove solder from BGA joints.

Figure 11 : Rework of BGA Components



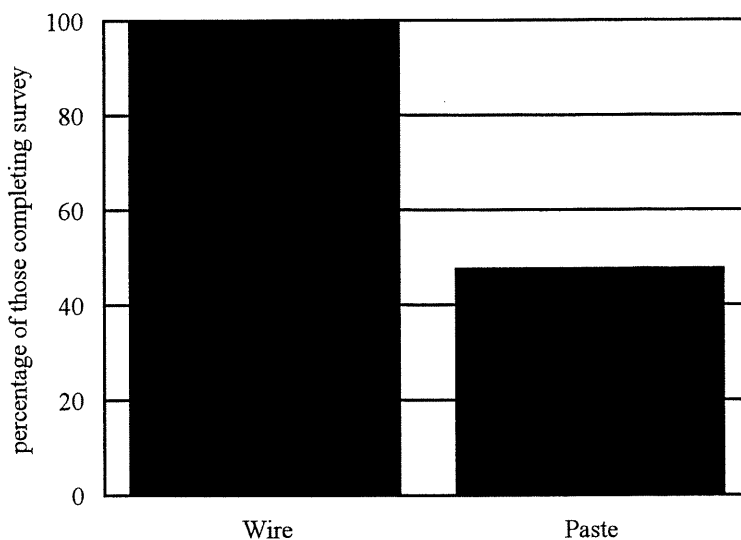
2.4.9 Rework of LCCC Components

As with the majority of other components, the rework of LCCC components as shown in Figure 12, was dominated by soldering irons. Heated tip irons were approximately twice as popular as standard irons. Miniature soldering irons were used by a limited few and heated tweezers were only used by around 5% of companies only to remove components. Hot air pencils were not used by any companies.

Figure 12 : Rework of LCCC Components

2.5 Solder Types Used in Rework

Solder wire is used by all companies who responded (Figure 13). Around 50% of companies also used solder paste.

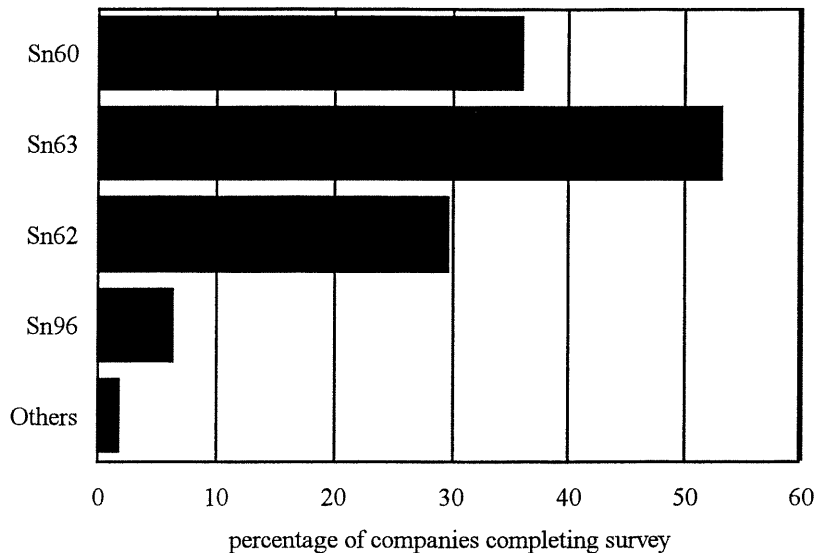
Figure 13 : Solder Type Used During Rework

2.6 Solder Alloys Used in Rework

Figure 14 shows the alloys used by responding companies for rework. Eutectic or near-eutectic alloys (63Sn37Pb & 60Sn40Pb) were favoured. The alloy containing 2% silver (62Sn36Pb2Ag) was used by nearly a third of companies. This alloy is traditionally used to prevent leaching of silver from the termination of chip components. These components are rarely used in manufacture today, being replaced by components with a nickel barrier in the termination. The continued use of the 2% silver alloy may be caused by the continuation of an out dated practice. However, several users have reported utilising this alloy as it maintains a

brighter joint when the solder is molten for extended periods. This practice may be doing a disservice to those companies by helping to hide poor quality rework. The high melting point alloy (96.5Sn3.5Ag) was used by around 5% of companies responding. This alloy may be used for assemblies required to operate at high temperatures or that have to withstand a subsequent soldering operation without joints reflowing.

