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Alternate Energy Sources

Ship acquisition affordability is a prime strategic focus for the United States Navy. The growing concern over the stability of the global energy market and the availability of energy stresses the need to address energy consumption – specifically fossil-fuel based energy – of companies that build Naval ships. Geopolitical instability, climate change, long-term supply, and the threat of natural disasters all contribute to problems associated with the supply and demand of fossil fuels. Manufactures of equipment for the Navy have recently been hurt by the increases

in energy pricing. Recent spikes in fossil fuel costs have caused budgetary problems for Navy shipbuilders, their subcontractors and industry in general which highlights the need to lessen the impact of energy costs fluctuations on Navy shipbuilding. As a leader of technology solutions, the U.S. Navy's Manufacturing Technology (ManTech) Program will work with it's industrial partners in the shipbuilding industry to evaluate alternative energy sources, and efficient manufacturing practices to lower manufacturing costs, and energy usage.

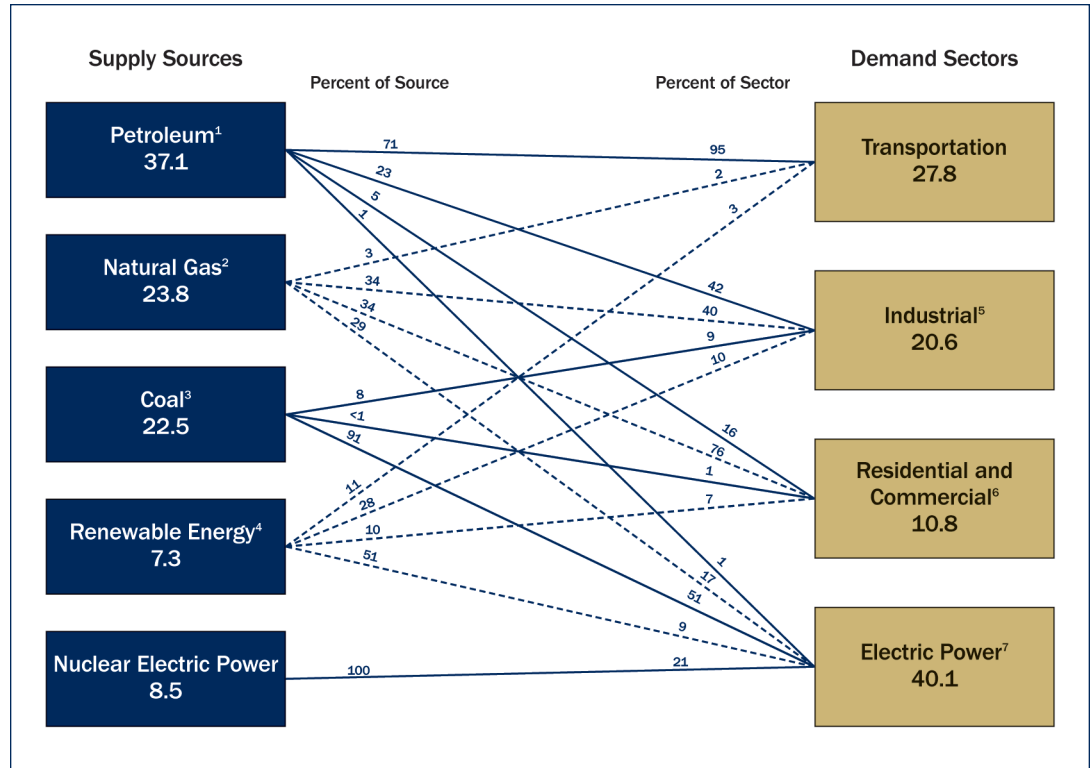


Figure 1-1: U.S. Energy Demand (see end of article for footnotes).

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Ask the EMPF Helpline!

A Systematic Approach to RoHS Analysis

One of the most frequently asked questions of the EMPF is how to qualify and verify that the electronic systems shipped by their respective companies are RoHS (Restriction of Hazardous Substances) compliant.

The RoHS directive has been implemented since July of 2006, and the preoccupation with what constitutes a compliant product continues to confuse the electronic industry. The EMPF receives countless inquiries regarding how to qualify and verify that the electronic systems shipped by their respective companies

are RoHS compliant. The approach to proving compliancy requires a sequential analytical process that utilizes a decision flow chart.

There is a progressive course of action which can be initiated, that will help a strategic company exercise due diligence regarding efforts toward

RoHS compliancy. The foundation to sustain a robust position of stewardship with trading partners, vendors, customers, and regulatory agencies should include the following.

I Quality Audit:

This is done to ensure that your facility has implemented a control plan to address the prevention of Pb into the product stream. The audit contains some of the following elements:

- 1 Verification and testing for RoHS compliance
 - a. component
 - b. PCB
 - c. other materials
- 2 Separation of tin-lead and lead-free processes and materials
 - a. labeling
 - b. component storage
 - c. solder materials
 - d. surface mount production lines
 - e. hand soldering
 - f. wave soldering
 - g. assembly storage and transportation
- 3 Documentation related to RoHS, for example:
 - a. Certificate of compliance
 - b. XRF testing records
- 4 Awareness and training of employees
 - a. RoHS experience
 - b. procedures
 - c. training
 - d. awareness

II Analytical Screening Process

A very fundamental and usually non-destructive method of screening Pb, Cd, Hg, Cr (total), and Br. Please note that hexavalent Cr requires a destructive analytical approach, and that the isomers of Br (PBB and PBDE) cannot be detected in the screening process.

The chart in Figure 2-1 illustrates a roadmap selection process intended to address the analysis of the restricted constituents outlined by the RoHS directive.

