Destruction and Decontamination Technologies for PCBs and Other POPs Wastes

A Training Manual for Hazardous Waste Project Managers

Part II. Destruction and Decontamination Strategy
Foreword

This Training Manual has been prepared by the University of Auckland, New Zealand in the context of the convening of the First Continental Conference for Africa on the Environmentally Sound Management of Unwanted Stocks of Hazardous Wastes and their Prevention, Rabat, Morocco, 8-12 January 2001.

It has been designed to assist those governments or organisations, not only in Africa, charged with the task of managing the destruction or decontamination of POPs (Persistent Organic Pollutants) with procedures that assist with the planning and selection of appropriate technologies that suit the particular circumstances whilst complying with the need for environmentally sound management principles and the principles of sustainability. In that context special consideration should be given to the local national frameworks and the responsibilities of the relevant competent authority.

New ideas and technologies are emerging rapidly and good practices are still evolving. The Training Manual however will remain useful in providing a selection process allowing new technologies to be evaluated under the provisions of the Training Manual and enabling organisations to continue to adopt new technologies as they become available. There are four parts to this Training Manual. Part Four is a detailed Field Application Training Manual to the handling and environmentally sound management of POPs as wastes covering obsolete pesticides and PCB's in particular.

The Training Manual should be considered in conjunction with other technical guidelines adopted by the Conference of the Parties to the basel Convention and governing the environmentally sound management of hazardous wastes, in particular the Technical Guidelines on Wastes.

The writer refers in particular to the Draft Technical Guidelines on the environmentally sound management of POPs wastes which, at the time of printing of this document, are being negotiated under the Basel Convention. Furthermore, this Training Manual aimed at providing practical training for waste managers should not be interpreted as preempting any of the principles, guidance and recommendations that will form part of the Technical Guidelines on the ESM of POPs wastes mentioned hereabove.

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How to use this Training Manual

This Training Manual is designed as a desk top manual for planners, project managers and government department staff. Its style aims to provide for ease of reference and absorption of complex ideas and areas of uncertainty. The Training Manual has been designed as a complete technical Training Manual for the management of POPs as waste in an Environmentally Sound Manner. This Training Manual not only covers the basic principles of hazardous waste such as POPs but seeks to provide a step by step Training Manual as to how such wastes are to be managed, packages, stored, transported, decontaminated and disposed of. The step by step strategy culminates in a set of Work Procedure Instructions that will allow a party to establish and manage a POPs waste project. At the end of Part IV there is a sample set of Tender and Contract documents that a party can use to create a contract for the management and handling of a POPs project. This technical Training Manual is based on the integrated matrix system of waste management and no part of the project can be initiated without the preceding parts being carried out. The reader must understand that all parts of this Training Manual have been consolidated to form a management programme.

The Training Manual is designed to be used in several complementary ways:

- In creating a project strategy for disposal or decontamination
- In establishing the appropriate technology to be used
- In establishing a set of rules and methods to actually perform a destruction of decontamination project.
- In providing the principles for site establishment and the basis for an operational manual.

The Training Manual can help with

Planning
- understanding background and principles
- correct inventory collation
- inventory analysis

Writing project Plans
- produce an overall plan for disposal or decontamination

Technology Decision making
- appraisal of appropriate technology
- selection of technology for destruction or decontamination

Writing tender documents
- produce tender documents for destruction or decontamination

Hazardous waste project Implementation
- produce implementation plans

Project manual
- produce comprehensive destruction or decontamination manual
Structure of the Training Manual

I  BASIC PRINCIPLES AND BACKGROUND

This section covers the background to the POP's problem and the actions of international organisations to deal with the toxic waste problems.

II  POPs PROJECT STRATEGIES

The formulation of strategies for destruction and decontamination depends on the inventory analysis. When the information is available then the strategy selection process commences.

III  TECHNOLOGY SELECTION PROCESS

When the destruction and decontamination strategy is in place then the specific technology decisions can be made and the appropriate technology selected. several destruction and decontamination technologies are presented in this section

IV  IMPLEMENTATION PROCESS

Tendering and project management documentation and plans. This section provides design guidance for site appraisals, packaging of hazardous wastes, storage, transportation as well as guidance for the destruction and decontamination processes.

Scope of the Training Manual

- The Training Manual can be used to prepare plans and strategies for the project management of hazardous waste projects involving intractable chemicals such as PCBs and other POP's.

- The scope is such that any organisation can use it to prepare simple plans for a small scale waste problem involving less than 5 tonnes of material or for a large scale operation involving say 5000 tonnes of material.

- In the final Part of the Training Manual there are planning guides so that large projects that demand a high standard of quality assurance are available.
PART II PROJECT STRATEGIES

The process to developing an Environmentally Sound Management Project strategy for destruction and decontamination is essentially the same for all POPs, PCBs and unwanted and obsolete pesticides. There are seven steps involved and these steps are the same for all. The Training Manual deals with each separately but follows the same seven steps.

Step one
Declaration to dispose PCBs and POPs

The decision to dispose is where the whole process starts. When a country or organisation decides that a POP or PCBs will be collected and disposed of and this is declared the entire process commences at the point of declaration. The important key issues at the point of declaration are also to state the boundaries of the disposal. Will it be only government agencies that have stock of PCBs or POPs or will it also cover private or public companies. Will stocks without owners be included and who will pay for the disposal. At the point of declaration the rules about end of service life for equipment contaminated with PCBs will need to be stated. The declaration of disposal needs to be short, clear and concise as to the boundaries of the project. Without a clear declaration it will be difficult to determine which stocks are to be disposed of and which are not. Once the declaration has been published then the project follows specific steps.

Step two
Inventory data collection POPs(PCBs)

The process involved with determining and selecting an appropriate destruction or decontamination technique begins with the inventory stage. It is important to understand that the whole process of selecting the destruction or decontamination stage is entirely dependent on the quality and quantity of the information obtained during the inventory phase. It is not possible to correctly select an appropriate technology unless the inventory stage is rigorous and detailed. The range of concentration and disposition of PCB for instance is so vast that is is unacceptable to determine the destruction or decontamination technology without the inventory analysis being in place.
Step two - Inventory data Collection POPs(PCBs) continued

When the inventory analysis is complete and the stock’s size, concentration and disposition is known then and only then can the process begin in order to establish the appropriate technology or combination of technologies that will deal with the waste in a sustainable manner.

