



BEST PRACTICE GUIDE NO. BPGCS001

GOOD HOUSEKEEPING MEASURES FOR SOLVENTS

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1.0 INTRODUCTION

Organic solvents are widely used within Irish industry for a wide range of processes. Their functions include dissolving contaminants (cleaning/degreasing), controlling viscosity and drying rate (thinning), and dissolving raw materials or products. In many cases they are an essential component in a manufacturing process.

The industrial use - or misuse - of solvents may, however, generate problems. Liquid solvents can contaminate the ground or water supplies - one litre is enough to contaminate about 100 million litres of drinking water. Certain organic solvents, also known as volatile organic compounds (VOCs), can give rise to emissions that contribute to low-level air pollution, contamination of the working environment, contribute directly to global warming and, in some cases, damage the stratospheric ozone layer. Low-level air pollution can result in unpleasant odours and affect human respiratory health, crops and natural vegetation.

For these reasons, solvents have long been recognised as hazardous, and their use and disposal are now subject to many legal requirements related to health, safety and environmental issues. Details of the most recent legislation regarding solvents and their use can be obtained in the legislation section of envirocentre.ie. The industry categories covered by this legislation are as follows; -

- Printing,
- Surface Cleaning,
- Vehicle Coating and Refinishing,
- Coil Coating,
- Other Coating (metal, plastic, textile, fabric, film, paper),
- Winding Wire Coating,
- Coating Wooden Surfaces, leather,
- Dry Cleaning,
- Wood Impregnation,
- Footwear Manufacture,
- Adhesive Coating,
- Manufacture of Coating Preparations, Varnishes, Inks, Adhesives,
- Rubber Conversion,
- Vegetable Oil and Animal Fat Extraction and Vegetable Oil Refining,
- Manufacture of Pharmaceutical Products.

The EI⁴ Business initiative encourages companies to act voluntarily to use solvents wisely. In this way a company can become more competitive while at the same time reducing its VOC emissions.

This “Good Housekeeping Measures for Solvents” guide takes the process down to the implementation level and provides information on a wide range of practical measures. It is relevant to companies of all sizes seeking a cost-effective way of reducing solvent consumption, including those working towards ISO 14001 or registration under the European Union’s Eco-Management and Audit Scheme (EMAS).

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1.1 What is good housekeeping?

Solvent good housekeeping can be defined as “*low-cost and no-cost practical measures that allow solvent consumption and VOC emissions to be minimised*”. Low-cost measures have minimal absolute cost and/or a payback period of generally less than 18 months.

The measures described cover:

- technical approaches, such as fitting conservation valves to bulk tanks, switching to welded pipe systems, fitting condensation equipment to extraction systems and process optimisation;

- procedural approaches, such as process elimination, preventive maintenance and better handling and cleaning practices.

1.2 Benefits of solvent good housekeeping

For many companies, simple, affordable good housekeeping measures are being effectively applied to minimise solvent consumption, improve efficiency, achieve a cleaner workplace and save money.

The information in this Guide can help your company become more competitive and more profitable by:

- reducing direct operating costs through reduced consumption of solvents and associated materials (e.g. inks) and reduced disposal costs,
- improving overall site efficiency,
- improving product quality,
- making your company more attractive to ‘green’ customers and investors,
- reducing the risk of pollution incidents, which have associated clean-up costs and, possibly, fines, and
- helping to eliminate the need for abatement equipment, by reducing solvent consumption below the registration threshold set out in the legislation implementing the Solvent Directive.

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2 SOLVENT GOOD HOUSEKEEPING FOR ALL COMPANIES

This Section contains information on solvent good housekeeping measures that will be applicable to all companies.

2.1 Employee training and solvent awareness

Theoretical and practical training in the handling, use and clean-up of solvents and related equipment is essential for any solvent reduction plan to succeed. Environmental, economic and health implications can also be emphasised.

Written documentation for all operations involving the handling or use of solvents should include:

- process manuals to detail the quantities of chemicals required, provide health and safety data sheets and identify the relevant operating procedures;
- operating procedures to explain how to use particular equipment/plant in conjunction with solvents or coatings.

To encourage continued high employee motivation, you may want to consider:

- awarding certificates of competence;
- holding regular one-day refresher courses;
- setting up a solvent-saving suggestions scheme with a financial reward;
- linking a bonus payment scheme to savings achieved as a result of reduced solvent consumption and lower waste disposal costs;
- displaying waste minimisation progress reports around the site.

