

## Cleaner Production

- read every item in the checklist
- tick one box for every question: **yes**, **no** or **n/a**
- when you have gone through all the questions, use the **Action List** sheet and write down every action you need to take to ensure your site is pollution and liability free
- check off the actions on your **Action List** as you complete each one
- check off the item in the **Milestones** checklist at the front of the document

Make sure you read right through each checklist – we guarantee you will find something you need to look at, even if you think you won't!

Section	Done	Date
Materials substitution	<input type="checkbox"/>	_____
Process change	<input type="checkbox"/>	_____
Containers and packaging	<input type="checkbox"/>	_____
Saving water	<input type="checkbox"/>	_____
Saving energy	<input type="checkbox"/>	_____
Office, canteen and washrooms	<input type="checkbox"/>	_____
Instant gains	<input type="checkbox"/>	_____
Other (specify)	<input type="checkbox"/>	_____
_____	<input type="checkbox"/>	_____
_____	<input type="checkbox"/>	_____

## How a Cleaner Production Audit benefits you

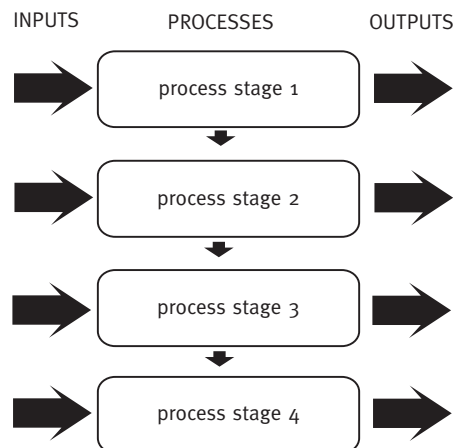
A cleaner production audit tells you:

- how much waste you are producing and just what your waste consists of
- which stages of your process are the most wasteful – and cost you the most money
- how much money it costs you to dispose of your waste
- how waste can be eliminated as well as reduced
- how much money you can save by implementing cleaner production measures

Cleaner production focuses on your whole process, not just 'end of pipe' waste treatment. By splitting up your operations and processes into separate stages, you can identify all wastes and where, how and why they are generated. Then you can work out where you can make changes to:

- inputs
- processes
- outputs

At each stage, you may be able to reduce waste by changing or reducing inputs and outputs and changing processes, as show in the diagram below.



Interested? – then read on for lots of useful, cost-saving suggestions!

## Materials substitution

Non-toxic or less toxic alternatives are available for many materials commonly used in manufacturing. Using them reduces the environmental impacts of your wastes and can reduce the cost of waste disposal. Look at your materials use and try to:

- eliminate
- reduce
- substitute less toxic materials or ones which are better suited to re-use

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1. Can your firm eliminate the use of materials not essential to process or quality?
2. Can you use the same material or chemical for as many products and processes as possible to increase possibilities of internal recycling?
3. Can you use hazardous materials as raw materials and cleaning agents?
4. Can you replace hazardous materials with non-hazardous – for example, replacing CFCs with HCFC or other gases? (see glossary)
5. Can you replace silicone spray with wash grains (external lubricants)?
6. Can you replace organic solvent-based inks, paints, coatings or cleaners with water-based ones where possible?
7. Can you use pigments, catalysts, batteries and other products without heavy metals?
8. Can you use non-halogenated instead of halogenated compounds? (see glossary)
9. Can you find any other examples of replacing a more polluting substance with a more environmentally friendly one in your operations?

If you have action items from the above questions, record them in the Action List.

## Process change

Changing how you go about things can offer big opportunities for waste reduction. You can investigate a number of modifications to process or equipment:

### Redesign the product

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1. Modify the product size and shape to reduce the quantity of materials used in the product.
2. Re-design or change the materials used in your products to create less waste, enable wastes to be re-used or recycled, or to produce wastes which are less environmentally harmful or expensive to dispose of.
3. Design the most economical cutting of sheets and similar processes to minimise waste from edge losses.
4. Re-use offcuts in the production process or recycle them where re-use is not possible.

### Improve your understanding of where waste occurs

1. Use the input-process-output approach in the diagram at the front of this section to identify every point where wastes are generated. Ask yourself why they are generated and how you can avoid this waste.
2. Identify and contain all leaks in pipes, equipment and other systems.
3. Set up loss control and housekeeping measures to minimise the amount of waste you generate.