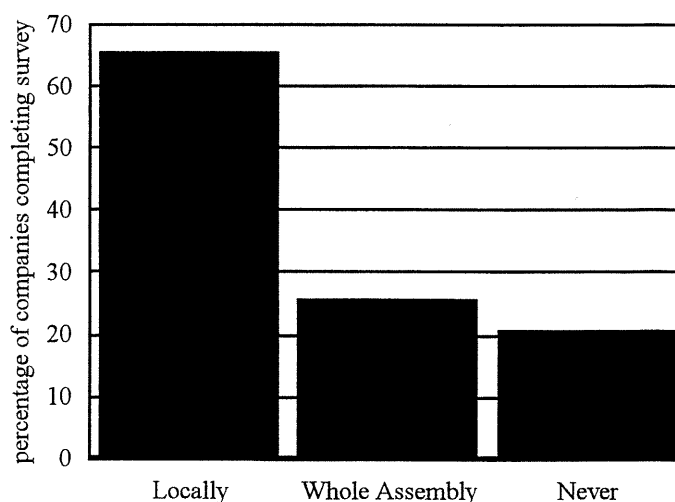
Figure 14 : Solder Alloy Used in Rework



2.7 Use of Cleaning After Rework

Figure 15 shows the survey responses related to cleaning after rework. Two thirds of those responding used localised cleaning methods after rework. About a quarter of companies undertook a complete cleaning of the reworked assembly. Perhaps most surprising is the low number of companies that do not clean at all after rework. Only one quarter of those responding did not clean, a lower fraction than might be expected, as it is believed that upwards of 50% of companies use no-clean fluxes in production.

Figure 15 : Use of Cleaning After Rework



2.8 Reusing components that have been previously removed

Just over one quarter of respondents did not reuse components as seen in Figure 16. A minority (~ 7%) reused components frequently. The majority of companies (2/3 of those responding) reused components occasionally. The types of component reused is shown in

Figure 17. TH components are the most frequently reused by slightly over half of those responding and reflects their robustness. BGA's, QFP's and PLCC's are reused almost as frequently. This is doubtless because these package styles generally represent the most expensive components and therefore the temptation to reuse them and reduce costs must be high. The reuse of these components must be undertaken with care as all these package styles can be prone to the "popcorn" effect, where moisture within the package can expand rapidly during heating cycles above 100°C, causing package distortion, delamination or cracking. These failure modes can cause component failure in the field or poor soldering yields. Reuse of SOICs and chip components is undertaken by around one third of companies using those components. Again, caution should be practiced with the reuse of chip components because of their potential damage by thermal shock as mentioned previously. Clearly the robustness, reliability and cost issues make chip components the least attractive to reuse. SOT and LCCC components are reused by around 25% of respondents. MELF components are reused the least at less than 20%.

Figure 16 : Reusing components that have previously been removed

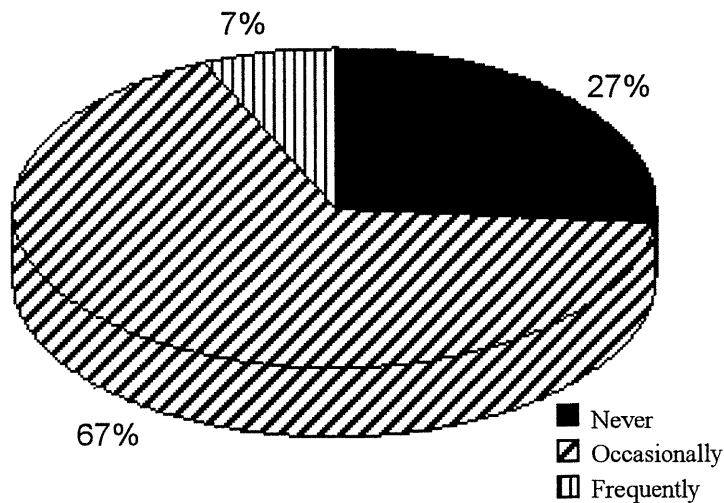
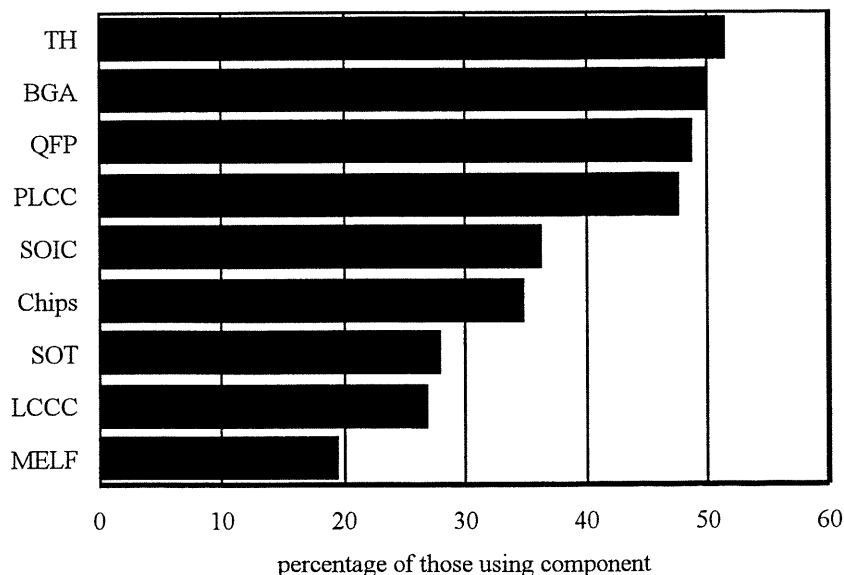