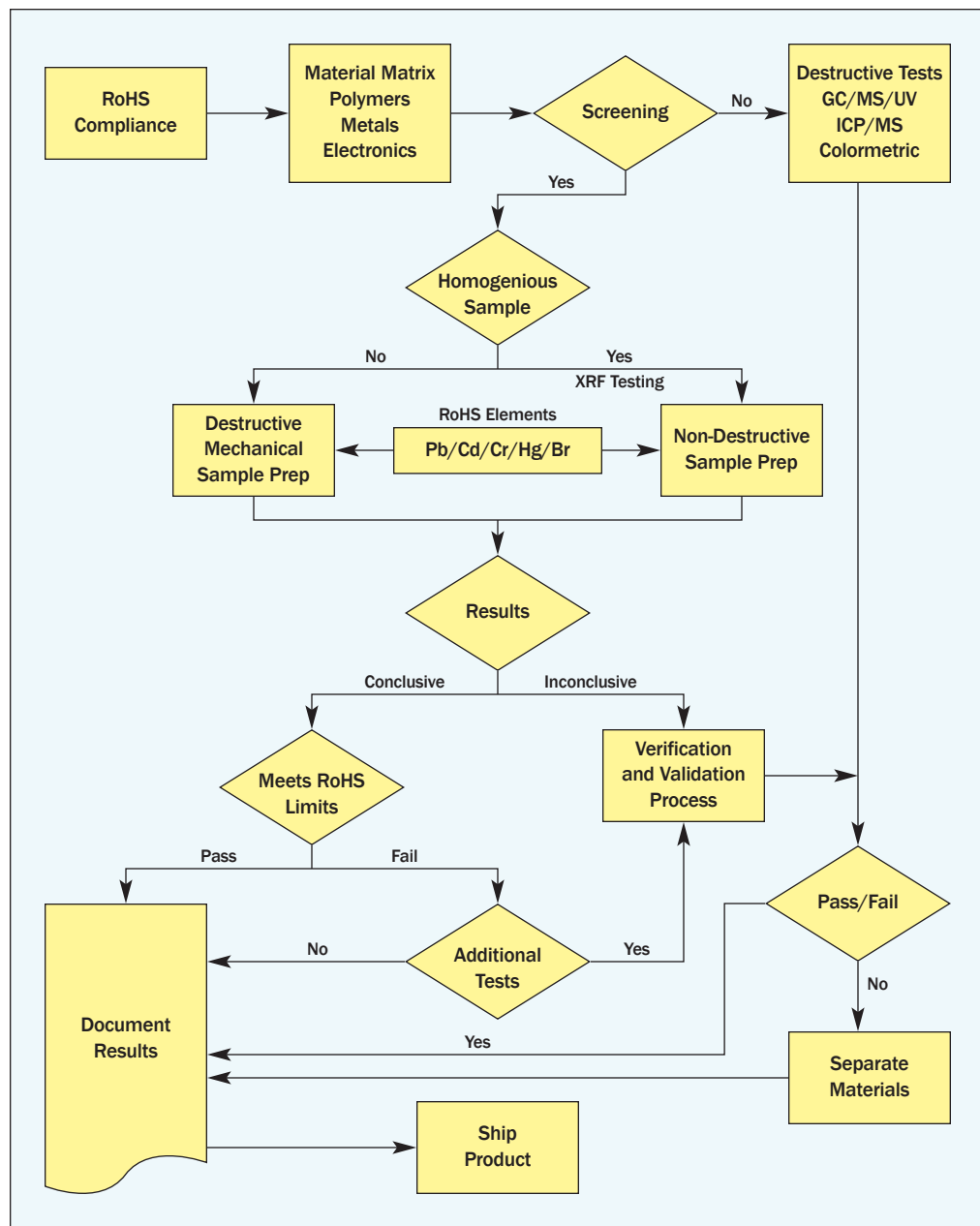


Figure 2-1: Roadmap selection process for the analysis of the restricted constituents outlined by the RoHS directive.

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Flying Probe Testing

In today's electronics manufacturing market, the race is always on to make smaller and faster electronics equipment with greater functional capabilities. Given this reality, printed circuit boards (PCBs) are increasingly smaller and more densely populated, and 100% test-point access may not be practical, or even possible. Recent improvements in both the software and hardware capabilities of most commercially available Flying Probe test systems have made these them increasingly popular tools for manufacturing verification, as well as some functional verification of PCBs. In this article we will examine some of the characteristics of flying probe test systems and how they may be applied.

Flying probe test systems come in a variety of configurations, but all utilize several mobile armatures equipped with moving probes for contacting test points on PCBs. They are most often used in analog signature analysis, testing of analog components, and continuity (short/open circuit) testing. These moving probes can be programmed to make contact to virtually any point within an x-y grid upon a PCB (Note: There are some systems that provide software options that allow for limited testing on bare boards.).

The operator loads the computer-aided design (CAD) file data of the PCB to be tested into the system software, from which the component value, part reference designation, component orientation, and the position of each land pad or part lead can be extracted. Although the flying probe tester only requires the CAD file, comparisons made against a known good sample (i.e., a "golden" board), will provide for adjusted file information that will help prevent false failure reports.

While heavy volume production lines will often utilize an in-circuit test (ICT) fixture that employs some form of "bed-of-nails" (BON) probe arrangement, this kind of fixture can be very costly for low volume and prototype boards. Although common ICT configurations allow ample

control and repeatability of testing within an established production line, these systems must be reconfigured with each modification or change of the board being tested. This can be time consuming and costly. The lack of a required set fixture for flying probe systems gives them a distinct advantage over ICT testers for low volume and prototype applications.