Y N n/a



## Re-design the workspace for efficiency

1. Redesign workspaces and processes to improve efficiency by storing materials closest to where they are used and minimising the amount of handling or decanting between processes.
2. Use dedicated mixing or supply lines for products to reduce changeover clean-ups and down time.



## Re-think the production process for improved efficiency

1. Use automated feed systems to minimise wastage.
2. Optimise process control settings to minimise wastage.
3. Change from batch to continuous production.
4. Collect remainders of the master batch to use for the next run.
5. Carefully plan colour and raw material changes (eg from lighterto darker) to minimise raw material losses.
6. Control overspray and dragout to reduce evaporation losses and spills
7. Allow for more drainage or drying time of products.
8. Plan and sequence production to even out generation of waste materials, to reduce peak loadings on treatment facilities.



## Make savings on cleaning

1. Put a pig through supply lines before flushing to capture more product and reduce the volume of cleaning waste.
2. Rinse or clean machines without additives to save cost.
3. Use alternative cleaning methods which maximum cleaning efficiency such as abrasives, high pressure sprays, water or steam



## Process change to eliminate or reduce waste volumes and reduce waste strength

1. Change from wet to dry processes to reduce or eliminate waste.
2. Use mechanical instead of chemical processes.
3. Replace single pass with closed loop recycling processes.
4. Replace acidic or alkaline treatment processes with mechanical ones.



## Solve your solvent problems

1. Use water-based instead of solvent-based processes and systems.
2. Standardise solvents and cleaning agents to minimise the number of different products used – bulk buying one product will be cheaper, too.
3. Replace solvent based cleaning systems with mechanical or thermal alternatives such as air blast or dry stripping.
4. Minimise solids concentration in solvent wastes for easier re-use
5. Minimise solvent content in solid waste to make it less hazardous
6. Regenerate/recover/re-use spent solvent through distillation, depending on quantities

used. As this is not always possible when solvents are mixed, it is better to use only one solvent or to avoid mixing them.

## Unmixed wastes are resources

Y N n/a



1. Separate your wastes at source to make it easier to re-use or recycle some or all of them, to reduce the volumes of waste requiring special treatment or to facilitate treatment and disposal.

For example, you could segregate:

- hazardous from non-hazardous wastes
- recyclable waste from non-recyclables
- organic (food/garden) waste from metal-containing or inorganic waste
- highly toxic waste (such as cyanides) from all other waste
- aqueous wastes from flammables
- chemical waste from general waste
- halogenated from non-halogenated solvents
- aliphatic from aromatic solvent wastes
- chlorine-fluorocarbons from methylene chloride. (see glossary)



2. Install systems such as ion exchange, ultrafiltration, reverse osmosis and electro dialysis to separate waste stream components and return useful ones to your production process for re-use. (see glossary)

## Environmental upgrades



1. When you buy new equipment or replace old equipment, do you ask suppliers to give you information on environmental performance efficient materials use or ability to eliminate or minimise waste?

If you have action items from the above questions, record them in the Action List.

## Containers and Packaging

Your firm has a lot of options for minimising container and packaging waste.

### Your suppliers



1. Ask your suppliers to provide goods in re-useable, returnable or refillable packaging, like crates, drums, containers, pallets (consider your available storage area), or in recyclable packaging.



2. Buy in bulk and distribute goods to various departments using waste cardboard boxes.



3. Buy the same product from one supplier, to reduce the amount and variety of packing material.



4. Ask suppliers to use machines to wrap plastic around boxes and pallets rather than manual wrapping, to reduce the amount of plastic used



5. Ask your suppliers for information on new products, new ways of using existing products and new processes that reduce environmental impacts



6. Avoid over-packaged products or ask the supplier to reduce the amount of packaging.



7. Request re-useable or recyclable containers from suppliers, or ask them to take back their containers or packaging.

### Your products



1. Minimise packaging on your own products, for example by packing loose or in bulk.



2. Use returnable, refillable or re-useable containers and packaging.



3. Ensure containers and packaging on your own products are recyclable.

Y N n/a



4. Use single material packaging where possible – it is easier for your customers to recycle.



5. Use vacuum packaging.



6. Shred non-recyclable paper items for packing materials.



7. Segregate packaging waste for recycling (paper, plastic, glass, steel straps).

### Your customers



1. Include a message on your containers and packaging encouraging people to re-use or recycle them.



2. Offer your customers a 'take-back' service for containers or packaging so you can re-use or recycle them.

If you have action items from the above questions, record them in the Action List.