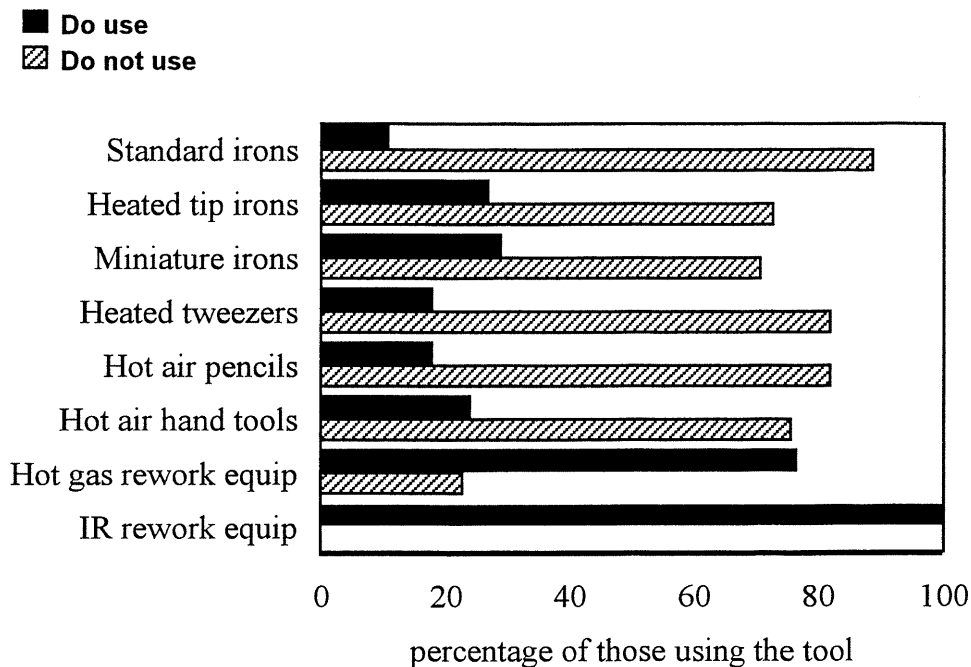
Figure 17 : Reusing Components



2.9 Use of background heating

For the majority of rework equipment, background heating was used by less than 25% of respondents (Figure 18). The exceptions were nearly 80% of respondents using hot gas rework equipment and all users of IR rework equipment.

Figure 18 : Use of background heating



2.10 Control of tool tip temperature on soldering irons

Around two thirds of respondents did not control the temperatures of their soldering irons (Figure 19). With the rework using standard irons, tool tip temperatures were controlled less frequently for SM components than for TH components. This despite thermal shock sensitivity of many SM components as detailed earlier. Tip temperatures for SM rework with heated tip irons were more often controlled than for TH rework.

With both iron types, the average set temperature was lower for SM components than for TH components (Figure 20). However, the set temperatures were all in excess of 325°C. This is much higher than that often recommended by chip capacitor manufacturers (280°C) to help prevent thermal shock and also that recommended by manufacturers of thermoplastic SOT23 components (again 280°C) to prevent damage to component bodies.