Most recent models can be fitted with armatures that allow the test probes to make contact at more acute angles, allowing greater access to test points, component lands, or vias that were not readily accessible utilizing older models which had more fixed angles. Additionally, most new models boast 24 probes, as opposed to the older generations that were limited to four probes. This increase helps to accelerate test-cycle time and allows for higher fault coverage.

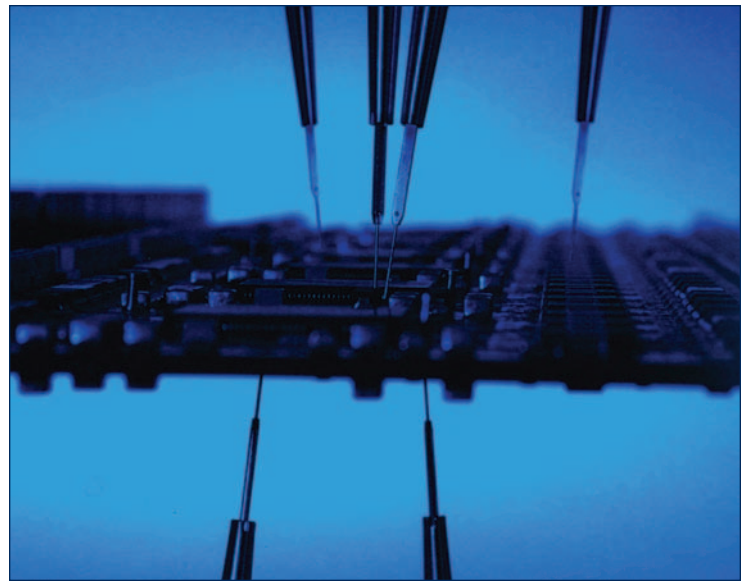


Figure 3-2: Mobile armatures equipped with moving probes for contacting test points on PCBs.

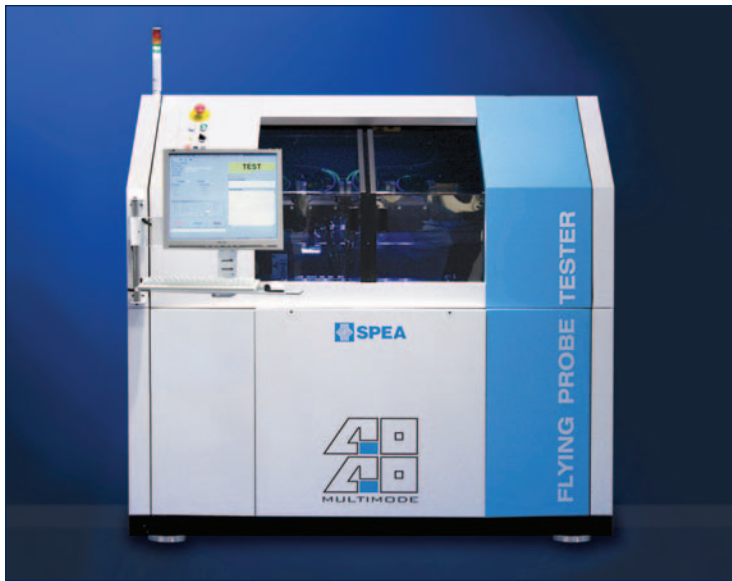


Figure 3-1: The 4040 Multimode Flying Probe Tester from SPEA.

Another way to accelerate test-cycle time and increase throughput is the ability to adjust for parallel components. The latest version of the SPEA 4040 flying probe tester (Figure 3-1) optimizes the speed of its linear motor with magnetic bearings and allows for the probe height to be adjusted for low profile PCBs. These innovations are reducing flying probe test-cycle times to a level comparable to some ICT applications.

A few other considerations include double sided testing (flying probe testers used to be limited to one side, Figure 3-2), and the capability to adjust the amount of pressure the probe uses when making contact with the test point (ultra soft touch). The later, eliminates depressions in the solder joint due to probe contact.

These systems can also be used to test fine and ultra fine pitch boards. While as recently as 2005, the test point limits stood at approximately 4 mils (0.004 inches), current models boast of being able to test down to

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Tech Tips: Identifying Battery Load Qualification Test Parameters

In a recent Tech Tips column of *EMPFasis* (September 2009), considerations were discussed for selecting an appropriate battery for an application. After selection, testing should be performed to confirm that the battery can provide the power required for the specific application. Some battery definitions should be understood when discussing power load qualification testing of batteries.

Definitions

Cell: Electro-chemical unit consisting of at least one anode and one cathode. The cell voltage is the voltage potential between the anode and cathode material.

Cell Element: One or more cells wired in parallel.

Battery: One or more cells (elements) wired in series. The battery voltage is the total voltage of each cell element.

Cell Numbers in a Battery: Cells in a battery are numbered starting at the negative side of the battery. For example, Cell 2 is the second cell from the negative end of the battery.

Primary Battery: Battery that is disposed after a single use. A primary battery is not designed to be recharged.

Secondary Battery: A secondary battery can be charged after use. These batteries are also called “rechargeable” batteries.

Run Time: Time it takes to discharge a fully charged battery.

Cycle: A single discharge followed by a single charge of a secondary battery.

Cycle Life: Cycle life is the number of cycles until the discharged capacity is less than 80% of the capacity in the manufacturer’s specification, or the capacity when the battery is new.

Simple Capacity Discharge Test: Constant current discharge to minimum discharge voltage.

Typical Run Time Discharge Test: Discharge a fully charged battery under the application load and record the time when the battery reaches the minimum voltage.