Depending on the inventory analysis there are many options available and this Training Manual will provide a method for working out the best technology and management plan as well as provide details of the available technologies.

The inventory data collection must be detailed enough to provide the following information. When collecting data for PCB inventory there are four fundamental questions to be asked.

- What is it?
- Where is it?
- How much is there?
- Who owns it?

These questions are answered by the provision of the following data against the following segments:

- In service transformers
- Out of service transformers
- Inservice capacitors
- Out of service capacitors
- Bulk storage tanks, drums and containers

Compiling a National PCB inventory

Scope
- determine the regions to be inventoried
- locate areas where PCBs are likely to be found
- divide areas into logical units to be inventoried

Selection of facilities to inventory
- select those facilities that are likely to have significant quantities of PCBs
- also consider facilities that may have disposed of PCBs inadequately

Facilities that may have PCBs
- electric utilities
- industrial facilities
- railroad systems
- military installations
- research labs
- manufacturing plants
- mining operations
- landfills

Priority facilities
- electric utilities, power companies
- electronics manufacturing
- petrochemical plants
- railroad systems
- transformer repair
- mining operations
**Step two - Inventory Data Collection POPs(PCBs) Continued**

For each of the segments there are several data required as follows.

In service transformers

| KVA rating | Brand name |
| Fluid qty | location |
| number (EPA) | PCB concentration |
| Year of manufacture | Scheduled year of replacement |
| weight | status/owner |

Out of service transformers

| KVA rating | Brand name |
| Fluid qty | location |
| number (EPA) | PCB Concentration |
| Year of manufacture | weight |
| status/owner | |

In service capacitors

| KVAR Rating | Brand name |
| Weight | number (EPA) |
| location | status/owner |

Out of service capacitors

| KVAR rating | Brand by name |
| weight | number (EPA) |
| location | status/owner |

Bulk storage, drums, tanks etc.

| Type | location |
| weight | fluid qty |
| PCB Concentration | status/owner |

The data entry for status can includes codes for leaking, stable, packed etc.

**Which Inventory system to use**

Self reporting or physical inventory

**Considerations:-**

- Scale of inventory
- how many facilities
- where are they located
- complexity of facilities
- responsiveness of industry

**Self reporting management**

- notifications
- education
- transmission of information
- handling of responses
- performing spot checks

**Self reporting Notification/Education**

- send forms and instructions to identified facilities
- use advertising
- contact professional and trade associations
- specify places to call for assistance

**Transmission of PCB survey information**

- to whom should you send forms?  
- how long to wait for a response?  
- how should you follow up?

**Handling of Responses**

- check form for completeness
- enter the information into the database
- devise a process to ensure quality of data
Step two - Inventory data Collection POPs (PCBs) Continued

Selecting the equipment to be inventoried

- must do
  - transformers
  - capacitors
- ought to do
  - hydraulic fluids
  - oil filled cables
- get information on
  - PCB containing wastes
  - Soil contamination

Determining if the equipment contains PCB.

- look for manufacturers label
- locate other records or information about the equipment
- apply assumption rules

Assumption rules

| Transformers and capacitors with no information | Assume PCB |
| Transformers with mineral oil dielectric fluids and no other information | Assume PCB contaminated |
| Circuit breakers, voltage regulators, Fluorescent light ballasts with no information | Assume PCB contaminated |

Inspect service records

- determine if the equipment has been retrofilled
- if retrofilled obtain records ppm levels

Sampling and analysis

- direct sampling of dielectric fluids
  - from equipment drums etc.

Testing for PCBs

- simple screening tests (done on site using kits)
  - density
  - chlorine content

Laboratory testing

- gas chromatography

Communicating with facility management

- obtain co-operation of facility managers before conducting the inventory
- explain the purpose of the inventory
- schedule the inventory visit
- discuss equipment locations, if possible
- learn plant safety procedures

Conducting the inventory

- facility entry
- pre-inventory meeting with facility managers
- selecting the equipment to be inventoried
- working with facility managers to conduct the inventory
- inventorizing
- sampling and analysis
- completing the inventory form
- post inventory meeting
In many respects the inventory data collection for POPs other than PCBs including unwanted and obsolete pesticides is very similar to that of PCBs. The four questions are the same:

What is it?
Where is it?
How much is there?
Who owns it?

Whereas the testing and sampling of PCB is a relatively straightforward exercise, in the field for pesticides and POPs as waste in general it is a different matter. In many cases of long term storage of POPs and unwanted and obsolete pesticides the question "What is it?" becomes very difficult. However it is very important that during the inventory process the "what is it?" question is answered fully. There are many experts available that can readily identify the class of pesticides and agri-chemicals in general and at the very least the class must be identified. This is because unlike PCB the segregation of the various unwanted agri-chemicals classes is very important when the material is to be transported.

During the process of repackaging of POPs, waste streams must be kept separate and hence the inventory data collection process must identify the streams. A waste steam can be made up of separate types of waste so long as they are compatible with each other. The first step is to keep liquids and solids separated from the very beginning. The inventory data collection must therefore contain information that permits the construction of a segregation strategy which will eventually impact on the transportation strategies.

Pesticides are categorised into groups of pesticides, such as organic chlorine pesticides, organic phosphorus pesticides and pyrethroid pesticides. Pyrethroid pesticides have a low toxicity level, chlorinated pesticides are toxic, but not acute, phosphorus pesticides are acute toxic.
Inventory data for unwanted and obsolete pesticides should include:

- location
- classes and type of material
- weight and volumes of each material
- Owner information
- storage situation
- leakage and contamination information
- product information - active ingredient, formulation, concentration
- product age and condition

As for PCBs the inventory data collection for other POPs is the starting point for the formulation of a project plan to deal with the unwanted and obsolete pesticides. An additional factor for a pesticides project is site stabilisation. During the inventory data collection information is collected that provides details of the site situation and disposition of the chemicals that during the project activity a stabilisation of the site can be applied. Within the project plans outlined in this Training Manual this is covered in the site clearance and site preparation plans.