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2.2 Delivery

Solvents and coatings are delivered in bulk by tanker, in drums, in intermediate bulk containers (IBCs), or even small cans. The following measures apply across all of these types of delivery.

2.2.1 General

The delivery area should be a concrete bunded area or a sloped area with purpose-built drains and underground interceptors or containment pits/tanks. It should not be located near main drainage. Make provision for solvents to be pumped away from the area for re-use or safe disposal in the event of a spillage. In addition:

- accept deliveries only from drivers who are properly trained to handle solvents,
- ensure deliveries are supervised by a trained representative of your own company,
- keep the delivery area clear of obstacles and well lit (if possible, accept deliveries only during daylight hours),
- check drains, interceptors, tanks and bunds regularly and especially following a delivery for any possible source of leaks.

2.2.2 Bulk deliveries

- Prior to filling, ensure that bulk storage tanks have sufficient spare capacity for the delivery and that vents and overfill protection devices are not obstructed.
- Ensure that deliveries are discharged through a lockable fixed coupling to the tank. Check the tanker hose and couplings for leaks and stop delivery if any leaks are detected.
- Fit audible level alarms and overfill protection devices (e.g. ‘slam shut’ valves) to tanks to avoid overfill.
- Where possible, direct displaced tank vapours to recovery or abatement equipment. Back-venting to tankers is generally not cost-effective although it may be worthwhile in some cases involving frequent deliveries or high volumes. Discuss the issue with your solvent supplier. Certain highly toxic materials must be back-vented, therefore you should consult the materials handling safety data sheets for further information.

- For companies with several bulk tanks, it may be worthwhile fitting tanks with carbon canisters to adsorb displaced vapours. In these cases it is important that captured VOCs are recovered or, possibly, destroyed using recommended procedures.

2.2.3 Delivery in containers

- Where possible, encourage suppliers to deliver solvents, and in particular coatings, in IBCs rather than drums. By the nature of their design, less will be lost through both evaporation and container residues. IBCs are also easier and safer to move by fork-lift (see Fig 1).
- Refuse to accept damaged containers. Check for leaks in lid seals, taps and valves, for rust holes in steel drums and for cracks in plastic seams.
- Refuse to accept damaged pallets that may lead to unstable stacking and/or carriage of drums.

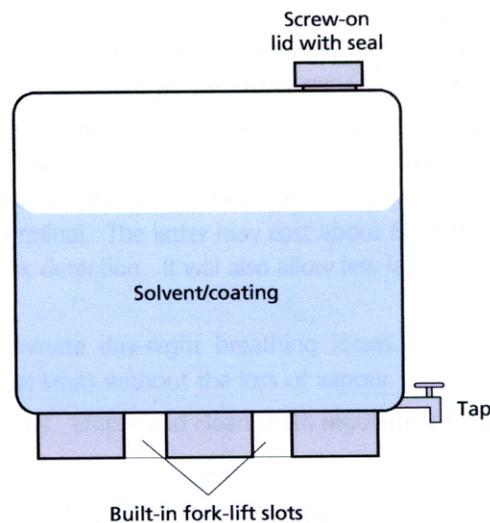


Figure 1. Intermediate Bulk Container (IBC)

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2.3 Storage

Safe and efficient storage of all solvents is important, but chlorinated solvents may require particular care.

2.3.1 General

- Ensure that the storage area is well ventilated for health and safety purposes. To reduce evaporative losses, this area should preferably be shaded and away from heat sources.
- Where possible, buy and store solvents in bulk to reduce costs. This may be particularly beneficial for high turnover materials.
- Ensure that tanks, containers, seals, bungs, etc., are resistant to the solvent to be contained and can withstand any pressure changes that may occur, for example, due to summer temperatures.
- Keep all solvents clearly segregated and labelled in separate tanks to avoid any possibility of cross-contamination and subsequent wastage.
- Paint bulk tanks with light reflective paint to minimise heating and subsequent solvent evaporation. Where possible, use light-coloured drums and containers for the same reason.
- Provide impervious bunds and surfaces for all external storage areas. The bunded area should provide an emergency storage capacity equal to 110% of the volume of the largest bulk tank or 25% of the total volume of product in the bunded area, whichever is the greater. Concrete is not impervious to all solvents and may require a solvent-resistant membrane or lamination.
- Keep tanks and containers far enough away from the bund wall to ensure that solvent cannot ‘jet’ under pressure into an unbunded area. Where space is limited, it may be necessary to increase the height of the bund wall.
- Make provision for pumping solvents out of bunded areas.
- Keep bunded areas clean and dry so that any spilt solvent can be re-used, e.g. for cleaning. Pump out rainwater as required.
- Stored materials must not be able to permeate the floors, bases and walls of internal storerooms.

