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Report on Mission to
The Environmental Department
Ministry of Municipal Affairs & Agriculture
The State of Qatar

DEVELOPMENT OF A PROGRAMME FOR INDUSTRIAL POLLUTION PREVENTION IN THE STATE OF QATAR

During the period 28 April to 8 May, 1998

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The views expressed in this paper are those of the author and do not necessarily reflect those of the United Nations Economic and Social Commission for Western Asia.

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EXECUTIVE SUMMARY

The Environmental Department (ED) in the State of Qatar, has requested the technical assistance of ESCWA to develop an integrated program that is intended to minimize the waste generated by the heavy industrial sector in the State. The waste minimization program, better called, " Pollution Prevention Program" (PPP) is basically intended to help the local industries decide on which aspects of their operation should be assessed and how detailed this assessment should be.

Strict environmental regulations are currently under preparation by ED at the national level. In addition, the "General Agreement on Trade and Tariff" (GATT) is presently considering linking trade to environment at the global level. These two factors provided the local industries with strong incentive (possibly no alternative but) to reduce the toxicity and sheer volume of the waste they are generating through carefully planned PPP.

At the current stage, the State of Qatar has no environmental legislation requiring local industries to implement PPPs to reduce the quantity and toxicity of their generated waste. However, local industries in Qatar should recognize that it is not be too long before ED declares its national Pollution Prevention Acts.

The report emphasized on the fact that the establishment and implementation of a PPP will be the prime responsibility of each individual industrial enterprise in the country.

The proposed program has the following characteristics:

1. Clear, concise and in a cook-book format for easier implementation
2. Technically and economically feasible
3. Can be smoothly translated into an action plan for various industries
4. Conceptual in nature but applicable to all industries
5. Emphasize on pollution prevention constraints, options and opportunities.
6. Participatory in nature where stakeholders (industries) should be an inherent component in the implementation process of the program.

The succession of activities needed to develop and execute the proposed program were divided into four distinctive phases, namely, (Phase 1) initiation and organization of PPP, (Phase 2) preparation of PPP Plan (PPPP), (Phase 3) development of PP Projects, and (phase # 4) implementation of PP Projects.

A short visit was made to QASCO to explore the potential of initiation, organization and possibly implementation of a PP program. A preliminary assessment of the existing PP opportunities was conducted. The visit was organized and coordinated by ED.

I- INTRODUCTION

The best way to reduce pollution is to prevent it in the first place. In the developed West, industrial facilities have creatively implemented Pollution Prevention (PP) plans that resulted in the effective realization of the win-win-scenario. These industrial facilities have improved their efficiency, increased their profits while at the same time minimized their environmental impacts.

Pollution prevention can be defined as the use of materials, processes, or practices that reduce or eliminate the creation of pollutants or wastes at the source. This can be done in many ways such as reducing material inputs, re-engineering processes to reuse by-products, improving management and housekeeping practices, and employing substitution to toxic chemicals. In this way, PPP is fundamentally different from off-site recycling, treatment, and disposal and is meant to reduce the need for these measures. Treatment and disposal are to be viewed as the last-resort measures.

Pollution prevention programs are, by their basic nature, very dynamic and ongoing comprehensive examination of the operations at a facility with the main goal of minimizing all types of waste products.

In this way, the implementation of PPPs at the national level in The State of Qatar, will obviously co-incide the industry's economic interest with the national environmental protection goals set by ED. With the strict environmental regulations currently under preparation by ED at the national level and the future "General Agreement on Trade and Tariff" (GATT)'s trade and environment regulations presently under consideration at the global level, local industries have strong incentives -possibly no alternatives but- to reduce the toxicity and sheer volume of the waste they are generating. Implementation of PPP by local industries will provide them with national, regional and international competitive advantages.

The proposed guideline provided in this report is mostly based on the USEPA methodical approach in designing PPPs established in 1992 in response to the Resource Conservation and Recovery Act (RCRA, 1988) and the Pollution Prevention Act (PPA, 1990).

I-1- OBJECTIVE OF THE MISSION:

Extensive discussions, on the first day of the mission, with the director of the Environmental Department (ED) at the Ministry of Municipal Affairs and Agriculture (MMAA) and his senior staff, revealed that ED -as the competent environmental authority- is totally aware of the vast volume of emissions generated by the relatively old industrial sector in the country. The potential environmental impacts of the generated wastes are yet to be determined by ED.

It has been concluded that what is needed at the current stage is **to develop an integrated program intended to minimize the waste generated by the industrial sector in the country**. The main outcome of this mission is to prepare a guideline designed to assist the heavy industries in the State of Qatar in developing a Pollution Prevention Program (PPP) in full coordination with ED. The PPP is intended to help the local industries decide on which aspects of their operation should be assessed and how detailed this assessment should be.

This program should, at the request of ED, have the following characteristics:

1. Clear, concise and in a cook-book format for easier implementation
2. Technically and economically feasible
3. Can be smoothly translated into an action plan for various industries
4. Conceptual in nature but applicable to all industries
5. Emphasize on pollution prevention constraints, options and opportunities.
6. Participatory in nature where stakeholders (industries) should be an inherent component in the implementation process of the program.