**FAO STANDARD INVENTORY FORMS FOR RECORDING OBSOLETE PESTICIDES**

**Product Form**
A product sheet needs to be completed for each product (if one product is kept in different types of containers, one sheet should be completed for each type of container)

| SHEET NUMBER | DATE | OWNER OF PRODUCT | STORAGE SITE | LABELS ON CONTAINERS | TRADE NAME | ACTIVE INGREDIENT(S) | FORMULATION TYPE | CONCENTRATION | MANUFACTURER | BATCH NUMBER | MANUFACTURE DATE | ARRIVAL DATE | CONTAINER TYPE | UNIT SIZE | NUMBER OF CONTAINERS | QUANTITY | ORIGIN | CONDITION OF PESTICIDE | CONDITION OF CONTAINERS | HAVE CONTAINERS BEEN OPENED? | REASON FOR NOT USING THE PRODUCT | REMARKS |
|--------------|------|------------------|--------------|----------------------|------------|----------------------|-----------------|---------------|--------------|--------------|----------------|--------------|---------------|---------|------------------------|----------|-----------------|---------------------|----------|
|              |      |                  |              |                      |            |                      |                 |               |              |              |                |              |               |         |                       |          |                 |                     |          |                  |                     |          |                  |                     |          |                 |

**Pesticides Management Flow chart**

1. **Inventory data collection and evaluation**
2. **Site Stabilisation and Temporary Storage**
3. **Disposal**
4. **Prevention of accumulation**
Step three Inventory Analysis

The information contained in the inventory analysis allows us to commence the planning required to derive a destruction and decontamination strategy. There are several steps to this phase.

Inventory Analysis Step 2 - Data Breakdown

With the data collected during the inventory phase a breakdown of the information is required. This breakdown is designed to discover the size and nature of the waste material so that groupings can be assigned so that the appropriate technology selection process can be applied. Ultimately there are two overall categories. The first is material that is to be decontaminated and the second is material for destruction. It is very important to get the waste PCB properly assigned so that the appropriate technology can be selected. While the inventory data may refer to simply PCB transformer it is necessary to know the amounts and the concentrations of PCB as this will have a material effect on the technology selected to either decontaminate the transformer or to export it for destruction.

Inventory Analysis Step 3 - Establish groupings

For PCB contaminated equipment it is necessary to establish groupings for the waste to be categorized into. The groupings below are a suggestion for likely groupings that are based on appropriate technology for the decontamination of destruction of the PCB. The groupings should be laid out on a matrix so that amounts can be entered into and then the summarising can be done.

Likely PCB groupings

Gp 1 In service transformers (all sizes) with less than 50ppm PCB
Gp 2 In service transformers (less than 500KVA) with 50-5,000 ppm
Gp 3 In service transformers (less than 500KVA) with 5,000-50,000 ppm
Gp 4 In service transformers (More than 500KVA) with 50-5,000 ppm
Gp 5 In service transformers (more than 500KVA) with 5,000-50,000ppm
Gp 6 In service transformers (more than 500KVA) with 50,000-900,000ppm
Step three Inventory Analysis (Cont)
POPs (PCBs)

Gp 7 Out of Service transformers (all sizes) with less than 50ppm
Gp 8 Out of service transformers (less than 500KVA) with 50-5,000ppm
Gp 9 Out of service transformers (less than 500KVA) with 5,000-50,000ppm
Gp 10 Out of service transformers (less than 500KVA) with 50,000-900,000ppm
Gp 11 Out of service transformers (more than 500KVA) with less than 50ppm
Gp 12 Out of service transformers (more than 500KVA) with 50-5,000ppm
Gp 13 Out of service transformers (more than 500KVA) with 5,000-50,000ppm
Gp 14 Out of service transformers (more than 500KVA) with 50,000-900,000ppm
Gp 15 Empty out of service transformers
Gp 16 In service Capacitors
Gp 17 Out of Service capacitors
Gp 18 Storage tanks with oil less than 50ppm
Gp 19 Storage tanks with oil greater than 50ppm

This grouping breakdown is placed on a matrix with the quantities from the inventory analysis and then the matrix is passed to the next step in the process which is the strategy selection.

PCB Inventory Analysis - Step 2 Data Breakdown

<table>
<thead>
<tr>
<th>PCB Type</th>
<th>Manu Type</th>
<th>Service No.</th>
<th>Owner KVA/r</th>
<th>Total Oil Wt Kg</th>
<th>Oil Qty Litres</th>
<th>PCB ppm</th>
<th>Gp</th>
</tr>
</thead>
<tbody>
<tr>
<td>T/F ABB</td>
<td>TM 134</td>
<td>TPC</td>
<td>250</td>
<td>450</td>
<td>185</td>
<td>250</td>
<td>1</td>
</tr>
<tr>
<td>T/F Tyree</td>
<td>OB 145</td>
<td>TPC</td>
<td>5000</td>
<td>12500</td>
<td>2500</td>
<td>4000</td>
<td>6</td>
</tr>
<tr>
<td>Caps</td>
<td>T&amp;J TYY</td>
<td>PDC</td>
<td>125</td>
<td>60</td>
<td>25</td>
<td>35</td>
<td>16</td>
</tr>
</tbody>
</table>
## Step three: Inventory Analysis (Cont)

**POPs (PCBs)**

### PCB Inventory Analysis - Step 4: Estimate quantities

<table>
<thead>
<tr>
<th>Oil Qty</th>
<th>Oil Qty</th>
<th>PCB</th>
<th>Gp</th>
<th>Qty Decon</th>
<th>Qty Decon</th>
<th>Qty Destr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kg</td>
<td>Litres</td>
<td>ppm</td>
<td>Gp</td>
<td>Oil Kg</td>
<td>Mat Kg</td>
<td>PCB Kg</td>
</tr>
<tr>
<td>185</td>
<td>250</td>
<td>&lt;50</td>
<td>1</td>
<td>185</td>
<td>265</td>
<td>0</td>
</tr>
<tr>
<td>2500</td>
<td>4000</td>
<td>&gt;50000</td>
<td>6</td>
<td>2500</td>
<td>10000</td>
<td>2500</td>
</tr>
<tr>
<td>25</td>
<td>35</td>
<td>5000</td>
<td>16</td>
<td>25</td>
<td>55</td>
<td>55</td>
</tr>
</tbody>
</table>

### PCB Inventory Analysis - Step 5: Summarise data

<table>
<thead>
<tr>
<th>Gp</th>
<th>Qty Decon</th>
<th>Qty Decon</th>
<th>Qty Decon</th>
<th>Qty Decon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil Kg</td>
<td>Mat Kg</td>
<td>PCB Kg</td>
<td>Oil Kg</td>
<td>Mat Kg</td>
</tr>
<tr>
<td>1</td>
<td>2560</td>
<td>9562</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>2687</td>
<td>55</td>
<td>55</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>29500</td>
<td>48900</td>
<td>29500</td>
<td>6</td>
</tr>
</tbody>
</table>

**Photo:** Type 10 Storage

Step 4: Inventory analysis involves estimating the quantities of PCB oil and PCB contaminated materials.