2.3.2 Bulk storage

- Where possible, keep tanks above ground for easy inspection and maintenance.
- Inspect all tanks regularly for cracks and leaks. Larger tanks should be fitted with a manhole for inspection and cleaning purposes.
- Test for solvent contamination in underground tanks as this can indicate the ingress of water and other materials. A hydrostatic suction pipe can make regular sampling much easier.
- Fit level meters or, as a minimum, dipsticks and use them to reconcile tank levels with process use, through a mass balance. Meters reduce the possibility of overfill and help in leak detection. With electronic meters, data can be displayed on a centralised indoor control board or through a computer terminal. The latter may cost about €3,000 per bulk tank, but will allow accurate and rapid leak detection. It will also allow less labour-intensive and more accurate solvent auditing.
- Fit ‘conservation valves’ to eliminate day/night breathing losses. These allow tanks to pressurise and depressurise to set limits without the loss of vapour.

- Fit drip trays under valves and taps. Empty and clean them regularly for solvent re-use.

2.3.3 Container storage

- Stack drums and IBCs only on a solid and stable rack system. Stacking drums and pallets on top of each other can lead to accidents, particularly when using a fork-lift.
- Keep spare clean empty drums and IBCs to allow transfer from leaking containers.

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2.4 Distribution

The following measures are divided into those relevant to solvents contained in cans, drums and IBCs and those relevant to solvents in piped distribution systems.

2.4.1 General

Where possible, pump solvents directly through a piped system (e.g. a ring main) to the point of use. For companies using adhesives, a move to less viscous, water-based adhesives may allow greater use of pumped/piped distribution. Piped systems have a number of advantages since they:

- reduce the risk of spillage through transfer and decanting;
- remove the need to uncover tanks and reservoirs, allowing better sealing and reducing the risk of exposure to contaminants;
- can be fitted with flowmeters to allow accurate auditing.

Where necessary, decant canned and drummed solvents into a larger sealed tank or IBC to facilitate pumping. This should be done in a flameproof and bunded area.

2.4.2 Distribution of solvent containers

- Dispense canned and drummed solvents from a centralised store, keeping a record of the solvent type, quantity and process/department. This will allow a better check to be kept on usage, spillage and theft. A fully trained nominated member of staff should carry this out.
- Return surplus solvents to the store after use to avoid having cans lying around in areas where they may be spilled.
- Use IBCs and not drums where possible, as the built-in fork-lift slots on IBCs make them easier and safer to handle.
- Do not roll full drums on their rims as this can cause seams to distort and leak.
- When moving drums by fork-lift, use a pallet to allow lifting by forks rather than drum clamps. When carrying drums on fork-lifts and trolleys, use a drum catch, which latches on to the rim of the drum, to keep the drum stable and prevent accidents. Where more than two drums are carried, tape or strap them together to improve stability.

- Carry out a ‘hazardous operations’ (HazOp) study to determine whether the routes taken through the site are hazardous in terms of obstacles, drains, flame sources, etc. Keep routes well defined and clear of obstacles.
- Ensure that drums can be moved on to raised platforms through safety gates and not through a permanent gap in the platform fence through which they (and people) can accidentally fall.
- Do not decant full drums by tipping them as this can cause accidents and large spills. Instead, pump from the drum, using a hose and a steel drop pipe passed through a bung to the bottom of the container (Fig 2). Be careful to withdraw the pipe slowly, continuing to pump and tilting it backwards to avoid spillage from the pipe. Finally tip the drum manually to empty the remnants into the receiving container.