## Saving water

The Auckland Regional Council has produced a short series of guidelines for industries to audit their water use. To get your copy, call ENVIROLINE on 0800 8060 40 and ask for Technical Publication No. 82, Industrial Water Audit Guidelines.

You can also investigate the following options to minimise water consumption.

### Measure water use



1. Install water meters to measure consumption in key activity or process areas. Compare these with readings at the gate to ensure there are no large unexplained losses.



2. Monitor water use in each process to identify opportunities for savings, to quantify flow-rate reductions and calculate your water and cost savings.



3. Investigate any unexplained increases in water consumption.

### Eliminate unnecessary water use



1. Sweep where possible rather than hosing using brooms, mops and scrapers to clean floors, pools, or outside areas.



2. Pre-clean equipment or surfaces with a broom or vacuum cleaner before hosing down.



3. Use non-water based cleaning systems such as vacuums.

### Reduce water use



1. Educate staff about minimising waste by turning taps and hoses off after use.



2. Make it easy for staff to reduce water use by putting shut off valves on hoses so they don't have to walk to the tap.



3. Use spray-adjustable nozzles on hoses and taps.



4. Use process controls or timers to restrict water flow rates, including:

- installing photosensors in spray-rinse chambers
- repairing or replacing defective photosensors, process controls or timers
- performing routine maintenance (clean and readjust).



5. Use water flow restrictors on flowing rinses and all water using process



6. Halve your toilet flushing water by:

- flush controls so toilets stop flushing when the hand is removed
- installing dual flush or low-flush toilets

Y N n/a



- reduce toilet flush capacity by installing a 'brick' in the cistern.

7. Modify urinals to flush only on demand and replace urinals with low flush toilets in new buildings.
8. Use low volume shower roses and taps.

## Maintenance

1. Regularly inspect for leaks and running water on taps, toilets, showers, all visible pipe work, all valves and plant rooms.
2. Set up a system that makes it easy for staff to report leaks promptly.
3. Repair leaks immediately they are reported.

## Efficient water use

1. Use a proper ratio of water to cleaning agent and minimise the use of cleaning agents as far as possible.
2. Use a proper ratio of water to materials to be diluted or mixed to minimise the use of water and materials as far as possible and provide staff with the right-sized container or calibrated dispensers to ensure this.
3. Increase rinsing efficiency while reducing waste by:
  - using counter-flow rinsing
  - using spray rinsing
  - installing fog nozzles
  - using reactive rinsing
  - using agitation to ensure adequate rinsing, rather than more water.
4. Maintain and optimise plumbing and other equipment using for directing water flow through the production facility, by improving water spray cabinet sumps and immersion baths to maximise water rinsing capabilities.

## Re-use water

1. Sequencing your process operations so that wastewater from one process can be used for another.
2. Re-use cooling water for other purposes.
3. Filter and re-use cleaning or process waters.
4. Treat and re-use spent rinse or process water by recovery techniques

## Café and laundry water use

1. Install water efficient appliances such as dishwashers and rinsing taps and
  - operate dishwashers only when full
  - use appropriately sized dishwashers for the number of dishes generated by the organisation
  - do not defrost or cleaning food under running water
  - make ice in the most effective sizes and amounts.
2. Install small, regular and high washing load options in the laundry and
  - use optimal washing load options for different loads (include one small machine for urgent washes)
  - ensure machines have low, medium and high water use options.

## Outdoor water use

1. Use alternative water sources for irrigation, such as rainwater, recycled wastewater from buildings, cooling water.

Y N n/a

2. In gardens:
  - use native plants rather than exotics to reduce water and chemical
  - control irrigation using timers, tensiometers (to determine when irrigation is necessary), soil humidity sensors, rainwater sensors to stop or reduce irrigation as appropriate
  - install sub-surface irrigation systems fed from waste or rain water
  - investigate landscaping to prevent weed growth and reduce evaporation
  - irrigate at night or evening to reduce transpiration water loss by evaporation through leaves).

If you have action items from the above questions, record them in the Action List.