Step 5: Inventory analysis involves reordering the data into the group total quantities and summarised across decontamination and destruction.
### PCB Inventory Analysis - Step 6 Decontamination

<table>
<thead>
<tr>
<th>Gp</th>
<th>Qty Decon Oil Kg</th>
<th>Qty Decon Mat Kg</th>
<th>Decon Qty Kg Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2560</td>
<td>9562</td>
<td>12122</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>10000</td>
<td>10000</td>
</tr>
<tr>
<td>3</td>
<td>2687</td>
<td>55</td>
<td>2742</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>28000</td>
<td>28000</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>48900</td>
<td>48900</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>29500</td>
<td>29500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TOTAL 131,264</td>
</tr>
</tbody>
</table>

### PCB Inventory Analysis - Step 7 Destruction

<table>
<thead>
<tr>
<th>Gp</th>
<th>Qty Dest Oil Kg</th>
<th>Qty Dest Mat Kg</th>
<th>Destr Qty Kg Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>3540</td>
<td>0</td>
<td>3540</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>15000</td>
<td>0</td>
<td>15000</td>
</tr>
<tr>
<td>5</td>
<td>29500</td>
<td>0</td>
<td>29500</td>
</tr>
<tr>
<td>6</td>
<td>16500</td>
<td>0</td>
<td>16500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TOTAL 64,540</td>
</tr>
</tbody>
</table>
Step 3

Inventory Analysis

POPs (Unwanted and Obsolete pesticides)

The analysis for unwanted pesticides and POPs is somewhat simpler than for PCBs. Generally the waste falls into the broad classes of segregation and in the main these products must be exported for destruction rather than local decontamination. Decontamination procedures may be required for soil and water clean up and this in the main involves extraction of the contaminated soil rather than treatment of it. There are some technologies however that can be used in situ for soil contaminated with pesticides and involve bioremediation or phytoremediation.

The analysis must provide detailed summaries of the quantities of stored waste and the location and disposition of it. Whereas the inventory analysis for PCBs generally falls into two categories, decontamination or destruction, the analysis of inventory for pesticides should be broadly placed into the four categories as follows:

Obsolete products requiring disposal

- products that are banned
- Products that are deteriorated beyond usability
- Products that testing has show to beyond usability
- Contaminated products rendering them unusable

Products requiring further identification

- Unidentified products
- Older products passed useby dates

Usable products

- Use is still permitted and not unusable

Usable after reformulation

- Products in good condition but need reformulating so they can be reused.
Step 4 Strategy Selection
POPs (PCBs)

The quality of the inventory analysis becomes important at this stage. So that the correct technology is selected that data contained in the matrix from stages 1, 2 and 3 must be accurate.

The actual grouping make up will also have a bearing on the combination of technology selection. If there is much more of one grouping over another then a single technology may be chosen to cover all the stock.

The possible technology selections for PCBs that can be made against each of the groupings above are as follows:

Gp1  In service transformers (all sizes) with less than 50ppm PCB

In general in service transformers with less than 50ppm may be left in service and not touched. Retrofilling is possible but this creates stocks of lightly contaminated oil. In the main most countries prefer to treat below 50ppm as not PCB. From an environmentally sound management point of view with retrofilling producing stocks of contaminated oil the best option is to leave the less than 50ppm as it is.

Gp2  In service transformers (less than 500KVA) with 50-5,000 ppm

For transformers in service with less than 5000ppm retrofilling is cost effective and valid with in situ treatment not cost effective for transformers of this size.

Gp 3  In service transformers (less than 500KVA) with 5,000-50,000 ppm

Retrofilling with in situ treatment of solvent washing or bio reaction and circulating polishing with Perchloroethylene. Also replacement option is valid

Gp 4  In service transformers (More than 500KVA) with 50-5,000 ppm

Retrofilling with in situ treatment is required due to the size of the transformers and the capacity for long term leaching. Removed oil which may be up two two times the transformer capacity will require to be destroyed. Replacement option not valid due to high capital cost and destruction costs.

Note: Only Oil, Internal Transformer cardboard, wood and ceramics etc is ever destroyed. All other transformer components, steel, copper, aluminium are recovered and recycled.
**Step 4 - Strategy Selection - POPs - PCBs (Cont)**

**Gp 5**  In service transformers (more than 500KVA) with 5,000-50,000ppm

Retrofilling with in situ treatment for residual leaching. Recovered contaminated oil must go for destruction.

**Gp 6**  In service transformers (more than 500KVA) with 50,000-900,000ppm

Oil for destruction and transformer for decontamination and recycling after autoclaving.

**Gp 7**  Out of Service transformers (all sizes) with less than 50ppm

Oil for destruction, transformer may be reused or recycled

**Gp 8**  Out of service transformers (less than 500KVA) with 50-5,000ppm

Oil for destruction, transformer for solvent washing and reused or recycled

**Gp 9**  Out of service transformers (less than 500KVA) with 5,000-50,000ppm

Drain Oil for destruction, transformer to autoclaving, solvent washing and recycling

**Gp 10**  Out of service transformers (less than 500KVA) with 50,000-900,000ppm

Drain Oil for destruction, transformer for autoclaving, solvent washing and recycling

**Gp 11**  Out of service transformers (more than 500KVA) with less than 50ppm

Drain oil for destruction, transformer for autoclaving, solvent washing and recycling

**Gp 12**  Out of service transformers (more than 500KVA) with 50-5,000ppm

Drain oil for destruction, transformer for autoclaving, solvent washing and recycling

**Gp 13**  Out of service transformers (more than 500KVA) with 5,000-50,000ppm

Drain oil for destruction, transformer to solvent washing, autoclaving and recycling

Photo: Type 1 Storage
Step 4 Strategy selection - POPs - PCBs (Cont)

Gp 14  Out of service transformers (more than 500KVA) with 50,000-900,000ppm
Drain oil for destruction, transformer for autoclaving and recycling

Gp 15  Empty out of service transformers
Autoclaving and/or solvent washing and recycling

Gp 16  In service Capacitors
Remove and send for shredding and destruction or autoclaving

Gp 17  Out of Service capacitors
Shredding and autoclaving or destruction

Gp 18  Storage tanks with oil less than 50ppm
No action

Gp 19  Storage tanks with oil greater than 50ppm
Drain oil for destruction, solvent wash tank.