Cell String: “Cell string” or “cell stack” is another term for a battery with one set of cells wired in series. Some high reliability battery designs may have parallel sets of cells wired in series (essentially multiple batteries wired in parallel). An individual battery in this type of set up is sometimes referred to as a “cell string.” This type of redundant battery design is useful if one cell string fails, but the device can operate with the lower capacity and current rate capability of the remaining cell string(s).

Cell element capacity is equal to the number of cells wired in parallel times the capacity of an individual pack. The unit of capacity is ampere-hours. Selecting cells with similar capacities for cell elements is recommended.

Battery Capacity is equal to the lowest capacity cell element in the battery. (Capacity is not additive when cells are wired in series.) The lowest capacity cell works the hardest in a battery and as a result it will reach end of life before the other battery cells. Individual battery cells should have near identical (matched) capacities. If resources are not available for testing and matching cells, then cells should be selected from the same manufacturer with the same lot number.

C-rate: The battery capacity is listed in the battery manufacturer’s specification and C-rate is generally defined as the current it takes to discharge a fully charged battery or cell in one hour. For example, the 0.5C rate means the cell will take two hours for a full discharge. A C-rate discharge for low current rate, long run time batteries can be misleading. Light weight batteries designed for long runtimes typically have sacrificed high current discharge capability for the long run times and are not capable of discharging their full capacity in one hour.

Initial load qualification testing may be as simple as installing battery cells in an electronic device, such as an alarm clock or flashlight, and checking that the device performs as expected and the device runs for the expected time. This “quick and dirty” type of testing may be adequate as an initial test for non mission critical applications that draw constant current.

For high reliability applications and applications with variable power loads, load qualification testing is more complicated and a test plan should be made. The engineer should characterize the power requirements (Figure 4-1) of the electronic device and the operating voltage range. The maximum and minimum current rates should be identified along with the time spent at the different current rates. The required run time before battery replacement or battery charge should be identified. If the device will be switched off and stored several times before battery charge or replacement, this too should be noted. Typically, during standby mode, the device will have low current draw. During high power load, it is important to estimate time and current of the current load.



Figure 4-1: BT2000 allows for the characterization of various battery attributes such as charge and discharge capacity.

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Manufacturer's Corner: Nisene Technology Group

Advances in plastic packaging have resulted in complex packages with very high interconnect densities. The requirements for package opening become very stringent when such high densities are incorporated into packages such as micro ball grid arrays (BGAs) and fine pitch BGAs (FPBGAs). Other complex configurations such as multi-die BGAs and chip scale packages pose unique problems. The encapsulant must be removed while preserving the integrity of the die, bond pads, bond wires, and lead frame interconnects.

The EMPF utilizes the JetEtch II decapsulation machine by Nisene Technology Group (Figure 5-1). The JetEtch is very easy to operate using intuitive software that leads the operator step by step through the simple programming sequence. Once set, the software enables an entire etching program to be completed with only two keystrokes. It is fully programmable and capable of storing multiple etch programs for different package types. A high brightness, six-line, alphanumeric display ensures good visibility under all conditions of fume hood illumination.



Figure 5-1: JetEtch II Decapsulation System

The etch head assembly can be supplied with a standard fixed etch head or with an optional removable etch head insert (Figure 5-2). Removable inserts offer the ability to select specific etchant dispersion patterns for large or complex packages, such as large quad flat pack (QFP) or extra-long thin-shrink small outline package (TSSOP) devices. Three basic removable inserts are available: the standard slot design, long slot design, and the Quadraport – a multiple-hole design. Additional custom configurations are available to accommodate specific decapsulation needs.

The sample cover is lightly pressurized with a continuous stream of nitrogen gas to remove water vapor and oxygen from the region of the etch head, eliminating metal corrosion. When the sample cover is first closed, it is purged with nitrogen gas at a high flow rate to ensure complete removal of undesirable gases. The flow then reduces to a low level to maintain a slight positive pressure until the programmed etching and rinse program has finished. At the end of the etching sequence, the entire acid path is gas purged to remove all residual acid. The use of gas is only required during operation – no gas is consumed while in the stand by/idle mode.

The precise and rapid removal of encapsulant material is achieved by maintaining a regular, gentle oscillation of the etchant across the sample surface every two seconds. This VortexEtch produces a high level of decap quality when pure (single) acids are used and is particularly critical when mixed etchants are employed. Unless precautions are taken to ensure thorough and continual mixing, an etchant mix can separate into its constituent parts, resulting in unreproducible decapping. Pulse Etch has the same efficiency for PBGA packages. The JetEtch design is at least 30 times more efficient than less sophisticated acid decapsulators not equipped with VortexEtch and Pulse Etch technology.



Figure 5-2: Optional removable etch head assembly showing etch insert adapters and removable etch head inserts.

For more information or to schedule a demonstration of Nisene's JetEtch decapsulation machine located at the EMPF, contact Ken Friedman at 610.362.1200, extension 279 or via email at kfriedman@aciusa.org.



Ken Friedman | EAB Coordinator

Custom Training

At the EMPF Learning Center, a variety of courses are available for personnel skills development and IPC certification. The courses that are offered at our Philadelphia facility include Certified IPC Trainer (CIT) for IPC A 610D, J STD 001D, IPC A 600G, and IPC 7711/7721B as well as Certified IPC Specialist (CIS) for IPC/WHMA A 620A. The Learning Center also offers training in topics such as BGA Manufacturing, Rework, and Inspection; Lead Free Manufacturing; Electronics Manufacturing Boot Camp; and Failure Analysis and Reliability Testing. The schedule for these courses can be accessed via the EMPF website (www.empf.org).

