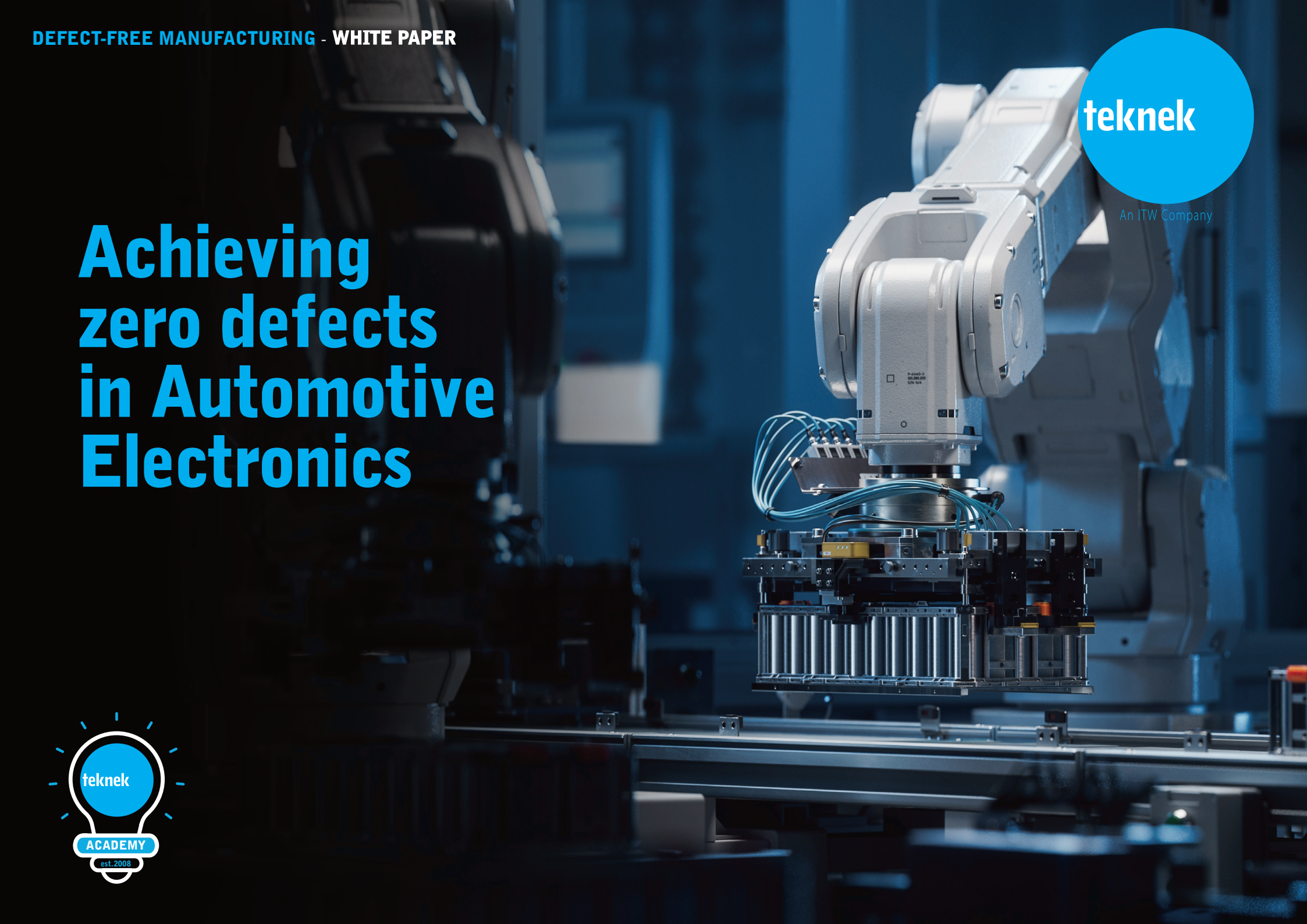
teknek

An ITW Company

Achieving zero defects in Automotive Electronics



teknek ACADEMY est.2008

Introduction

In recent years the amount of electronics integrated into vehicles has increased considerably driven by safety and security advancements for systems such as automatic airbags, emergency braking, and lane departure and the integration of computer like displays for visual information.