Photo: Temporary bunding for transformer decanting
Compared to management of PCBs unwanted and obsolete pesticides have another step that must be applied before the disposal strategy is selected. This involves site stabilisation. Generally it is helpful if this process is done with the inventory and data collection phase but in reality it is done at a later date. Stabilisation of sites is necessary to reduce further loss to the environment and increasing risks to the local population and site workers. Site stabilisation involves repackaging of the unwanted chemicals that are leaking from unstable and deteriorated containers. Site stabilisation also involved segregation of classes and separation of dangerous combinations. It is during this phase along with the information from the inventory analysis that the strategy selection for destruction and decontamination can commence.

In the main for unwanted and obsolete pesticides and POPs in general decontamination is not an option apart for contaminated soils. Destruction is required for those products that cannot be reused as they are, or reused after reformulation. The disposal or destruction method chosen will depend on the type and quality of product involved and local circumstances. While a destruction technology may be suitable for one situation it may be unsuitable for another. This means that the process of formulating a strategy will have to consider the combination of the technology and the chemicals involved at the particular site.

The five main alternatives for strategy selection are:

- high temperature incineration
- landfill
- chemical treatment
- long term storage
- ball milling

These alternatives are discussed in PART III of the Training Manual.
Given the amount of PCB oil to be disposed of, should the country import the technology to incinerate the oil using a mobile incinerator or due to the low quantities should it be exported to another country that is set up with incineration facilities. Would it be feasible to import Plasma Arc technology and dispose within the country. What are the issues of dioxins and furans that impinge on this decision and are they managed by the chosen technology. Is storage long term a feasible option so that when a cheaper more friendly option is available then disposal can occur. Should the country import dechlorination, solvent washing, autoclaving technology or biotech technologies to decontaminate the PCB equipment? Can the recycling business cope with the materials from the autoclaving process. All of these decisions depend on the quantity of the material, the concentration (PCBs) of the material, the infrastructure available within the country and the logistical framework necessary to handle the project. The steps involved in the rationalisation activity are as follows:

- After the basic strategy selection has been performed the matrix is updated to show the reality of the chosen strategies and thus the quantities of materials that will be available to each part of the chosen strategies.

- It is then appropriate to rationalise the process by examining the matrix to see where the bulk of the material lies and determine where a particular group may be combined with another group as far as treatment is concerned.

- Major decisions are made at this point based on the reality of the country situation and the disposition and size of the waste to be disposed. It is during this stage that the requirements of environmentally sound management are delivered. Decisions in this step include;

- export all or part of the PCBs

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**Extracts from the Basel Convention**

(d) Ensure that the Transboundary movement of hazardous wastes and other wastes is reduced to a minimum consistent with the environmentally sound and efficient management of such wastes, and is conducted in a manner that will protect human health and the environment against the adverse effects which may result from such movement.

(e) Not allow the export of hazardous waste or other wastes to a State or group of States belonging to an economic and/or political integration organisation that are Parties, particularly developing countries, which have prohibited by their legislation all imports, or if it has reason to believe that the wastes in question will not be managed in an environmentally sound manner, according to criteria to be decided on by the Parties at their first meeting.

(f) Require that information about proposed Transboundary movement of hazardous wastes and other wastes be provided to the States concerned according to annex V.A to State clearly the effects of the proposed movement on human health and environment:

(g) Prevent the import of hazardous wastes and other wastes if it has reason to believe that the wastes in question will not be managed in an environmentally sound manner:
Step 5 - Rationalisation - PCBs (Cont)

- Construct or import PCBs destruction or decontamination technology
- remove PCB contaminated equipment from service or leave in situ and treat

All of these questions and decisions must be framed within the concept of environmentally sound management, minimisation of transboundary movements, sustainability and sound management practice as well as economic considerations. A balance must be achieved here that provides a solution that is best for all the elements described. It will not be possible to satisfy all of the requirements. It may be that the best environmentally sound management solution involves total export because the rationalisation analysis has indicated that it is not technically feasible nor economically feasible to develop an indigenous technology or import a technology to dispose of small amounts of highly contaminated PCB oil. On the other hand it may be feasible to import autoclaving systems to take care of decontamination of empty transformers with the concentrated PCB oil being exported for destruction. These are the decision that can only be made after the rationalisation procedure is complete and that procedure is dependent on an accurate inventory analysis.
In a similar manner to that of rationalisation for PCBs, POPs and unwanted or obsolete pesticides must go through rationalisation. Because unwanted or obsolete pesticides are generally sent for destruction the rationalisation involves the feasibility of the various options open to the country involved. If high temperature incineration is chosen should it be a mobile machine imported to the country or should the waste travel overseas to a developed country that provides a service of destruction using a HTI. It is usually not an option for a developing country to consider constructing its own high temperature incinerator as a fixed plant. The cost for this is prohibitive and there are issues related to operational safety and training etc. It is feasible to import a mobile High temperature incinerator that can be transported from site to site should there be sufficient material available to make it economic. Quantities at each site would need to be in the order of 7000 tonnes for this option to be successful.

Cement kilns can provide a useful alternative for purpose built HTI but it needs to be a rotary kiln with appropriate gas treatment systems such as an electrostatic precipitator. Often the owner of the cement kiln will not allow its use for pesticide destruction. The time taken to evaluate and determine such kilns can be used usually exceeds that required for other options.

Export to a HTI incinerator in a developed country is a valid option for all quantities from one tonne to 10,000 tonnes and more. These days the cost of HTI incineration for pesticides is very competitive and is the preferred technology at this time.

In situ chemical treatment is an option but there are many problems associated with performing treatment within developing countries. Generally it is often not cost effective when compared to incineration and difficult to ensure environmental protection during treatment. Chemical treatment is generally viewed as simply preparing the product for further treatment such as landfilling or incineration rather than an end in itself.
Step 5 Rationalization Project Strategy Management

For hazardous waste projects of some size there needs to be a project management strategy for the implementation of the strategies chosen. While PART IV has a full set of implementation plans there needs to be an understanding of basic project management and that is defined here. There are five distinct areas that are required to be “managed” so that the waste project is successfully completed. These five areas of the waste project areas that must be managed by the project team and they are described as management functions.

Managing Scope
Managing Project Organisation
Managing Quality
Managing Cost
Managing Time

Each of these elements is delivered within the Implementation plans in PART IV. Within each of these five elements is the element of risk management and this is discussed separately.