In addition to the regularly scheduled courses, the EMPF also offers customized training to interested companies. Courses that require the use of the equipment in the EMPF Demonstration Factory will be offered at the EMPF, but when large manufacturing equipment is not required,

courses can also be delivered at any location. The EMPF can provide hand tools and soldering equipment at a customer's location as well as the audio/visual equipment required to provide lectures.

The main types of customized courses that are available are Certified IPC Specialist courses. These courses are designed in a modular manner, which allows the training topics to be chosen to meet the specific needs of the students. For example, the J STD 001 CIS course includes five modules: General Requirements, Wires and Terminals, Through-Hole, Surface Mount, and Inspection (Figure 6-1). Companies can choose as few as one or as many as five of the modules of instruction. Generally, companies choose between two and four (General Requirements is required for all other modules). All of the other IPC CIS courses are designed in a similar manner, allowing companies a great deal of flexibility when choosing to certify their personnel.



Figure 6-1: The EMPF Learning Center, located at ACI, offers the latest in visual inspection equipment for its IPC course certificates.

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Alternate Energy Sources

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Figure 1-1 shows the demand for US energy by sector and source. In 2008, the industrial sector accounted for approximately 20% of the total United States consumption with petroleum and natural gas accounting for over 80% of the supply. In the early 1970s, the U.S. started transitioning away from heavy industry and towards the commercial and service sectors. This has contributed to slower energy consumption growth in the industrial sector compared to that in other sectors of the U.S. economy. However, the industrial sector still remains the largest end user of energy. Reducing energy consumption in energy-intensive manufacturing industries offers opportunities for improving environmental performance as well as reducing operational costs in an increasingly competitive global economy.

The current strategy by many large industrial companies, including many shipbuilders, is to manage demand by conservation. There are many immediate short-term steps that these industries can implement in their manufacturing processes which will cut energy consumption. Most of these steps involve regular maintenance including equipment repair, replacing leaky air lines to pneumatic tools, changing air filters, and reducing the air pressure to the minimum requirement for the tool. Other improvements include converting to energy efficient lighting, installing timers on thermostats, and insulating equipment such as hot water heaters. Changes in the manufacturing process could include the replacement of old air compressors with new, more efficient, multi-step compressors with improved system controls. Reducing the amount of air lines needed can also reduce costs by reducing set-up and break-down times as well decreasing the possibility of leaks. This could be accomplished by the use of more efficient portable hand tools that do not necessarily need to be connected to a fixed power source.

These improvements to the manufacturing process could be implemented immediately without the aid of any new technology. However, this approach alone may not achieve the proposed cost reductions. What is needed is a comprehensive approach to the reduction of energy usage in a complex industrial environment that will involve new technologies in manufacturing processes, renewable energy, as well as conservation. These approaches will not only help to conserve what energy is used, but it will also help insulate companies from dramatic price swings due to the instability of the energy markets.

One major area that needs to be explored is the use of alternative energy sources such as wind, solar, and wave power. These are available now and look to become more efficient and affordable in the next decade. However, these technologies require investment not only in development, but also in the commercialization of that technology for use on a large industrial scale.

Solar energy, both photovoltaic (PV) and passive, has been in use for a long time. PV solar energy takes light energy in the form of photons and converts it to electric energy through a solar panel. Photovoltaic cells are semiconductor devices (usually made of silicon) which contain no liquids, corrosive chemicals, or moving parts. They produce electricity as long as light shines on them, they require little maintenance, do not pollute,

and operate silently. Passive solar energy relies on the sun to directly heat water or a building without any energy converting equipment. Commercial passive solar water heaters have been in use since the 1890s, but have diminished with the advent of cheaper more reliable fuels. PV solar increased in popularity in the 1970s during the OPEC



Figure 1-2: A solar array on the roof of a Federal Express hub in Oakland, CA covers 80% of its peak energy needs.

oil embargo, but then declined due to the drop in fossil fuel prices in the following decades [1]. One success story in the use of PV solar power, is Federal Express [2]. A solar array on the roof of their Oakland, California hub (Figure 1-2) generates a maximum of 904kW and covers 80% of its peak energy needs. However, most solar energy is used only as a supplement to other conventional types of energy. Problems with start up costs, cloud cover, geographical location, and the large area needed for a sizable return have slowed the adoption of PV systems.

Commercial wind energy has also seen a large increase in demand. Wind energy derived from small sources, such as residential wind mills, are generally less than 10 kW systems and are not suitable for industrial applications [3]. Global wind capacity increased almost 29% in 2008, ending the year at 120,798 megawatts. This growth rate exceeded the annual average of the past decade. In 2008, wind machines in the US generated a total of 52 billion kilowatt-hours, about 1.3% of total US electricity generation. The wind now generates more than 1.5% of the world's electricity, up from 0.1% in 1997. Eighty countries are now using wind power on a commercial basis with the US passing Germany as the top producer of electricity from wind power [4].

Recently a number of technologies have been developed to extract energy directly from the surface motion of ocean waves or from pressure fluctuations below the surface. This is done on a commercial scale in two ways. One method uses point absorbers that have components that move relative to each other due to wave action (e.g., a floating buoy inside a

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Alternate Energy Sources

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fixed cylinder). This relative motion is used to drive electromechanical or hydraulic energy converters. The other method is an actuator system where two floating cylinders are connected together by hydraulic pumps that convert the up and down motion of the waves to electrical energy. Agucadoura, the world's first wave farm built off the north coast of Portugal, is such a system (Figure 1-3). This wave farm has three Pelamis wave energy converters that currently produce a total of 2.25MW. Plans are now underway to increase Agucadoura's capacity to 21MW [5]. These types of systems have the advantage of generating almost continuous power; however, they are limited geographically to where they can be placed. They can also be a hazard or an obstacle to maritime ship traffic. This technology is still in its early stages and will take time to mature.