This trend is likely to continue with several market forecasts predicting 7% CAGR for the next decade from a base of around £250 billion in 2023.

As new electronic technologies are developed components will become smaller and circuit density will rise. These trends will not only increase the risk of defects but will also elevate the challenges associated with defect prevention.

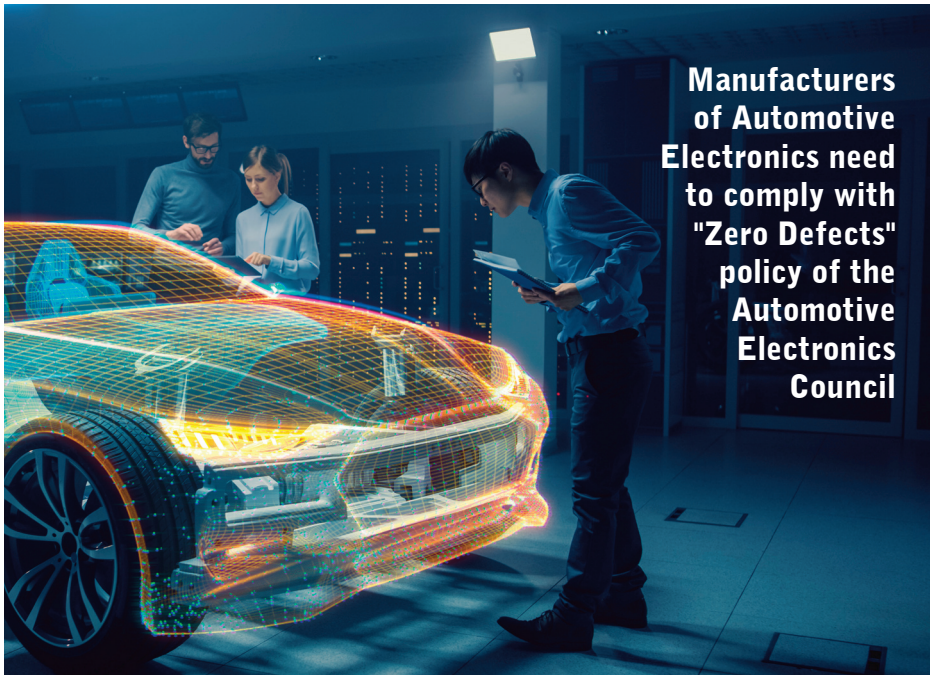
Key Issues

Automotive Electronics have to function in extremely harsh environments with a wide range of temperatures and a lot of vibration and still have to perform reliably. Safety is a key concern for the vehicle manufacturers because many of the electronic systems within a vehicle are safety critical, such as the engine management and braking systems. The Automotive Electronics Council is an organisation originally established in the 1990s by Chrysler, Ford, and GM for the purpose of establishing common part-qualification and quality-system standards. Manufacturers of Automotive Electronics are constrained in their manufacturing processes by the need to comply with a "Zero Defects" policy as defined by the Automotive Electronics Council. The following documents are related to the "Zero Defects" policy:

1 Automotive Zero Defects Framework Q004, February 26, 2020

2 International AEC -Automotive Task Force
"IATF 16949:2016- 8.6.6 Zero Defects"

An additional requirement is that no repair or rework of any defect is allowed during manufacture and so defective components must be scrapped.



Defect data

In order to eliminate defects, each type of defect must be identified, quantified and the cause and process location of the defect established. Analysis of manufacturing data like that generated by statistical process control (SPC) is essential in order to prioritise defect elimination strategies.