Before these elements are considered the project definition must be formulated. The project definition initiates the project and therefore relates the work to projects objectives.
Managing the Scope

Scope management is often the most overlooked aspect of project management. It is within this element that the project objectives are set and generally where the biggest failure component occurs. It is within the definition of scope and its subsequent management that the true direction of the boards intentions can be lost. The purpose of scope management can be summarised as follows:

The management of the project scope shall be defined so that the activity engaged ensures that enough, but only enough, work is undertaken to deliver the project’s purpose.

Within this definition are three key elements (J Turner):

- an adequate, or sufficient, amount of work is done
- unnecessary work is not done
- the work that is done delivers the stated business purpose

There are four steps to make this definition a reality for this project and they are:

1) Develop the concept through the projects objectives

2) Define the scope through the work breakdown structure

3) Authorise and execute the work, and monitor and control progress

4) Commission the facility to produce the system and obtain the benefits.
Step 5  Rationalization Project Strategy Management (Cont)

The main emphasis is at the start of this process, as the mistakes made here are rarely corrected. Item 3 above is the purpose behind the “Ownership” of the project. The development of the Project Concept (1) is a critical issue and this must be properly completed after the project leader has had the opportunity to evaluate the site situation.

Work Breakdown structure (2) is a process by which during the first stage of formulating the management of the project the work of the project is divided and subdivided for management and control purposes. In preference to breaking the project into a low level of detailed in a single step the idea is to devolve through increasing levels of detail. Therefore the work breakdown structure is developed by breaking the project into intermediate and sub project steps and the work required to execute that sub group is identified.

There are three fundamental levels of work breakdown:

- Integrated
- Strategic
- Detail
For this project due to its nature of involving the entire Business the Work breakdown must start at the first Breakdown level and progress down. As it devolves downwards then the detail level breaks down into project phase, task, activity etc and there will be probably about seven levels that are finally listed. This process as mentioned devolves as the project unfolds and the detail of the project becomes clearer as a result of the business purpose clarification.

The advantages of the Work Breakdown concept are:
- It provides better control of work definitions
- It allows work to be delegated in coherent packages
- It allows work to be defined at an appropriate level for estimating and control of the current stage
- It allows risk to be contained within the work breakdown structure

The use of work breakdown structures will satisfy the principles of good management:

1. Manage through a structured breakdown of the project
2. Focus on results: what to achieve and how to achieve it
3. Balance results through the work breakdown, between areas of technology, people, systems and organisation
4. Organise a contract between all the parties involved, by defining their role, responsibilities and working relationships
5. Adopt a clear and simple reporting structure

In order to create the work breakdown the process of defining the project must be carried out:

**Defining Projects**

The project definition always has the role of initiating the project and therefore as previously mentioned relates the work of the project to management’s requirements. The following three requirements should be defined:

- the purpose
- the scope
- the objectives
The **purpose** statement should be clear and concise and once the project is underway it will become the mission of all those involved in the project, both as team members and as resource providers.

The **scope** is an initial high level description of the way in which the purpose will be commissioned. The Statement of Scope should include two elements:

- The work that falls within the remit of the project and is required to achieve the benefits
- The work that falls outside of the remit of the project

The **objectives** should be quantitative and qualitative measures by which the completion of the project will be judged. In effect they define the outcome that will be produced. The objectives should address:

- Address all the work within the scope of the project
- Not address work outside of the scope of the project
- Begin to set the parameters for managing quality, cost and time.
Step 5  Rationalization Project Strategy Management (Cont)

Summary of Managing Scope

The purpose of scope management methodology is to ensure that:

- adequate work is done
- unnecessary work is not done
- the project’s purpose is achieved

There are four steps of scope management:

- develop the concept through the project’s objectives
- define the scope through the work breakdown structure
- authorise and execute the work, and monitor and control progress
- commission the project and produce the benefit

Work breakdown is a process by which the work is subdivided for management, control purposes and logical arrangement purposes.

The project is defined at the strategic level through:

- the purpose
- the Scope inclusions and exclusions

- the objectives
At the strategic level the Milestones plan:
- shows how the deliverables build towards the final objectives
- sets a stable framework
- controls the unfolding and devolution of the management of the scope

A good milestone plan
- is clear, simple and concise
- focusses on necessary sections
- gives an overview of the project

There are seven steps in milestone planning

- agree the final milestone
- brainstorm milestones
- review the list
- experiment with result paths
- draw the logical dependencies
- make the final plan

Plans at the lower level include:

- subsidiary milestones plans
- work package scope statements
- activity plans developed on a rolling wave basis.
Managing Project Organisation

The next major project management objective is that related to managing the project Organisation. Through this process the project Manager defines the type and level of resources inputs, and how they are to be managed in order to achieve the purpose of the project that has been stated in the management of scope.

When the Scope and the Organisation have been fully defined they represent the Project Contract that then exists between the project team and the Corporate Management.

The purposes, principles and processes of project organisation are defined as below;

Project Organisation Purpose is defined for this project as follows:

to assemble sufficient resources (human, material and financial) of the appropriate type and quality to undertake the work of the project and to deliver the strategic intention of the project.

Three of the principles of good project management are discharged by the management of the project organisation:

- negotiate a contract between all parties
- assign roles and responsibilities at all levels of work breakdown
- adopt a clear and simple reporting structure

Negotiating Contracts

The Project must establish an organisational structure and the project manager must establish a contract between all parties involved at all levels as follows:

- between Management and the Project Manager Level
- between the parties making up the PCG at the Strategic Level
- between the members of the project team at the tactical level

The project manager is responsible for negotiating the “Contracts” by building a clear vision of the project and devolving that mission or vision down to objectives at each level of the organisational structure.
### Defining Roles and responsibilities

The “Contract” is defined by the process of defining roles and responsibilities of the parties involved for the work elements at each level of the breakdown. This can take the following format:

<table>
<thead>
<tr>
<th>For work</th>
<th>Who is to undertake the task</th>
</tr>
</thead>
<tbody>
<tr>
<td>For management</td>
<td>Who is to make decisions</td>
</tr>
<tr>
<td></td>
<td>Who is to manage progress</td>
</tr>
<tr>
<td></td>
<td>Who Training Manuals new resources</td>
</tr>
<tr>
<td>For Communication</td>
<td>Who must provide information and opinions</td>
</tr>
<tr>
<td></td>
<td>Who may provide information and knowledge</td>
</tr>
<tr>
<td></td>
<td>Who must be informed of outcomes</td>
</tr>
</tbody>
</table>

The responsibility chart should be kept simple and clear. It should be a single page defining resources and inputs. It defines the “Contracts” at all levels of breakdown and is the document against which the “contracts” are negotiated and agreed. The responsibility chart is the document that is used to foster cooperation and ensure that the project operation is brought on quickly and effectively.