Figure 19 : Control of tool tip temperature

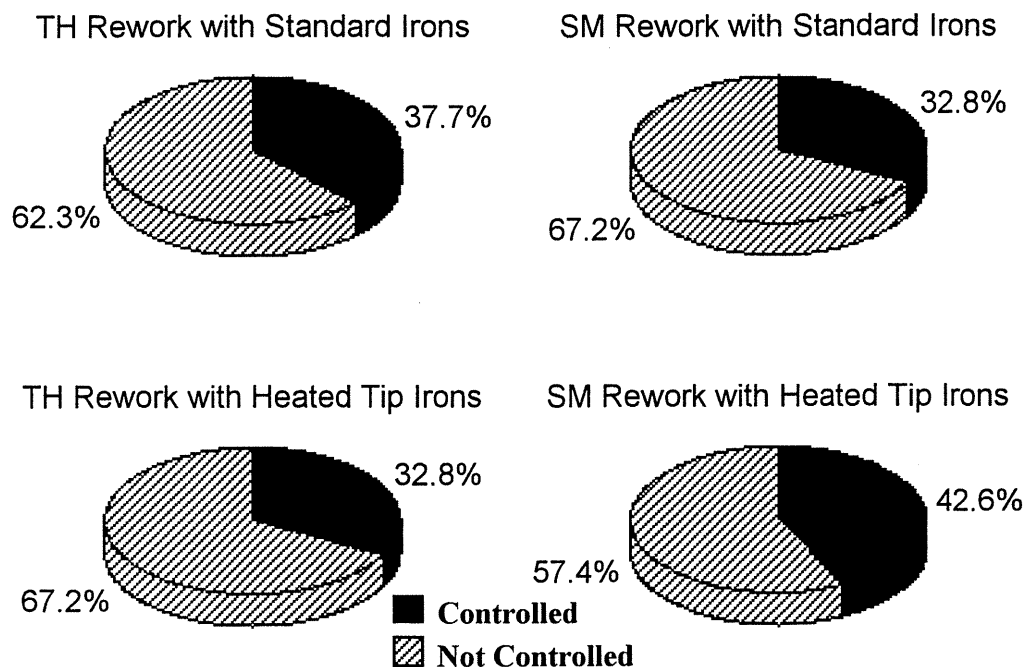
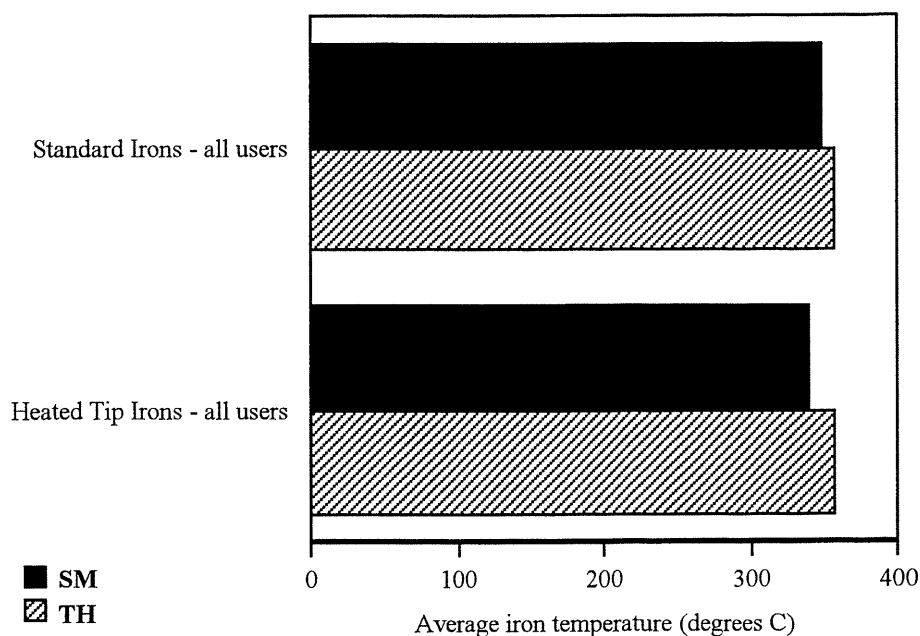


Figure 20 : Average Iron Temperatures



2.11 Control of rework with soldering irons

In general, with rework using soldering irons, neither the length of the soldering operation nor the number of times that a component could be reworked were controlled (Figures 21, 22, 23 & 24). With standard soldering irons the rework of SM components was slightly more

controlled than for TH components. The use of heated tip irons was more controlled than standard irons.