For the PCB assembly process analysis of the SPC data from major Tier 1 manufacturers identifies particulate contamination as the main cause of defects. Particles can be generated from many sources. Drilling and routing are major sources but other processes such as laser marking generate substantial amounts of particles. Every stage of the process must be individually analysed and results show that one process step, namely Solder Paste Print, is responsible for 60% of defects.

Defects related to particles of contamination on the PCB before Solder Paste Printing include short circuits where the solder paste is wicked between pads by fibres of contamination, open circuits where holes in the stencil have become blocked and tombstoning of components when particles of contamination are incorporated into the solder paste during print and the volatilise during reflow blowing the component off the pad.

With increasing use of High Density Interconnect (HDI) technology in Automotive Electronics particle sizes which can result in defects is reducing. Sub -micron particles which would have had no impact on the conventional circuitry used in the past now cause significant levels of defects and must be removed.

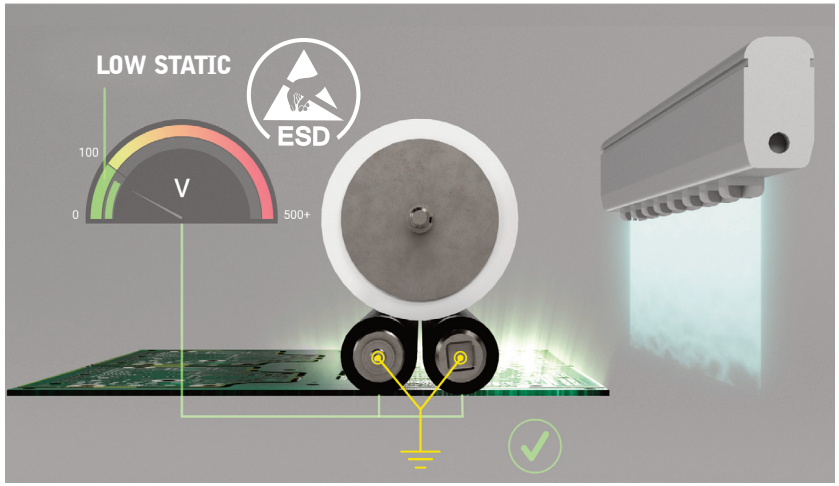
>60% defects are at solder print

Need to clean before solder paste

Preferred Cleaning Technology

To remove defects caused by particles, high levels of cleanliness are required not only in the materials and components used but also within the equipment used at each stage of the manufacturing process.

In the automotive PCBA sector, Contact Cleaning equipment, such as the Teknek Tek-BC-20C is the preferred method of particle removal in Tier 1 suppliers throughout the world. This equipment is integrated into the assembly line immediately before solder paste print removing particles which can block the print stencil apertures or become incorporated into the solder paste causing defects. It operates using specially formulated elastomer cleaning rollers to remove the particles which are transferred onto the adhesive rolls where the particles are permanently captured for future disposal.



No reverse contamination

Low static cleaning = No ESD

Low static cleaning = No EOS

Precision touch = No strain

Cleaning Challenges

In the search for "Zero Defects" highly efficient cleaning must not generate any other detrimental conditions which might result in defects.

1 Chemical transfer

One such condition is the leaching of chemicals from the elastomer cleaning rollers which run in contact with the PCB. Some elastomer roller manufacturers incorporate additives such as plasticisers and oils into their rollers. These additives temporarily improve cleaning performance but gradually permeate through the elastomer onto the surface of the PCB causing adhesion issues during subsequent process steps. As the rollers age the cleaning performance drops off and the rollers can become brittle as the amount of additives declines. Similar issues can occur if any adhesive from the adhesive rolls transfers onto the cleaning rollers and then onto the PCB.