The use of a responsibility chart is now widespread in project management of the project type that water is engaged in. Typically the chart is a matrix with work elements shown as rows and organisational elements as columns. Symbols placed in the body of the matrix show the level of involvement of a particular organisational unit. Communications assisted by the use of identification letters as shown on the sample responsibility chart attached with the report.
Step 5  Rationalization Project Strategy Management (Cont)

Use of the Responsibility chart

This chart can be used at all levels within the Work Breakdown Structure. Specifically it can be used in three fundamental levels.

Project level : Procedural Responsibility Chart

This level is used for defining procedures to be employed on the project and include:

- procedures for monitoring and control
- change control procedures
- quality control procedures

Strategic Level : Milestone responsibility chart

This level is used for defining roles and responsibilities for achieving milestones. Sometimes both milestones and procedures can be used on the same page and the two levels are then merged into one management level.

Tactical Level : Activity schedule

At this level the responsibility chart defines the roles and responsibilities of named people and resources to do the work to achieve a milestone. Because these activity schedules are to be planned on a rolling wave basis during implementation planning, the people involved can now be named. As previously described the Milestone plan is developed during the initial stages by group negotiation and agreement. The same principle applies to the responsibility chart. By using the group principle all inputs from all members can be integrated into the responsibility chart result and then the end product is bought by all. The responsibility chart is built up after the Milestones chart which is after the Work Breakdown Structure.
Summary of Managing project Organisation

The purpose of project organisation is:
- assemble adequate resources
- to execute the work of the project
- to ensure successful outcome

The principle elements of Organisational management are:
- the contract between the parties involved
- organisational breakdown structure which matches the work breakdown
- responsibility charts

There are two critical elements when choosing an organisational structure:
- type of organisational structure
- location of resources

The Contract requires recording estimates of work content, so that resource providers can commit themselves to the release of their people.

Drawings, materials, plant and equipment are managed using registers and lists against the activities in which they are required.
Managing Quality

Quality is the first project constraint. The scope and organisation sections mentioned above are the primary project objectives and the methodology required to achieve them. The next three sections refer to the constraints on the project and the methodology required to manage them. The first constraint on the project is that related to quality.

There are two aspects of quality that must be managed. The first is that quality aspect that involves the work, materials, drawings, equipment etc of the project. The second aspect is that related to the management of the project itself. The quality management of the project management structure, the quality maintenance of the responsibility chart and the work Breakdown structures etc. The second aspect of quality involves all aspects of the internal documentation, communications and reporting systems and the on line tracking of the project against the corporate strategy etc.

Project Quality

Project quality has traditionally been a difficult concept to define within the concepts of the project itself. Obviously a definition of project quality is required for this project if it is to have any use at all. J Turner defines quality as a concept that has three essential elements:

- good quality vs High quality
- fitness for purpose
- conforming to the project requirement

Good Quality Vs High quality

Good quality does not imply High quality. It means supplying a product or service to a standard or a specification and thus supplying what the end user wants, with a predictable degree of reliability an uniformity at a price that is acceptable.

Fitness of Purpose

The concept is often adopted as a measure of good quality and it can be applied equally well whether the facility produced is an organisational change, an information system or an engineering product. The project that is the subject of this methodology is an integrated example of all of these.
Conforming to the project requirement

Saying something is fit for the purpose begs the question of who makes the judgment. The answer to this of course is management and this implies that quality means meeting management’s requirement or specification. This is the definition of quality that is now normally applied. In order to set the measure of quality is is therefore necessary to set out management’s requirement in advance in a formal document or specification. This usually takes the form of a Statement of User requirement and is part of the project definition report.

In order to assure the quality of the project it is essential to have the following:

- a clear specification
- use of defined standards
- historical experience
- qualified resources
- impartial design reviews
- change control

Assuring the quality of the management processes

This is similar to that applied to the project output itself and it means having a set of defined procedures for managing projects. Procedures clearly specify how projects are to be managed by qualified resources. This can be own experience or standard practice.

In this type of project it would be beneficial to apply the ISO 9001 standards for quality assurance on the management processes. This will mean automatically many of the project quality issues will be covered by the ISO approach as the management has total responsibility for all aspects of the project including such matters as quality control over drawings and design decisions etc.
Step 5  Rationalization Project Strategy Management (Cont)

Summary of management of Quality

There are five quality elements to total quality management on projects

- quality of the design
- quality of the management processes
- quality assurance
- quality control
- the right attitude

Assuring the quality of the project requires

- a clear specification
- use of defined standards
- historical experience
- qualified resources
- impartial design reviews
- change control

Controlling the quality of the project must be:

- planned
- tested
- recorded
- analysed
- independent

Assuring the quality of the management processes requires defined procedures for managing projects, which are fully implemented. These procedures can then be used to conduct audits to control the quality of the management processes.

The Standard to be used for this project should be ISO 9001 Quality Management Systems.
Managing Cost

This is the fourth project objective managing cost by which the project manager ensure that the project cost is financially viable, worthwhile and within the project budget constraints.

Normally this process would start at the estimating of the project costs but this has already been performed for the approval stage. While a budget approval has been received it is the project managers responsibility to control all aspects of the total budget so that costs do not run out of control.

The activity that is performed during the setting of the Work Breakdown Structure leans itself to applying the cost estimates so that the monitoring system can be applied. In addition to this the business unit runs its own counter cost system and this will be run in parallel to the managing cost regime.

Controlling Costs : Obtaining Value for Money

The common mistake that many project managers make and a mistake that often gets management support is to control cost by using as the measure the rate of monthly expenditure and compare this with the monthly estimate rate. The cost estimate is to be prepared against the Work breakdown structure. This is then scheduled in time by scheduling the work elements to produce an expenditure profile. This profile is what is normally referred to in Water as the predicted cash flow of the project.

To actually control the costs some measure of the actual work done must be determined so that accurate comparisons can be made. The Work Breakdown Structure provides the means to do this. As an element of work is complete, you can compare how much it actually cost against what it was estimated to cost. Within the Counter Cost method this is usually referred to as the earned value.