## Saving energy

Does your plant have any of the following equipment, machines or systems?

Equipment/machines/systems used to support manufacturing, such as:

Y N

- steam and hot water systems – including boilers
- electrical/lighting systems – such as electronic motors, transformers, pumps, building lights, electric heaters
- air handling or ventilation systems – including fans
- refrigeration/process cooling/compressed air systems
- cleaning or washing systems

Equipment/machines/systems directly used in your manufacturing process:

- processing tanks such as reactors, vats
- size reduction equipment such as metal or cloth cutting machines
- fluid flow systems or pneumatic conveyance

If you answered 'Yes' to any of the above questions, then your firm could usefully investigate the process or equipment modifications suggested below.

Start with the basics:

- ➔ turn off lights, heaters, air conditions and equipment when not in use
- ➔ don't use them when they are not needed – e.g. lights by windows
- ➔ use installation and ventilation instead of heating and cooling
- ➔ install energy efficient lighting and other equipment
- ➔ maintain equipment to optimum efficiency
- ➔ post signs and educate your staff

You will be surprised at how much money these simple steps will save.

## Measure energy use

Y N n/a

1. Ask your electricity supplier to provide energy data on a regular basis and how much detail they can give you above your energy use (some companies will give you charts of energy consumption at 30 minute intervals).
2. Install submain check meters to measure energy consumption in key activity or process areas.
3. Monitor energy use in each process or area to identify opportunities for savings, to quantify reductions and calculate your energy and cost savings. Your energy supplier will be able to give you a lot of helpful advice.
4. Investigate any unexplained increases in energy consumption.

Y N n/a



## Eliminate unnecessary energy use

Don't draw power at nights, weekends or during breaks when no-one's around:

- turn off lights, photocopiers, computers, heaters, air conditioners and other equipment and machinery when not in use
- don't use them when they are not needed – e.g. lights by windows
- use insulation and ventilation instead of heating and cooling.

## Reduce energy use



1. Use equipment such as printers, VDUs and photocopiers with a 'sleep' or 'greensave' feature.
2. Install timer controls to prevent machines being left on after use where out-of-hours use is unlikely.
3. Incorporate a 'lights off' check into off shift security inspections.
4. Carry out energy awareness campaigns (especially relating to 'Turn it Off') on a regular basis.
5. Install energy-efficient lighting systems, including:
  - efficient reflectors
  - energy efficient bulbs or tubes – e.g. replace incandescent lamps in exterior fittings with miniature fluorescent lamps
  - effective but not superfluous lighting levels
  - modular lighting controls, so that small areas can be lit.
6. Conduct checks of:
  - average lighting levels against codes/special requirements and removing fittings or de-lamp fittings where levels are higher than required
  - disconnecting redundant ballasts where de-lamping has been carried out
  - the feasibility of relocating light switching panels to more convenient positions.
7. Investigate installing:
  - occupancy sensing for lighting store rooms, basements and other places where there are multiple entrances and variable occupancy rates
  - daylight sensing controls for rooms and areas with good daylight and adjustable lighting levels
  - specialist lighting controls to provide reduced voltage operation for larger areas with general area switching, such as Southpower Light Manager
  - extra lighting controls so that smaller areas can be separately and individually lit.

## Maintenance



1. Set up inspection and maintenance schedules to ensure that:
  - water heating systems are maintained at optimum efficiency as indicated by EECA (the Energy Efficiency and Conservation Authority) or your local energy supplier
  - energy efficient heating and cooling systems are installed and maintained to optimum performance.
2. Do you:
  - have prompt reporting and repair of faults?
  - monitor the performance of your equipment?
  - assess available electricity purchase tariffs annually?
  - select replacement equipment on the basis of capital investment, operating costs, labour costs, reliability, maintenance costs and running costs?
3. Regularly check for and seal all thermal and mechanical leaks on the system. It is easiest to find compressor leaks outside operating hours when all plant is off: the noise indicates the size of the leak, for example, from:
  - compressor air leaks
  - heat loss due to poor insulation.

Y N n/a



4. Regularly inspect to ensure that process conditions, particularly the temperatures and pressures, in your equipment are as close to the manufacturer's specification as practicable and that no equipment is over-heated or maintained at a higher pressure than that recommended by the manufacturer.