2 Electrostatic Discharge (ESD)

Any movement of a PCB down an automatic process line will generate static electricity and contact cleaning with its rolling interactions can generate significant charges. Electrostatic discharges (ESD) are well known in the electronics industry. Manufacturers in the SMT sector have long been aware that ESD can cause defects in assembled PCBs. To eliminate these defects, the industry has developed standards to minimise the risk of ESD throughout the manufacturing environment. One such standard is ANSI/ESDs20.20, also known as IEC 61340-5-1. This standard contains a section specifically relating to ESD control for Automated Handline Equipment (AHE), namely ANSI/ESD SP10.1. This applies to the complete assembly line used in Automotive Electronics manufacture including any Contact Cleaning equipment.

3 Electrical overstress (EOS)

Electrical overstress (EOS) is often overlooked but it is just as important as ESD because you can't detect EOS during manufacturing but it is the major cause of defects in the field. EOS occurs when components are subject to a voltage above their specified limits. This can weaken and degrade the performance of the component leading to premature failure. EOS can be a single event with a short duration or exposure can last for a long time. It can occur within a machine when a PCB encounters an induced voltage. Conventional static control measures such as ionising bars are ineffective in countering EOS as they cannot control charges within the machine and by the time the PCB exits the machine under an ionising bar it is too late to avoid damage.

4 Strain

Thinner, more flexible PCBs which are connected to smaller components are more affected by strain which can cause the connections to fail either completely or partially. The loading applied to the PCB during processing must be reduced to a minimum as this load can cause bending and distortion of the board resulting in bending stresses on the components and circuitry. While Contact Cleaning has the weight of two cleaning rollers and an adhesive roll acting on the PCB, Teknek incorporates a new patented system which maintains strain rates at less than the 200 microstrain units specified by IPC/JEDEC 9704. Defects induced by strain are mainly experienced as in-field failures.

TEKNEK approach to "Zero Defects" Technology.

While there are several Contact Cleaning systems on the market it has to be understood that not all Contact Cleaners perform equally. Teknek has taken a unique approach to develop a "Zero Defects" machine

Teknek invented and patented Contact Cleaning technology in 1987 to meet the needs of PCB manufacturers. In the years since its invention Teknek has developed formulations of both the elastomer rollers and the adhesive rolls to remove contamination in a variety of high technology applications such as Display, Organic electronics, EV battery, Micro LED and optical films which all have different cleaning requirements. To have efficient particle removal special elastomers are required which are not readily available from conventional roller manufacturers. To enhance the cleaning performance of elastomers requires an in-depth understanding of Physics and the forces involved in small particle adhesion.

To assist in tailoring its elastomer and adhesive formulations for specific applications Teknek has worked with several universities to develop a scientific model of the contact cleaning process. This model is then used to develop new products. To cope with removing sub-micron particles Teknek was part of a European research project called Clean4Yield which developed and qualified the effectiveness of Nanocleen™ Elastomer rollers in removing particles down to 100 nanometres in size.

No process additives are used in Teknek rollers and a special curing process ensures that any chemicals generated in the process are completely removed. Teknek adhesives are designed not to transfer from the base material and are subject to rigorous quality control. Teknek rollers and adhesive have been tested by SGS, an independent test house, to confirm the absence of any chemical transfer.

To mitigate any potential risks of ESD and EOS defects Teknek equipment fully complies with ANSI/ESDs20.20 and in particular ANSI/ESD SP10.1 which requires static dissipative elastomers and adhesives which are fully grounded. This has resulted in the development of the new Teknek GNT™ elastomer roller for SMT cleaning together with the matching Teknek GAR™ adhesive roll both of which comply with the ANSI/ESD standards with a resistivity between 10^6 and 10^9 Ohms making them static dissipative. The connection of the rollers to ground, which is difficult to achieve also meets the standard. Teknek is currently the only manufacturer of Contact Cleaning to have their machine tested for compliance with the standard by an independent qualified Test House. They are also the only company that develops and makes its own cleaning rollers and adhesive rolls from formulation through to finished product.