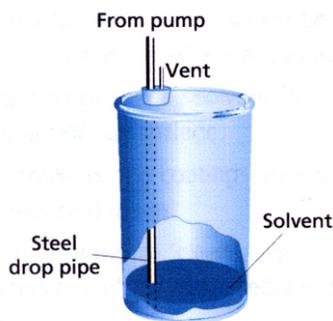


Figure 2. Pumping using steel drop pipe

2.4.3 Piped distribution

- Where possible, bring pipework above ground to minimise corrosion and ease inspection.
- Ensure that pipework is not in a position where it can be accidentally damaged, e.g. by vehicle manoeuvring.
- Use welded pipe, rather than flanged and bolted pipe, to minimise leaks.
- Keep pipe runs as short as possible, with the minimum of joints and valves.
- Design pipework without solvent/coating traps to ensure good drainage of lines.
- Ensure that new and replacement valves and gaskets are ‘low emission’ types (e.g. carbon-based) and that gaskets are solvent resistant. This information should be available from suppliers. Note that polytetrafluoroethylene (PTFE) coatings are generally appropriate only in relatively low temperature applications.
- Check, both visually and by pressure testing, all pipes, valves and joints for leaks.

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2.5 Processing

The following general measures and principles apply to most forms of industrial process;

- Always re-lid partly emptied drums or cans of solvent and, where practical, seal with adhesive tape to prevent vapour losses.
- Keep solvent containers away from sources of heat and draughts to minimise evaporation.
- Encapsulate vessels, reservoirs and machinery as much as possible, using well-fitting sealed lids and covers.
- Where vessels and reservoirs do not have proper covers, use anti-static plastic covers (attached by elastic bands, tyre inner tubes, or nylon hook and loop fasteners etc.) or cling-film. Such covers have the added advantage of keeping dust and debris out of the mix.
- Remove containers of residue solvent from working areas to safe storage areas on a regular basis to avoid accidental spillage.
- When mixing solvents and coatings pour the least volatile material first and the most volatile last, thereby reducing losses.
- Train operators to adopt a ‘clean as you go’ philosophy. This will prevent the build-up of stubborn materials and therefore reduce the need for excessive cleaning at the end of the batch or shift.
- Use drop pipes that pass to the bottom of the container to avoid top-filling of mixing vessels and machine reservoirs. This prevents splashing and excessive disturbance of the fluid surface, and therefore reduces losses. Where the filler pipe has to be withdrawn, do this slowly, switching off any pump first and emptying any remaining solvent that may be contained in the pipe into the container.
- Fit mixing vessels and reservoirs with automatically closing inlet valves to avoid overflow.
- Talk to suppliers, trade associations and other companies in your sector to identify new products, equipment and processes that either eliminate solvent consumption, e.g., compliant coatings, or reduce usage.
- Pump solvents into the mixing vessel through an accurate metering system or formulation computer, where possible. The information gathered can also be used to help calculate solvent consumption for the site.
- Calibrate meters on a regular basis to ensure continued accuracy and to avoid overuse of solvents in the process.

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2.6 Avoiding and Managing spills

Although raised operator awareness of both the cost and implications of solvent loss will help prevent spills, it is important that employees know how to manage those spills that do occur.

- Avoid spilling and splashing solvents and coatings by ensuring that lids are always securely fitted to all containers.
- When transferring solvents, where possible use a pipe to below the solvent level; this will stop splashes occurring, will not disturb the solvent surface and will thus prevent solvent evaporation.
- Provide clear instructions to operators on how any spill should be dealt with.

- Ensure that all movable and partially open containers have sufficient clearance between the fluid level and the rim (ullage) to avoid spillage.
- Provide spillage kits around the site at relevant locations. These can either be purchased from specialist manufacturers or be ‘home-made’ in the form of ‘socks’ and booms using a variety of absorbent materials. Textile or garment factory waste is ideal for this purpose.
- Set up a reporting system for significant spills (for example more than 1 litre of solvent or more than 2.5 litres of solvent-based coating) to discourage careless practice and encourage effective spills management.
- Set up a spillage emergency procedure for large spills of, say, 15-20 litres or more. This may involve notifying emergency crews to fit drain covers and drain valves, using spillage kits to contain and mop up the spill, placing solvent-soaked materials into a sealed drum for recovery/disposal and reporting the spillage to the production manager or director.

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2.7 Cleaning

Cleaning operations often use unnecessarily large quantities of solvent. In many cases such operations can be avoided altogether or the process improved to reduce the quantities of solvent consumed.