5. Operate compressors at the lowest pressure that will meet your needs. A compressor operating at 100 psi uses 12% more electricity than one operating at 80 psi.

### Efficient energy use



1. Have you carried out a cost-benefit analysis to determine the optimum time and market conditions to replace older equipment?



2. Investigate and reduce building losses:

- have you minimised infiltration and heat loss, including checking that:
  - doors and windows seal properly
  - building fabric is in good condition
  - ventilation is optimum?
- have you determined if it is practical to physically separate heated/non-heated areas using insulation material, fast closing doors and air locks?
- have you insulated ceiling/roof spaces? Older buildings and spaces above and around hot water cylinders and heaters/radiators can especially benefit.
- have you re-evaluated your space needs, so you are not heating buildings or sections of buildings that are not frequently used or are in poor repair?
- have you inspected and repaired existing ceiling/roof insulation and repaired any areas that have been water-damaged or altered?



3. Investigate and reduce energy use for heating. For example, have you:

- scrutinised areas where supplementary electric heating is used (such as portable fan heaters)?
- repaired or extended the main heating system or provided controllable electric heating?
- ensured that fan coil heaters are isolated from heat and electricity outside the heating season? Investigating whether the installation of power factor correction equipment will reduce electrical system losses.
- insulated and regularly maintain insulation on all pipes, (hot water, steam and condensate) flanges, valves etc?
- removed or blanked off all redundant piping and dead legs?
- checked and maintaining regularly all joints, glands, valves for leaks?
- ensured water pumping rate is correct throughout the heating system?
- determined whether reducing valves, steam traps or by-passes are correctly installed, and have drain points, air vents and strainer protection where appropriate?

### Efficient air handling or ventilation systems



1. Can you use natural ventilation instead of mechanical ventilation? Roof vents with pneumatic or electric dampers can be used to encourage natural ventilation in the summer.



2. Have you scrutinised existing operating times and requirements in detail? Often systems are on because they always have been and no-one knows where the switch is!



3. Have you determined the extent of local exhaust ventilation systems and modified systems to only extract air where required?



4. Have you balanced ventilation systems and controlled extraction volumes to actual needs?



5. Can you use speed control in fans and motors to control air flows rather than installing more dampers in the system?



6. Can you use timers and demand control to prevent plant running when not required? Occupancy detection can be used in toilet and store areas (though it is important that the Health & Safety of the room occupants is not compromised).



7. Can you use a heat exchanger to transfer energy from heated exhaust air to inlet air, while avoiding re-ingestion of exhaust air into inlet grilles?

Y N n/a

8. Do you carry out filter maintenance correctly and keep records? If manometers are not fitted, install them cleaning diffusers, return grilles and extract grilles regularly. Note areas where dirt or loose material builds up.

### Efficient boilers and efficient use of heated water

1. Ensure that boilers are sequenced correctly, to make sure that boilers are at maximum possible loading, for example:
- can you run one at high load rather than two at moderate load?
  - is there a demand for a service such as heating or control air outside standard working hours? If so, is it more cost effective to have an additional low capacity equipment (e.g. electric heater, low pressure compressor) to provide this demand and allow the main equipment to be shut off?

2. Where the heat requirement of the system is close to the maximum output from a single boiler, do you maintain the highest possible temperature in the feed water tank in order to maximise the boiler rating (this could avoid the need for a second boiler)?

3. Can you maximise the use of waste heat for pre-heating feedwater from contaminated condensate, hot discharges to waste, boiler blowdown and flash steam?

4. Have you covered and insulated your feed water tanks and hot water supply lines?

5. Can you use smaller on-demand hot water heating systems at the point of use, instead of a large centralise supply?

6. Have you determined the most appropriate chemical dosing system for the feed water and the boiler operation?

7. Check heating in process treatment tanks. For example, have you:
- used 'Croffles' or covers where possible to minimise the evaporative loss from process tanks? (Croffles can reduce heat consumption by over 50% when compared to bare tanks).
  - ensured the air extraction rate above tanks is the minimal required rate? (high extraction rates can result in high heat loads)
  - investigated re-using condensate from process heating coils? It is now possible to design systems which can detect contamination of the condensate, thereby allowing condensate to be returned and disposing of contaminated condensate. This can considerably reduce water heating costs.