Figure 21 : Control of TH Rework With Standard Soldering Irons

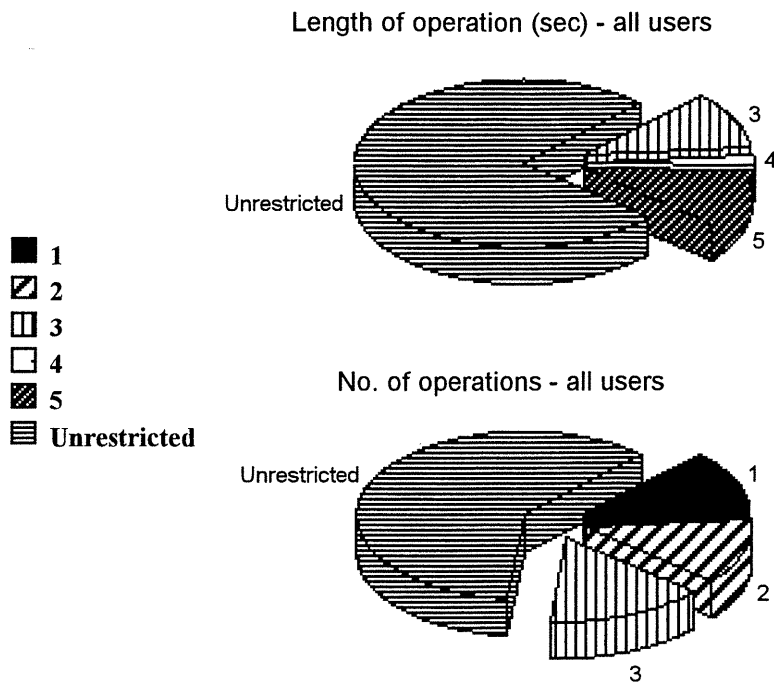


Figure 22 : Control of SM Rework With Standard Soldering Irons

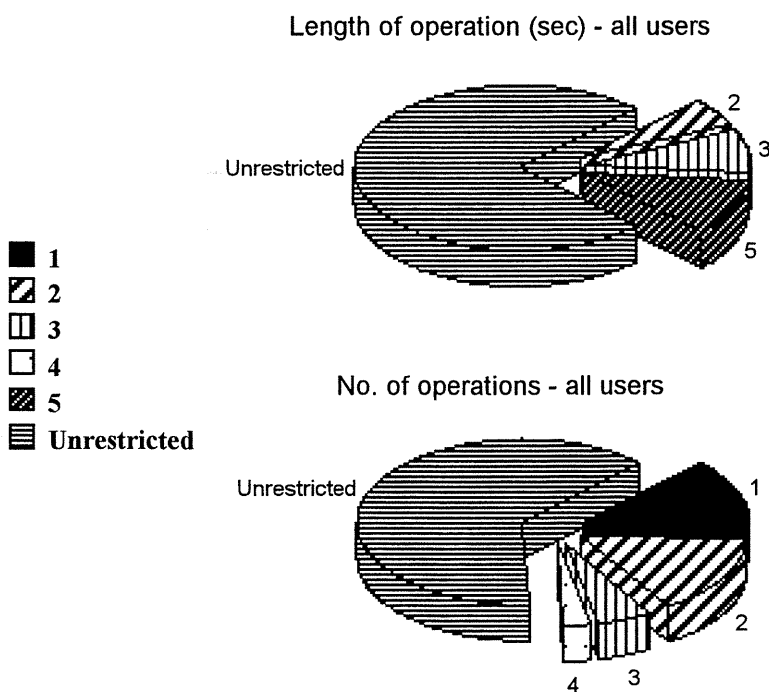


Figure 23 : Control of TH Rework With Heated Tip Soldering Irons

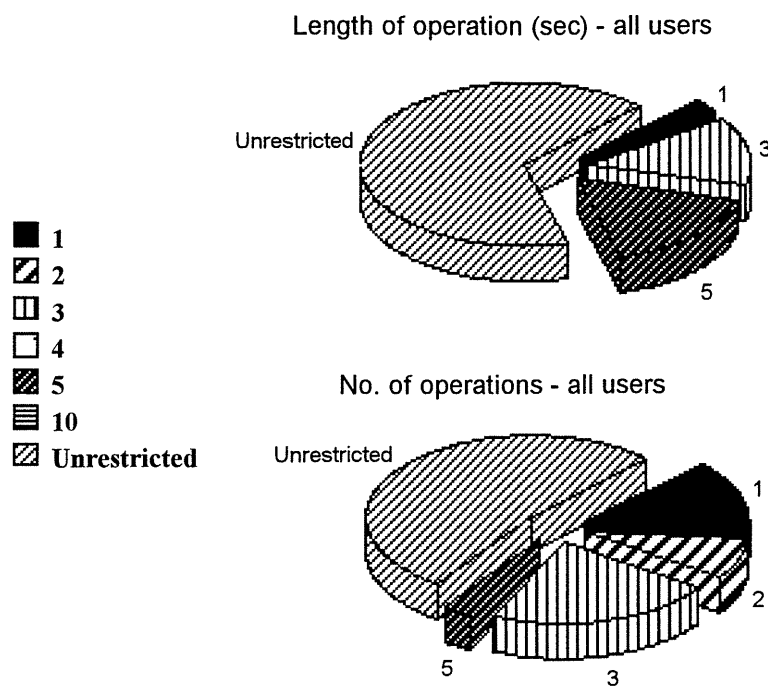
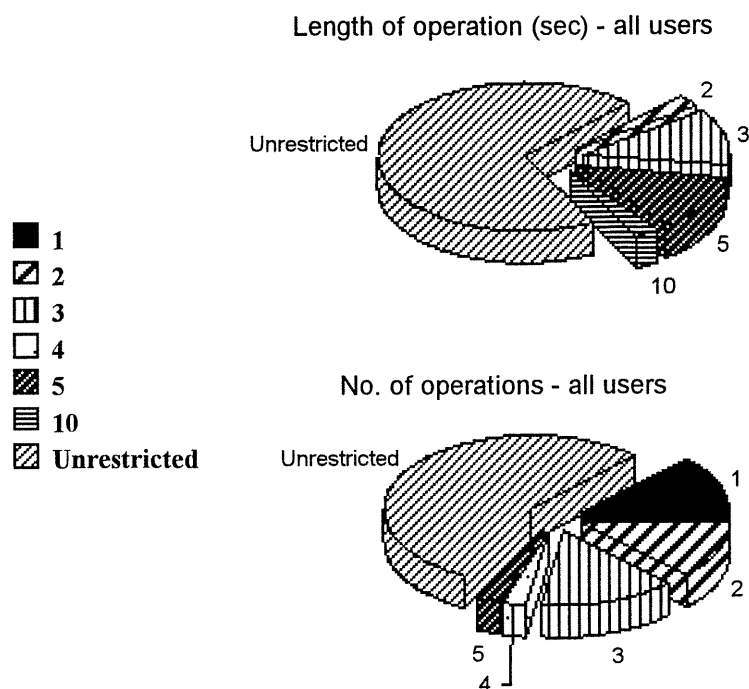
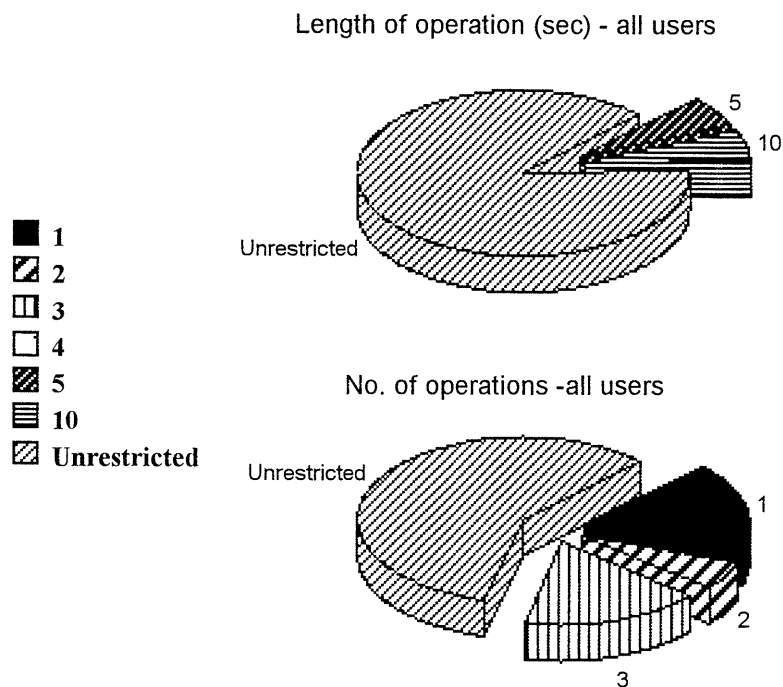