- For general surface/floor cleaning, try using a detergent and warm water in isolation or, for more difficult deposits, in conjunction with mechanical measures such as scrapers, floor scrubbers and high-pressure water jets. This will avoid the need for solvents.
- Use only the minimum amount of solvent reasonably required for specific cleaning operations. Spray the cleaning solvent onto the surface instead of dipping the cloth into it. This will use less solvent and will also keep the solvent enclosed, so reducing operator exposure.
- Remove deposits as soon as possible, following a ‘clean as you go’ policy. A build-up of coating can become increasingly difficult to remove as time passes, and will require a disproportionate amount of effort and cleaning material.
- Initially, remove surface deposit (e.g. using a leather-bladed scraper) to avoid excessive solvent use.
- Recover solvent from soaked rags and gloves by wringing them out and letting them drip into a container. The container should be covered to prevent evaporation.
- Where dirty solvents and coatings have been collected, consider distillation so that the solvent can be re-used for cleaning operations.
- Examine all cleaning operations throughout the business to determine if alternative cleaning solutions are already being used and, if they are, whether they can be applied in any other cleaning operations.
- Try low-VOC or VOC-free cleaners. For example, in printing, vegetable-based and other non-solvent cleaners are being used with negligible net cost associated with the change.

There are many alternative products on the market - it may take several trials to identify the one that is best for your process.

- Make sure cleaning areas with drains are fitted with solvent interceptors from which solvent can be pumped.
- Where possible, dedicate vessels, pipelines and other equipment to specific formulations and processes to avoid cleaning between batches. In the long-term, it may be cheaper to purchase one or two new process tanks than to spend large sums of money on cleaning solvents that you may use only once.
- Companies that use spraying equipment should consider renting or buying an enclosed gun-washing machine. This recovers, for re-use, the solvent used in cleaning the gun. Similarly, a small parts wash machine can be purchased or rented to minimise solvent use during machine maintenance. Rental costs for such machines, including the cost of solvent and maintenance, are minimal.
- For larger items, e.g. print rollers and containers, consider buying an enclosed wash machine preferably linked to distillation equipment. This reduces emissions, recovers a large proportion of 'waste' solvents and reduces the waste storage and disposal problem. For most companies the investment is repaid within a year.
- Where large mixing tanks are used, fit automated wash systems, incorporating in-tank spray-heads, to minimise solvent use. Consider fitting more modern spray-heads to mixing tanks as these can significantly improve washing efficiency and may cost as little as €300 per tank.
- Where possible, use nitrogen to purge coating pipe runs. This can recover considerable quantities of coating, outweighing the costs and overheads associated with the cleaning operation.
- Where large quantities of bulk coatings are being dispensed into tankers, consider installing a 'pig-line' cleaning system. In pig-line systems, delivery lines are cleaned out using a 'solvent sandwich' consisting of two tightly fitting resin bungs, or pigs, with solvent in between. The pig is blown down the delivery line using compressed nitrogen. This process ensures that the pipe remains clean for the next delivery, with no paint being left to dry in the pipe. For large-scale coatings suppliers, a pig-line system can save tens of thousands of Euro each year through reductions in paint, cleaning solvent and labour.

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2.8 Recovery and re-use on-site

Rather than disposing of liquid solvents as waste, it can often pay to re-use residue solvents directly or recover them through on-site or off-site distillation. A number of re-use and recovery suggestions are given below. Keep a careful record of all wastes and product 'tails' to facilitate re-use.

- Re-use solvent from line flushing and similar processes in other cleaning operations.
- Use clean solvent (distilled/virgin) only for the last wash. Use dirty solvent for the initial washes as shown in Fig 3.