Figure 1-3: Pelamis wave generator used off the north coast of Portugal.

All these sources share the one problem of what to do when energy is not being produced. There have been many ideas put forth to solve this problem, but currently there is no clear solution. One obvious solution, is a large battery or a series of batteries linked into the power grid. While this is one of the leading ideas, the smart grid infrastructure needed to accomplish this doesn't exist. Other ideas are large fly wheels that store excess electrical energy as kinetic energy. All of these solutions show promise, however, right now they are small scale and not suitable for industrial application.

With the global energy market in flux due to geopolitical instability, the peak in global oil production approaching, and increasing environmental concerns, the shipbuilding industry (and other US industries) needs a comprehensive energy usage plan in order to operate efficiently in an increasingly uncertain energy market. The steps outlined above will help enable shipbuilders and industry as a whole, to meet the challenges of energy generation, lessen the impact of erratic fossil fuel prices, and take a step towards energy independence from foreign sources. It will also help builders of naval ships to better control construction expenses and lower acquisition costs to the Navy.

References:

- [1] Butti, K. and J. Perlin. A Golden Thread: 2500 Years of Solar Architecture and Technology. New York: Wiley, 1981.
- [2] FedEx's Oakland Hub Goes Solar. 08 Aug. 2005. <<http://www.redherring.com/Home/13107>>
- [3] American Wind Energy Association. <<http://www.awea.org/smallwind/>>
- [4] U.S. Edges Out Germany as World Wind Power Leader. Environment News Service. 26 Dec. 2008. <<http://www.ens-newswire.com/ens/dec2008/2008-12-26-01.asp>>
- [5] Charlier, R.H. and C.W. Finkel. Ocean Energy: Tide and Tidal Power. Berlin: Springer-Verlag, 2009.

Footnotes from Figure 1-1:

- 1 Does not include the fuel ethanol portion of motor gasoline-fuel ethanol is included in "Renewable Energy."
- 2 Excludes supplemental gaseous fuels.
- 3 Includes less than 0.1 quadrillion Btu of coal coke net imports.
- 4 Conventional hydroelectric power, geothermal, solar/photovoltaic, wind, and biomass.
- 5 Includes industrial combined-heat-and-power (CHP) and industrial electricity-only plants.
- 6 Includes commercial CHP and commercial electricity-only plants.
- 7 Electricity-only and CHP plants whose primary business is to sell electricity, or electricity and heat, to the public.

Note: Sum of components may not equal 100 percent due to independent rounding.

Sources: Energy Information Administration, *Annual Energy Review 2008*, Tables 1.3, 2.1b-2.1f, 10.3, and 10.4.



Mark Shiners | Senior R&D Engineer

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This flow chart gives guidance on the appropriate course of actions to:

- minimize unnecessary analytical activities that can be resolved with non-destructive screening
- provide a logical analytical sequence that can be used for documenting the screening results, and subsequent testing when analytical uncertainties arise

The material matrix plays a pivotal role in determining what the analytical threshold limits are for the various instruments used to detect the constituents of interest. The matrices that surround or sequester the restricted substances are analytically defined as polymeric, metallic, and electronic. Instruments such as EDXRF can be used as a screening technique to detect the presence of Pb and other elements. However, depending on the geometry and matrix of the samples, a quantitative analysis approaching the allowable upper limits, as defined by RoHS,

can be difficult and often inconclusive. A statistically valid data set requires a minimum of seven measurements to determine a viable three sigma value. It is suggested that if the three sigma value added to the average reading exceeds the upper limit, additional testing is warranted. This may require a destructive test method, and more sensitive analytical techniques. As a point of interest, the EMPF analytical lab has found that grinding or pulverizing the sample can render a more accurate XRF (or other) analysis. Though this is a destructive test, the additional sample preparation can preclude the necessity of more expensive analytical verification.

III Material Verification Testing

As a subsequent step, it is often required that if uncertainties exist in the screening analysis, a more thorough and sensitive analytical technique be used. Figure 2-2 outlines a series of analytical techniques that can be used to determine the various RoHS restricted materials.

As stated previously, the matrix surrounding the RoHS constituent will determine the proper instrumental conditions, sample preparation, and calibration standards required to avoid overlapping spectral interferences. This is especially true of spectroscopic techniques where samples requiring acidic decomposition or alkali digestion may recombine, precipitate, or attach ligands that can produce interfering emissions, or prevent atomization. Sample preparation can take a number of forms:

- acid decomposition
- alkali digestion
- microwave digestion
- solvent extraction
- elution

The EMPF has helped a number of companies clarify the confusion surrounding RoHS by offering analytical services and assisting in the preparation of Pb-free compliance through our Pb-free auditing services. For more information please contact Ken Friedman at 610.362.1200, extension 279 or via email at kfriedman@aciusa.org.