Figure 24 : Control of SM Rework With Heated Tip Soldering Irons



2.12 Control of SM rework with hot gas pencils

As with soldering irons, the survey showed that few companies controlled the rework of SM components when using hot gas pencils (Figure 24).

Figure 25 : Control of SM Rework With Hot Gas Pencils

3 CONCLUSIONS

Rework of electronics components in the UK is dominated by the use of soldering irons. The recommendations by manufacturers of thermally sensitive components do not appear to have been heeded by many companies. The lack of control of tip temperatures, rework times, background heating or the number of rework operations must be seen as worrying, particularly when the respondents to the survey included such a large number of companies who marketed high reliability products. It is heartening that those companies which do control rework temperatures, do reduce rework temperatures for SM components. However, in general rework temperatures are much higher than those recommended by component manufacturers.

A great deal of cleaning is undertaken after rework with most companies doing some form of local cleaning. Most companies reuse components, if only on an occasional basis.

Any future studies looking at the harmfulness of rework must consider temperatures upto 400°C and applications upto 20 seconds.

This work was carried out as part of a project in the Materials Measurements Which Affect Processability (MMP8) Programme of the UK Department of Trade and Industry.

Appendix - Survey Questionnaire

National Physical Laboratory Rework Survey - Front Page - To be completed by all respondents, anonymously if wished

Name : _____ Company : _____

Town & Postcode : _____

Telephone : _____ Fax : _____ E-mail : _____

Please tick the relevant box or boxes and complete comments sections where appropriate :

1) In which market sectors does your company operate?

Avionics/Military	Automotive	Telecomms	Control & Instrumentation	Consumer	Computers, peripherals etc.	Other (please state)

2) For rework applications what kinds of solder do you use?

Cored wire	Solder paste	Both

Solder alloy used? _____

Flux used? _____

3) Is the area that has been reworked cleaned after rework?

Locally	Whole assembly	Never

4) If the assembly is cleaned after rework, how is this done ?

Not cleaned	Machine	Hand immersion	Hand Spray	Brush	Other (Please state)

Cleaning materials supplier & type : _____

5) Do you reuse components that have previously been removed from an assembly?

Never	Occasionally	Frequently

6) If components are reused, please indicate which package style or styles these are :

Through hole	Chips - Cs, Rs, tantal, inductors	SOT packages	MELFs & SODs	SOICs & TSOP	PLCCs	QFPs	BGAs	Less Ceramic Carriers

Section A - Standard soldering and desoldering irons

These are conventional soldering irons. They use an electrical heater to warm an iron core which is thermally connected to tip. The energy from the core is rapidly transferred to the tip when it is cooled. These irons normally have a power rating of greater than 35W (for less than 35W see miniature soldering irons) and many have variable temperature control. Desoldering irons usually have an integral method for removing solder from the joint. Modified tips may be used to solder and de-solder multi-pin devices.

Please tick the relevant box or boxes and complete comments sections where appropriate

- 1) Manufacturers and models of standard soldering irons used : _____
- 2) Please indicate which of the following tasks your company uses this type of soldering iron for by ticking the appropriate box.

Standard Soldering Irons	Through hole components	Chips Cs, Rs, tanis, inductors	SOT packages	MELFs & SODs	SOICs & TSOPs	PLCCs	QFPs	BGAs	Leadless ceramic carriers
Removing component									
Replacing component									
Adding solder to insufficient joints									
Removing solder from excess joints									

- 3) Do you use any background heating when using this tool ?