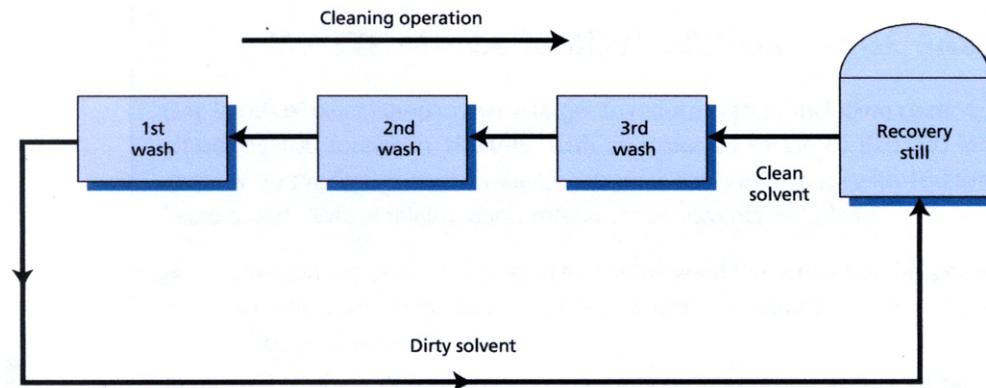


Figure 3 Optimised Cleaning Cycle using Dirty Solvents

- Wring out solvent-soaked rags and gloves into a waste container and cover it, and re-use the solvent. Ensure that this is carried out in a well ventilated area.
- Keep items that are to be cleaned or treated in solvent, free from water, dust and other contamination. This will facilitate solvent recovery by minimising sludge build-up.
- Match cleaning solvents to those used in product formulations. This avoids contamination and may allow the re-use of the ‘cleaning mix’ in subsequent product batches.
- Where possible, use obsolete product in new formulations to avoid disposal.
- Consider buying distillation equipment for the recovery of dirty solvents and coatings for re-use.

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2.9 Disposal off-site

Many of the measures noted earlier in this Section apply as much to the handling of waste solvents/coatings as they do to fresh materials. However, a number of measures are listed below that are specific to waste handling, storage and disposal.

- Keep a careful record of all wastes (as required under the Waste Management Acts) to assist in overall solvent management and auditing activities.
- Check that you are not disposing of containers that still contain solvents/coatings.
- Segregate wastes using clear labelling or drum/tank colouring to avoid cross-contamination. This can aid recovery, in particular where there are chlorinated and non-chlorinated waste streams. Use waterproof labels that record a description of the waste (chemical type, quantity, hazard designation) and the date it was deposited.
- Ensure that waste containers are well sealed and in good condition with no evidence of corrosion or leaks.
- Consider using bulk tanks rather than drums where waste volumes are large, as this minimises the risk of drum spills and leaks and reduces disposal charges.

- Have waste solvents removed from site regularly. This minimises the possibility of spillage and reduces the risk of drum corrosion.
- Design solvent mixes to be simple and attractive to recoverers. Talk to solvent recoverers to see what the market requires.
- Make full use of waste exchange directories and recovery companies.

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2.10 Maintenance

Consider establishing a preventive maintenance programme to:

- visually check for leaking flanges, valves, welds, tanks, bunds, etc;
- pressure-test pipelines, tanks, etc;
- check the tightness of nuts and bolts;
- check for wear and tear on machinery, valves, bunds etc;
- recalibrate metering systems.

Such programmes reduce solvent losses, improve efficiency and product quality, and help to keep the workplace generally tidy and pleasant.

It is a good idea to keep a maintenance schedule and record of all inspections and maintenance activities. Where possible, the preventive maintenance programme should be organised and supported by computer software. By flagging-up planned maintenance on a daily basis until it is completed, preventive maintenance software can help to ensure that no maintenance jobs are forgotten. This may involve some expenditure, but it will contribute substantially to a thorough and efficient maintenance programme.

Process operators can be provided with individual devices to help identify fugitive losses and hence help to focus unscheduled maintenance.

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2.11 Solvent auditing

Establish a Solvent Management Plan to help:

- Keep records of all solvents brought on to site and monitor and audit their movement through all stages of production to assess solvent consumption,
- Keep records of all solvents taken off-site.

In addition, carry out a health, safety and environmental audit regularly to ensure that all company departments/sites are continuing to work to the same high standards.

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3.0 Further Information

Solvent Regulations:-

<http://www.envirocentre.ie/downloads/LEGAL%20SOLVENTS%20REG%20GUIDE%2030Nov%202005.pdf>

Disposal of hazardous wastes:-

<http://www.envirocentre.ie/downloads/Legislation04WasteRevised%20DEC%2002.pdf>

Control of major accidents and hazards:

<http://www.envirocentre.ie/downloads/Legislation08ControlOfMajorAcc.pdf>

EPA Solvent Regulations supports:-

<http://www.epa.ie/TechnicalGuidanceandAdvice/SolventRegulations/>

ACKNOWLEDGMENT

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