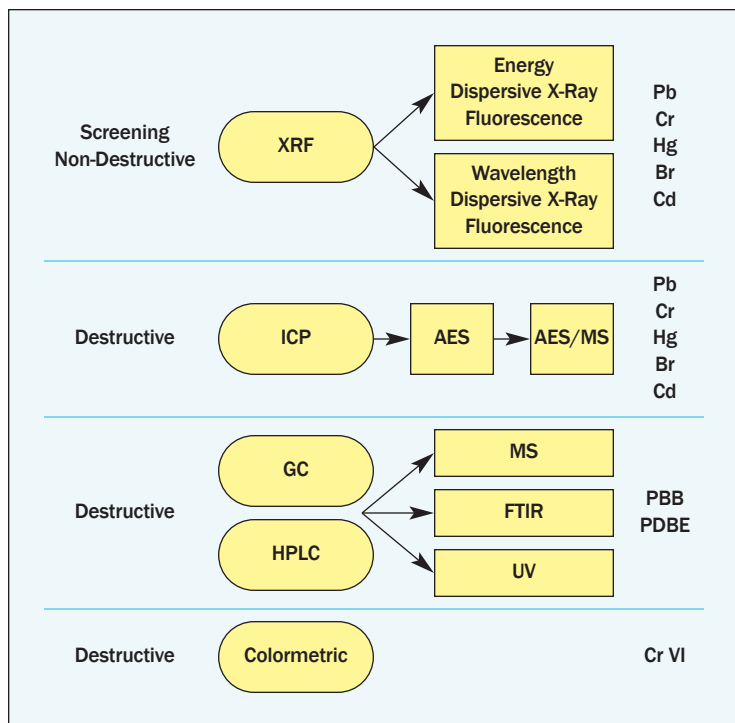


Figure 2-2: Analytical techniques that can be used to determine RoHS restricted materials.



Carmine Meola | R&D Projects Manager

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Flying Probe Testing

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1 mil (0.001 inch). This allows for testing of component package sizes that have previously been too small to test, such as 0201, 01005, and RQFPs (power quad flat packs).

While it is clear that flying probe testing is not the answer to all test requirements, the latest generation of flying probe testers does provide fault coverage that rivals and, in some cases, exceeds traditional ICT systems. When properly employed, these systems can provide excellent diagnostics at a low cost and increase the long term quality of manufactured electronic assemblies.

The EMPF has recently added the newest version of the SPEA 4040 flying probe tester to its extensive range of manufacturing equipment. It

will be utilized in a variety of applications both military and commercial for both low volume, as well as engineering prototypes. If you would like more information on flying probe test systems or a demonstration of the system we have on site here at the EMPF, please contact Ken Friedman at 610.362.1200, extension 279 or via email at kfriedman@aciusa.org.



Ross Dillman | Technician/Instructor

Tech Tips: Identifying Battery Load Qualification Test Parameters

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Next, the current should be plotted against time to create an estimated current load profile for the application (Figure 4.2). If the device will be shut off and stored prior to replacing or charging the battery, the current profile should include half hour to one hour rest periods with no current load (open circuit) to simulate off times. Since batteries produce current by chemical reactions, during open circuit periods, the battery “rests” and reaches a new electro-chemical equilibrium. The open circuit voltage will gradually rise until the new equilibrium is established. After the open circuit rest, the battery may be able to handle higher current rates than at the start of the open circuit. The new equilibrium also allows the battery to discharge additional capacity available from the total theoretical capacity of the electrode materials. Typically the new equilibrium is fully established within a half hour.

Another consideration for the test plan should be the timing of high current rate discharge loads. A fully charged battery can tolerate short duration

high rate discharge current better than batteries with low state of charge (SOC). For example, a current load profile for typical device use may have high current rate discharges only when the battery is at high SOC. If on rare occasions, a high rate current is required at low battery capacity, then include a high rate current discharge when 80 - 90% of the rated capacity has been discharged.

The test plan should include testing at the low and high temperature extremes the device may experience, as well as at room temperature. A battery discharged at its low temperature specification will have shorter run time and poorer high current rate performance than a warm battery. This performance degradation is because chemical reactions occur more slowly at low temperatures. Repeated discharge at high temperatures may shorten the cycle life while storage at elevated temperatures can shorten the shelf life of the battery.

Qualification load testing should occur prior to finalizing the housing design. Preferably, the qualification testing could start as soon as the power load can be estimated from the device design. Test early in the design cycle to allow the choice of an alternative battery if the selected battery has performance issues.

The EMPF offers power load testing of batteries at controlled temperatures. For more information, please contact the EAB Coordinator, Ken Friedman at 610.362.1200, extension 279 or via email at kfriedman@aciusa.org.

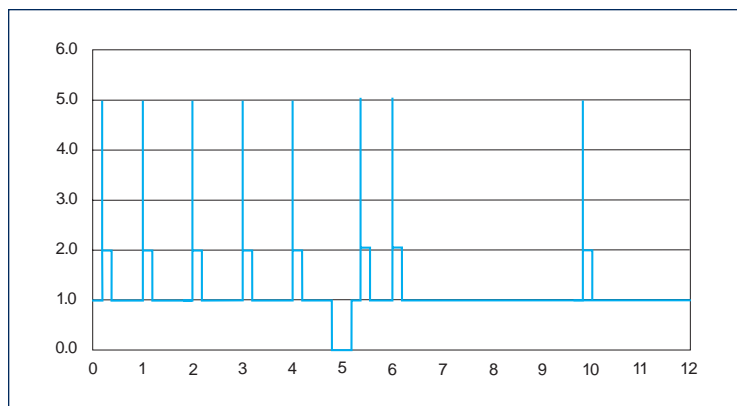


Figure 4-2: Typical current load profile for batteries.



Rebecca Morris | Materials Engineer

Custom Training

(continued from page 6)

The EMPF can also provide customized versions of other courses to suit specific needs. For example, a one-week version of the Electronics Manufacturing Boot Camp was delivered for a manufacturer of printed circuit boards (PCB). In order to better understand their customers' use of their product, the course was customized for training on electronics assembly processes rather than PCB manufacturing since that is one of their core competencies. The class was able to use the manufacturing equipment as part of the course, which allowed a better understanding of the areas where their customers' assembly processes could affect the quality and reliability of the PCBs they manufacture.