Do not use	Hot-plate	Oven	Other (please state)

- 4) If the tool temperature controlled, to what temperature is it set? (please enter temperature °C)

Set Temp - degC	Through-hole	Surface Mount	Not controlled

- 5) What is the maximum time operators are allowed to rework a solder joint for in a single operation? (please enter time secs)

Time (secs)	Through-hole	Surface Mount

If unrestricted, enter UR in appropriate box

- 6) How many such operations are allowed on a single joint? (please enter number of operations)

Number of operations	Through-hole	Surface Mount

If unrestricted, enter UR in appropriate box

Section B - Heated tip soldering irons

Irons which have a tip heated internally rather than using heat stored in an iron core within the shaft of the iron. Manufacturers include Metcal and Pace Sensatemp. Typically these irons do not have a power rating. Modified tips may be used to solder and de-solder multi-pin devices.

Please tick the relevant box or boxes and complete comments sections where appropriate

- 1) Manufacturers and models of heated tip soldering irons used : _____
- 2) Please indicate which of the following tasks your company uses this type of soldering iron for by ticking the appropriate box.

Heated Tip Soldering Irons	Through-hole components	Chips/Cs Resistors, Inductors	SOT packages	MELFs & SODs	SOICs & TSOPs	PLCCs	QFPs	BGAs	Leadless ceramic carriers
Removing component									
Replacing component									
Adding solder to insufficient joints									
Removing solder from excess joints									

- 3) Do you use any background heating when using this tool ?

Do not use	Hot-plate	Oven	Other (please state)

- 4) If the tool temperature controlled, to what temperature is it set? (please enter temperature °C)

Set Temp - degC	Through-hole	Surface Mount	Not controlled

- 5) What is the maximum time operators are allowed to rework a solder joint for in a single operation? (please enter time secs)

Time (secs)	Through-hole	Surface Mount

If unrestricted, enter UR in appropriate box

- 6) How many such operations are allowed on a single joint? (please enter number of operations)

Number of operations	Through-hole	Surface Mount

If unrestricted, enter UR in appropriate box

Section C - Miniature soldering irons

Similar to standard soldering irons but with a lower power rating, smaller thermal mass and a finer tip. Typical power ratings are between 18 and 25W. Some versions are temperature controlled.

Please tick the relevant box or boxes and complete comments sections where appropriate

- 1) Manufacturers and models of miniature soldering irons used : _____
- 2) Please indicate which of the following tasks your company uses this type of soldering iron for by ticking the appropriate box.

Miniature Soldering Irons	Through hole components	Chips Cs, Rs, tanis, inductors	SOT packages	MELFs & SODs	SOICs & TSOPs	PLCCs	QFPs	BGAs	Leadless ceramic carriers
Removing component									
Replacing component									
Adding solder to insufficient joints									
Removing solder from excess joints									

- 3) Do you use any background heating when using this tool ?

Do not use	Hot-plate	Oven	Other (please state)

- 4) If the tool temperature controlled, to what temperature is it set? (please enter temperature °C)

Set Temp - degC	Through-hole	Surface Mount	Not controlled

- 5) What is the maximum time operators are allowed to rework a solder joint for in a single operation? (please enter time secs)

Time (secs)	Through-hole	Surface Mount

If unrestricted, enter UR in appropriate box

- 6) How many such operations are allowed on a single joint? (please enter number of operations)

Number of operations	Through-hole	Surface Mount

If unrestricted, enter UR in appropriate box

Section D - Heated Tweezers

Tools which incorporate two heated tips which are joined by a hinged mechanism so that the tips can be clamped around both ends of the component to be reworked.

Please tick the relevant box or boxes and complete comments sections where appropriate

- 1) Manufacturers and models of heated tweezers used : _____
- 2) Please indicate which of the following tasks your company uses heated tweezers for by ticking the appropriate box.

Heated Tweezers	Through hole components	Chips Cs, Rs, tants, Inductors	SOT packages	MELFs & SODs	SOICs & TSOPs	PLCCs	QFPs	BGAAs	Leadless ceramic carriers
Removing component									
Replacing component									
Adding solder to insufficient joints									
Removing solder from excess joints									

- 3) Do you use any background heating when using this tool ?

Do not use	Hot-plate	Oven	Other (please state)

- 4) If the tool temperature controlled, to what temperature is it set? (please enter temperature °C)

Set Temp - degC	Through-hole	Surface Mount	Not controlled

- 5) What is the maximum time operators are allowed to rework a solder joint for in a single operation? (please enter time secs)

Time (secs)	Through-hole	Surface Mount

If unrestricted, enter UR in appropriate box

- 6) How many such operations are allowed on a single joint? (please enter number of operations)

Number of operations	Through-hole	Surface Mount

If unrestricted, enter UR in appropriate box

Section E - Hot air pencils : Small hand-held tools which emit a narrow stream of heated air. Usually a single nozzle less than 5mm in diameter is used. For larger diameter nozzles see next section.

Please tick the relevant box or boxes and complete comments sections where appropriate

- 1) Manufacturers and models of hot air pencils used : _____
- 2) Please indicate which of the following tasks your company uses hot air pencils for by ticking the appropriate box.