The earned value for a work package or the whole project is the sum of the estimate of the completed activities which constitute it. Cost is controlled by comparing the earned value to the actual expenditure, and calculating a cost variance.
A bias is introduced if the work in progress is ignored. To allow for this a subjective estimate of the percentage for activities started but not yet finished. J Turner suggests that it best to simply use an average (50%) which becomes self discharging as time goes along. We therefore have

- for activities
  \% completion = 0\%, 50\% or 100\%

- for the project and work packages
  \% completion = \text{earned value/Original estimate}

The next problem that comes up for cost control is when to actually make the comparisons. Many systems do the analysis only based on monies paid. This is still a valid approach but when the sums are done it is too late to change anything. Usually the way to overcome this is to use the committed funds approach where the entry is made to the cost control system when the money is committed but not necessarily paid. This way the costs can be controlled as the variances can be calculated well before the project cost overruns have occurred and something can then be done about it.

Summary of Managing Costs
A cost estimate is prepared:
- as a basis for control
- to estimate durations
- to prepare tenders

generally the cost estimates structure is:
- Proposal estimate
- budget estimate
- sanction estimate
- the control estimate

For this project the proposal and budget estimates have already been prepared and the approval reached. The sanction estimate will be left out but the control estimate will be prepared as part of the implementation process and so that cost control can be conducted on the basis of a sanction estimate.

The control estimate is prepared as a function of the Work Breakdown Structure where the allocation of costs is coordinated with the WBS.

Cost is controlled by comparing the earned value, a measure of the amount of work performed to date, to the actual expenditure to date.
Step 5  Rationalization Project Strategy Management (Cont)

Managing Time

This is the last of the project objective strategies. This is an objective of the project manager which ensures that the project is delivered on time to achieve the project objectives.

The Time schedule

The time schedule is set against the work breakdown structure. This schedule is constructed with forecast record of the time expected or when the work will occur and when the work actually does occur.

Purpose of the schedule.

The purpose of recording these dates and times within the work breakdown structure is as follow;

- to ensure that the project benefits are obtained on a time scale that justifies the project costs
- to enable the availability of the resources when actually required
- to allow the assignment of resources and priorities
- to meet the end date

The fits element mentioned above is the main reason for generating the time schedule. Overall the benefits of the projects must be understood and the time frame that is required to achieve those benefits should be recognised and formally entered into the schedule.

The second element is the mechanism for the project activity and sets the tasks in motion. The last item is of course what sets the team on the target and focusses all the activity. On a basic level, the schedule which is based on the work breakdown structure sets the planned and actual start date, finish date and the duration of each work element. Flexibility or float can also be recorded so that any adjustments that are made can be readily accommodated without the end date compromise.
Step 5  Rationalization Project Strategy Management (Cont)

Durations

This is the amount of time allocated for each work activity or task procedure to complete its work schedule. For this Integrated project there will be many work activities that are dependent on outside resources and operational constraints. Some of these elements may be outside of the control of the project team. For the purpose of the time schedule however they should be treated as fixed. As part for the time schedule therefore the project team must estimate the relevant durations for each and every activity and logically understand how they all fit together with prioritisation etc.

After the commencement of a work activity we can estimate the time remaining or the remaining duration. This may be equal to the planned duration less the time since the activity started, or we may have to estimate the remaining duration based on knowledge of the work performed to date. Once the work activity is completed we can record the actual duration and compare that with the overall critical path to ensure that the end date is not compromised.

For this project we should use early dates, late dates, float, planned, baseline and scheduled dates which are all standard time management concepts and can easily be introduced to the work breakdown structure without a large network system.

There are the following time schedule components that the system will require and these are normally presented on gantt charts.

| Early start | Duration | Early finish |
| Late Start | Float | Late Finish |
| Baseline start | Baseline float | Baseline finish |
| Schedule Start | Remaining Float | Schedule finish |
| Actual Start | Remaining duration | Actual Finish |

If the work breakdown structure is carefully constructed in the first place it is possible for the time schedule to place itself manually over the top of it and little use required of a computerised project scheduling system. Only when gantt charts were required would a computer be used. This approach is preferred so that the time schedule does not become a large unwieldy system that takes many hours of effort simply to keep up to date. To communicate the time schedule in its basic form involves generally two simple structures. Firstly activity schedules which are the product of the Work Breakdown structure. These lists produce the activities with the relevant durations, start date end dates and so on, and are produced as a simple schedule. See format samples. The second presentation is that of gantt charts.
Step 5  Rationalization Project Strategy Management (Cont)

Identifying the critical path

This is a series of non float activities with the longest durations. It is important to determine the critical path and not lose sight of it. An overall milestone chart showing the critical path is most useful and is best hand drawn (using CAD) rather than a computer project package.

Controlling time

The schedule is used to control the projects duration, which is the main reason for using the schedule. There are four steps in this process

- set a measure
- record progress
- calculate the variance
- take remedial action

Set the measure

The most common mistake is to measure the project time against the most recent update of the time schedule. If this happens the project manager will lose sight of where the time schedule is against the original time scale and will lose control of the project delivery. It is essential that the project time always be measured against the baseline so that updates are compared against the original time frame not the updated one.

Progress

By noting in the schedule the actual start and the actual end dates of each breakdown activity then progress can be properly measured.

For this project is will be appropriate to only measure actual start and end dates rather than attempt to estimate percentage complete. So long as the frequency of reporting is enough then control will be adequate. A frequency of about two weeks progress is measured against activities of two weeks duration.
Step 5  Rationalization Project Strategy Management (Cont)

Summary
The purpose of scheduling time on a project is to

- to obtain timely benefits that justify the expenditure
- to coordinate resource management
- to schedule resource availability
- to assign priorities
- to meet end dates

The schedule specifies the duration, start and finish dates and float of the activities in the project. Each activity has the following dates recorded.

- early date
- late date and float
- baseline date
- actual date and remaining duration

The schedule can be communicated and used as:
- an activity listing
- gantt chart

The duration is calculated by comparing work content to the number of resources available and comparing and allowing for:

- lost time
- interference
- communication
- lead times
- sequencing

The early and late dates can be calculated from the durations and logical sequence of the activities using a critical path network. There are two types of network that can be used:

- precedence network
- activity on arrow

Progress can be monitored on the schedule by

- recording progress on the critical path