In addition to continuous development of the cleaning rollers and adhesive rolls Teknek regularly files patents for improvements to the mechanical aspects of their equipment to meet new application requirements. The special system for grounding the elastomer cleaning rollers is one such patent. The most recent filing is for a Board Height Adjustment system which checks each PCB for thickness to ensure that the loading generated by the system on the PCB is kept to a minimum reducing tribocharging and mechanical overstress.

Best Cleaning performance

Low static cleaning

Precision touch

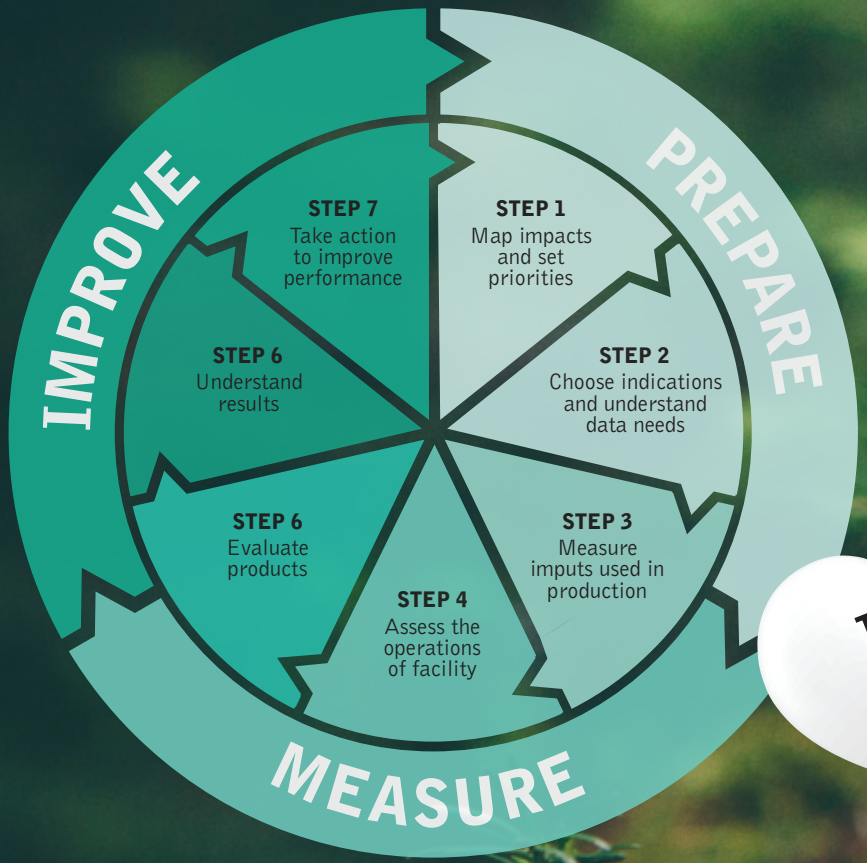
No reverse contamination

ntcleen

gntcleen

SUSTAINABILITY

With the current focus on sustainability companies are set on reducing waste and protecting increasingly scarce resources. The key feature of every piece of Teknek equipment is that it reduces defects and waste. Waste reduction is integral to its function. Internally Teknek is also focused on sustainability and has incorporated the OECD Sustainable Manufacturing Framework into its manufacturing operation.



OECD

CONCLUSIONS

Achieving "Zero Defects" policy to meet the needs of the automotive manufacturers is not easy and requires a disciplined, scientific approach from data collection through to equipment design and manufacture which meets all the standards for the industry.

Teknek, based on knowledge of Physics and collaboration with Universities, has developed equipment for integration into a PCBA line which not only removes the particulate responsible for the majority of defects but also offers low static cleaning while minimising any strain on the components or circuitry on the PCB. Independent verification is a vital part of Teknek's development policy to ensure these unique features provide a reliable way to achieve "Zero Defects"

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