The EMPF can also customize a course to focus on specific equipment. For example, if a company has just purchased a BGA rework machine that is also represented in the EMPF Demonstration Factory, the EMPF can deliver a customized BGA Manufacturing, Rework, and Inspection course that uses that specific piece of equipment. The topic coverage would be the same in the lecture portion of the class, but the students would receive an opportunity to apply those skills using the equipment they will be expected to use at their own facility. This type of customization is also available at a company's facility as long as the equipment at the facility doesn't differ significantly from the equipment at the EMPF.

Another example of a customized class is a course entitled "Lead Free Manufacturing in a Production Environment." This course is designed to introduce lead-free soldering processes to factory personnel. Using the standard Lead Free Manufacturing course as a basis, this course is delivered in a single day at the customer's factory rather than the standard

two days at the EMPF. The custom course focuses on the practical impact of the introduction of lead-free solders on processes without dwelling on some of the material science details that can be superfluous for assemblers and technicians. The custom course also provides time for the students to perform some hand soldering projects under the guidance of the instructor to introduce familiarity with the properties of lead-free solders. Further customization could include more technical details rather than a hand soldering project. In that case, more time could be spent on topics that aren't normally pertinent for assemblers such as the effects of tin whiskers or comparing long-term reliability of lead-free solders to tin-lead solders.

The EMPF can customize any course to suit any organization's requirements. IPC certification courses can be customized to provide training on the specific technologies that a company employs. Customizations can be provided to fit a schedule or to suit the required topic coverage for a company's personnel or to focus on specific equipment. If you are interested in a custom course, contact the EMPF Registrar at 610.362.1200, extension 250.



Jason Fullerton | Sr. Product and Applications Engineer

Upcoming Courses

Failure Analysis and Reliability Testing

November 16-18

This course features both lecture and lab sessions. Learn the latest analytical methods to troubleshoot from manufacturing and laboratory perspectives. Content includes the latest information on lead-free solder, x-ray fluorescence, RF plasma etching and micro-probing of integrated circuits.

IPC A-610

Nov. 30 - Dec. 1 Recertification | December 7-10 Certification

Achieve the highest quality and most cost-effective productivity by knowing how to correctly apply the IPC A-610 acceptability criteria.

Chip Scale Manufacturing

December 2-4

Receive hands-on training utilizing advanced packaging equipment in the on-site demo lab. Identify and perform critical process steps when manufacturing ball grid arrays (BGAs), micro-BGAs, flip chips and chip scale packages. Identify and implement process control methods and practices when manufacturing assemblies with advanced packages.

CONTACT THE REGISTRAR VIA:

phone at **610.362.1295**, email at **registrar@empf.org**
or online at **www.aciusa.org/courses**

ACI Technologies, Inc.

National Electronics Manufacturing Technology Center of Excellence Class Schedule for the Calendar Year 2009



Contact the Registrar
for course information
and pricing:
610.362.1295
FAX: 610.362.1289
registrar@empf.org

Contact the EMPF
Helpline for
electronics
manufacturing
assistance:
610.362.1320
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Electronics Manufacturing

Boot Camp A
January 26-30
March 23-27
June 15-19
August 17-21
November 2-6

Boot Camp B
February 2-6
March 30 - April 3
June 22-26
August 24-28
November 9-13

CIS/Operator

IPC J-STD-001
Call for Availability

IPC 7711/7721
Call for Availability

IPC A-610
Call for Availability

**IPC/WHMA-A-620A
CIS Certification**
March 16-18
May 4-6
August 10-12
October 5-7
December 14-16

IPC CIT Challenge Test

January 23
February 27
March 27
April 24
May 29
July 31
August 21
September 25
October 23
December 11
Call for Additional
Availabilities

IPC Certifications CIT/Instructor

**IPC J-STD-001
CIT Certification**
January 5-9
February 9-13
March 9-13
April 13-17
May 18-22
June 22-26
July 6-10
August 10-14
September 14-16
October 12-16
November 2-6
December 14-18

**IPC J-STD-001
CIT Recertification**
January 14-15
March 25-26
April 29-30
June 17-18
August 26-27
September 23-24
October 28-29

**IPC A-610
CIT Certification**
February 23-26
March 16-19
June 8-11
July 6-9
August 17-20
October 19-22
December 7-10

**IPC A-610
CIT Recertification**
January 12-13
March 23-24
April 27-28
June 15-16
July 27-28
August 24-25
September 21-22
October 26-27
November 30 -
December 1

**IPC A-600
CIT Certification**
January 20-22
April 6-8
July 20-22
August 31 - September 2
November 16-18

**IPC 7711/7721
CIT Certification**
March 2-6
June 1-5
August 3-7
November 9-13

**IPC 7711/7721
CIT Recertification**
February 23-24
May 4-5
July 13-14
September 28-29

High Reliability Addendum

**IPC J-STD-001 DS
CIT Certification**
January 16
May 1
August 28
October 30
December 4

Skills

**Chip Scale
Manufacturing**
March 2-4
May 13-15
August 3-5
December 2-4

**BGA Manufacturing,
Inspection, Rework**
January 5-6
April 20-21
July 13-14
September 14-15
December 7-8

Continuing Professional Advancement in Electronics Manufacturing

**Lead Free
Manufacturing**
March 9-10
May 11-12
July 27-28
September 16-17
November 30 -
December 1

**Design for
Manufacture**
January 12-13
April 27-28
July 20-21
September 21-22

**Failure Analysis and
Reliability Testing**
February 9-11
April 6-8
June 29 - July 1
August 31 - September 2
November 16-18

Please visit
www.aciusa.org
to see the 2010
Course Schedule!