Hot Air Pencils	Through hole components	Chips Cs, Rs, tanks, inductors	SOT packages	MELFs & SODs	SOICs & TSOPs	PLCCs	QFPs	BGAs	Leadless ceramic carriers
Removing component									
Replacing component									
Adding solder to insufficient joints									
Removing solder from excess joints									

- 3) Do you use any background heating when using this tool ?

Do not use	Hot-plate	Oven	Other (please state)

- 4) If the tool temperature controlled, to what temperature is it set? (please enter temperature °C)

Set Temp - degC	Through-hole	Surface Mount	Not controlled

- 5) What is the maximum time operators are allowed to rework a solder joint for in a single operation? (please enter time secs)

Time (secs)	Through-hole	Surface Mount

If unrestricted, enter UR in appropriate box

- 6) How many such operations are allowed on a single joint? (please enter number of operations)

Number of operations	Through-hole	Surface Mount

If unrestricted, enter UR in appropriate box

- 7) Is nitrogen used instead of air? (please tick appropriate box)

Always	Sometimes	Never

Section F - Hot air hand tools

Larger hand-held systems which resemble modified paint strippers or heat guns. These often use nozzles especially shaped to individual component types.

Please tick the relevant box or boxes and complete comments sections where appropriate

1) Manufacturers and models of hot air hand tools used : _____

2) Please indicate which of the following tasks your company uses hot air hand tools for by ticking the appropriate box.

Hot Air Pencils	Through hole components	Chips Cs, Resistors, Inductors	SOT packages	MELFs & SODs	SOICs & TSOPs	PLCCs	QFPs	BGAs	Leadless ceramic carriers
Removing component									
Replacing component									
Adding solder to insufficient joints									
Removing solder from excess joints									

3) Do you use any background heating when using this tool ?

Do not use	Hot-plate	Oven	Other (please state)

4) If the tool temperature controlled, to what temperature is it set? (please enter temperature °C)

Set Temp - degC	Through-hole	Surface Mount	Not controlled

5) What is the maximum time operators are allowed to rework a solder joint for in a single operation? (please enter time secs)

Time (secs)	Through-hole	Surface Mount

If unrestricted, enter UR in appropriate box

6) How many such operations are allowed on a single joint? (please enter number of operations)

Number of operations	Through-hole	Surface Mount

If unrestricted, enter UR in appropriate box

7) Is nitrogen used instead of air? (please tick appropriate box)

Always	Sometimes	Never

Section G - Hot gas rework equipment : Larger still, bench top models with interchangeable nozzles. These machines may have optical systems to assist the operator in aligning components with the substrate. Primarily designed for multi-pin surface mount devices.

Please tick the relevant box or boxes and complete comments sections where appropriate

1) Manufacturers and models of hot gas rework equipment used : _____

2) Please indicate which of the following tasks your company uses hot gas equipment for by ticking the appropriate box.

Hot Air Pencils	Through hole components	Chips Cs, Rs, tanis, inductors	SOT packages	MELFs & SODs	SOICs & TSOPs	PLCCs	QFPs	BGAs	Leadless ceramic carriers
Removing component									
Replacing component									
Adding solder to insufficient joints									
Removing solder from excess joints									

3) Do you use any background heating when using this tool ?

Do not use	Hot-plate	Oven	Other (please state)

4) If the tool temperature controlled, to what temperature is it set? (please enter temperature °C)

Set Temp - degC	Through-hole	Surface Mount	Not controlled

5) What is the maximum time operators are allowed to rework a solder joint for in a single operation? (please enter time secs)

Time (secs)	Through-hole	Surface Mount

If unrestricted, enter UR in appropriate box

6) How many such operations are allowed on a single joint? (please enter number of operations)

Number of operations	Through-hole	Surface Mount

If unrestricted, enter UR in appropriate box

7) Is nitrogen used instead of air? (please tick appropriate box)

Always	Sometimes	Never

Section H - Infrared rework equipment

Bench top equipment which heats the component to be reworked by an infrared source. This is usually either a focused IR lamp or a set of heated wire elements.

Please tick the relevant box or boxes and complete comments sections where appropriate

- 1) Manufacturers and models of IR rework equipment used : _____
- 2) Please indicate which of the following tasks your company uses IR rework equipment for by ticking the appropriate box.

Heated Tweezers	Through hole components	Chips Cs, Rs, tanis, inductors	SOT packages	MELFs & SODs	SOICs & TSOPs	PLCCs	QFPs	BGAs	Leadless ceramic carriers
Removing component									
Replacing component									
Adding solder to insufficient joints									
Removing solder from excess joints									

- 3) Do you use any background heating when using this tool ?

Do not use	Hot-plate	Oven	Other (please state)

- 4) If the tool temperature controlled, to what temperature is it set? (please enter temperature °C)

Set Temp - degC	Through-hole	Surface Mount	Not controlled

- 5) What is the maximum time operators are allowed to rework a solder joint for in a single operation? (please enter time secs)

Time (secs)	Through-hole	Surface Mount

If unrestricted, enter UR in appropriate box

- 6) How many such operations are allowed on a single joint? (please enter number of operations)

Number of operations	Through-hole	Surface Mount

If unrestricted, enter UR in appropriate box