### Efficient motors

1. Carry out performance tests on larger motors: it is common for fan motors and pump motors to be oversized and therefore operating very inefficiently

2. Fit variable speed controllers or soft start controllers with energy reduction features:
- where motors are oversized and/or
  - the load on the motor varies.

3. Investigate replacement of high use-existing motors with high efficiency motors when motors are:
- oversized
  - large
  - well loaded
  - operating for long periods
  - being replaced following breakdown or damage.

### Efficient air compressors

1. Is compressed air really required for the operation? Often electrical can be used instead, at less than a tenth of the operating cost of compressed air.

2. Is the air inlet for the compressor sited in a cool position? Every extra 4° C causes a 1% increase in electricity costs.

3. Where you need control air (20 psi) outside standard working hours, is it more cost

Y N n/a



effective to have an additional low pressure air compressor and shut off the main air compressor?

4. Can you shut off sections of the distribution network when not required, for example at weekends?
5. Are there adequate drain points in the system and are these opened automatically or can a manual system give better control? (Air receivers need regular draining because a receiver full of water will cause the compressor to cycle between load and no-load more frequently than necessary. This could result in cycling problems or overheating of the electrical starters, while running off-load still uses electricity).

## Cost-effective load management

1. Ensure no unnecessary replication of equipment or machinery, for example, using two boilers where one could handle the load at full capacity.
2. Ensure that the load in the system is evenly distributed to eliminate the need for extra equipment, for example:
  - can you use time-clock controls or other measures to eliminate peaks in heat demands that require additional boilers?
  - can you shift suitable loads to night time use, to make better use of night use energy rates and reduce required system capacity (maximum demand charges)?
3. Ensure that capacities and demands are matched. This is particularly applicable to boilers, transformers, compressors, motors and fans:
  - ensure no equipment or process systems are over-sized or under used
  - match the size of the equipment to actual requirements to reduce standing losses and connection charges.
4. Where you have insufficient or outdated control, have you investigated installing a building management system to time-schedule plant and report alarms and conditions to a central point?

## Investigate the use of waste and renewable energy

1. Have you investigated co-generation of heat and electricity, for example when large boilers are being replaced and there is a constant heat requirement throughout the year?
2. Can you use heat exchangers or direct use of waste heat for heating?
3. Have you investigated using renewable energy supplies like solar or wind energy?

If you have action items from the above questions, record them in the Action List.

## Office, Canteen and Washrooms

Don't forget these areas – their activities also have environmental effects and the costs of materials, water and energy use can be reduced.

1. The office: check the following areas:
  - energy use and efficiency
  - materials use: reduction, re-use, recycling
  - purchase of recycled content materials and supplies.
2. The canteen: check the following areas:
  - energy use and efficiency
  - water use and efficiency
  - materials use: reduction, re-use, recycling
  - purchase of recycled content materials and supplies (e.g. serviettes)
  - composting of green waste for use in gardens.
3. Washrooms: check the following in toilets and showers:
  - energy use

- water use and efficiency
- materials use: reduction, re-use, recycling
- purchase of recycled content materials and supplies.

## Instant gains

There are clear export and consumer benefits from implementing cleaner production or effective environmental management systems. An example is the New Zealand Government approved environmental label, Environmental Choice New Zealand. The label means that firms can get independent verification that their product has eased the burden on our environment.

But you can't do everything at once – so set some priorities:

**PRIORITY 1:** do the things necessary to comply with the law and/or the conditions of any resource consents or other permits

**PRIORITY 2:** identify and implement those changes that will make the biggest, quickest or easiest savings, for example:

- categorise your wastes by cost, according to:
  - costs in lost raw materials
  - cost in lost products
  - treatment or disposal cost
- look at your biggest volume or most expensive wastes. Which ones can be:
  - eliminated
  - reduced
  - re-used, or
  - recycled?
- work out the financial and environmental benefit of implementing change
- prioritise other changes for future financial years
- make provision in your annual budget process for further review so you can make ongoing improvements.

**Remember – 40% of financial and environmental improvements require ZERO cost outlay and generate significant savings!**

## More detail for your site

As you walk around the site and make new observations, there may be extra things you see that you want to add. If so, add them here.

ITEM: \_\_\_\_\_  
ACTION \_\_\_\_\_

Put it on the ACTION LIST

ITEM: \_\_\_\_\_  
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