I-2- BENEFITS ASSOCIATED WITH THE DEVELOPMENT OF A PPP:

With the future adoption of the pollution-pay-principle as the most effective economic instrumentality for environmental management in the state of Qatar, cost of disposing the waste to the environment will be ultimately surcharged to the generator. Keeping this supplementary environmental costs in mind, the implementation of an effective PPP by a company will undoubtedly put it as the lowest cost producer and give it a significant competitive edge. Furthermore, the cost per unit produced will decrease as pollution prevention measures lower liability risk and operating costs. The adoption and implementation of PPP by local industries in Qatar might result in the following benefits:

1. Reduction of Risk and Liability: The implementation of a PPP decreases the risk of civil and possibly criminal liability by reducing the volume and the potential toxicity of the vapor, liquid, and solid discharges that the local industry generates. Furthermore, ED in Qatar is on the verge of preparing environmental regulations namely a Pollution Prevention Act (PPA) requiring industries to document the pollution prevention and recycling measures they employ for wastes defined as hazardous. Companies that produce excessive waste will be risking heavy fines if toxic pollutants are mismanaged.

2. Improvement of the Industry Image: As the quality of the environment becomes an issue of greater importance to the Qatari Government officials and the society at large, the implementation of PPP will positively influence the attitude of the whole community towards the industries implementing PPPs. Serious implementation of PPPs will assist the industry at the global, regional and national levels in eco-labeling its products. The recent use of

consumers purchasing power in environmental pollution control mechanisms has made eco-labeling a marketing necessity into the markets of the developed world.

3. Reduction of Operating Costs: An effective PPP can reduce costs often by a margin that can offset the costs of PPP development and implementation. According to USEPA (1992), material costs can be reduced by adopting production and packaging procedures that consume fewer resources, thereby creating less waste. Furthermore, waste management and disposal costs are additional sources of savings to be realized from PP. The industrial sector in Qatar should recognize that ED at MMAA is preparing a set of environmental legislation's that mandate special in-plant handling procedures and specific treatment and disposal methods for toxic wastes. The implementation of the proposed regulations within the foreseeable future will add to the direct production costs of these industries. The waste management costs will decrease as PP measures are implemented. Among the benefits the following can be listed; (1) Reduced manpower and equipment requirements for on-site pollution control and treatment, (2) Less waste storage space, freeing more space for production, (3) Less pretreatment and packaging prior to disposal, (4) Smaller quantities of waste treatment, (5) Less need to transport for disposal, (6) Reduced paperwork and record-keeping requirements.

4. Environmental and Public Health Benefits: Reducing production wastes provides upstream benefits because it reduces ecological damage due to raw material extraction and refining operations.

I-3- HOW PP CAN BE ACHIEVED ?

In PPP, there are two general methods of source reduction that reduce the volume and toxicity of production waste and of end-products during their life cycle and at disposal. These two general methods are namely product changes and process changes:

I-3-1- Process Changes:

Process changes can be implemented more quickly than product changes. It involves input material changes, technology changes, and improved operating practices. All such changes can reduce worker exposure to pollutants during the manufacturing process. The following are some examples provided by USEPA (1992) for process changes that can be implemented in PPPs:

Examples of input material changes:

- Stop using heavy metal pigment
- Use of less hazardous or toxic solvent for cleaning or as coating
- Use raw materials that are free of trace hazardous or toxic impurities.

Examples of technology changes:

- Redesign equipment's and piping to reduce the volume of material contained, cutting losses during batch changes or when equipment is drained for maintenance or cleaning.
- Change to mechanical stripping/cleaning devices to avoid solvent use
- Install vapor recovery system to capture and return vaporous emissions
- Use more efficient motors and speed control on pump motors to reduce energy consumption.

Examples of improved operating practices:

- Train operators
- Cover solvent tanks when not in use
- Segregate waste streams to avoid cross contaminating hazardous and non-hazardous materials
- Improve maintenance scheduling, record keeping, or procedure to increase efficiency.
- Stop leaks, drips and spills
- Place equipment so as to minimize spills and losses during transport of parts or material
- Use drip pans and splash guards.

I-3-2- Product Change:

The goals of new products design can be reformulation and a rearrangement of the product's requirements to incorporate environmental considerations. For example the new product can be made out of renewable resources, have an efficient manufacturing process, have longer life, be non-toxic and be easy to reuse or recycle. In the design of a new product, these environmental considerations can become an integral part of the program of requirements.

I-4- PP REGULATORY FRAMEWORK IN THE STATE OF QATAR:

At the current stage, the State of Qatar has no environmental legislation requiring local industries to implement PPPs to reduce the quantity and toxicity of their generated waste.

However, local industries in Qatar should recognize that it will not be too long before ED declares its national Pollution Prevention Acts. In principle, this act will specifically requires facilities to report releases such as Toxic Releases Inventory (TRI) -a sort of a mass balance sheet- to ED and provide documentation on their environmental management procedures for preventing the release or reuse of toxic materials. ED will

most likely go beyond wastes designated as hazardous. It might likewise encourage the maximum possible elimination of wastes of all types. It will be emphasized that the preferred method to ED for preventing pollution is to reduce, at the source, the volume of waste generated and that reuse (closed loop recycling) should be performed whenever possible. ED might also require waste generators to submit plans and/or progress reports on waste minimization or pollution prevention efforts.

Due to the lack of PP legislation at the current stage in Qatar, It might be advisable for ED to start by identifying some reporting requirements to be imposed on local industries and reported regularly on an annual basis. The collected information will be very useful to ED in establishing a bench-mark or reference line to evaluate the environmental performance of the local industries in general and their self initiatives (if any) in reducing their industrial waste. The annual data reporting requirement on industrial waste should include:

1. The load of chemicals released into the environment before recycling, treatment, or disposal, and the percent change from the previous year.
2. Amount of waste recycled on site or off-site during each calendar year, the percent change from the previous year, and the recycling process used.
3. Source reduction practices used during each year (if available)
4. Amount projected to be reported for items 1 & 2 above for the two calendar years right after the current reporting year (reported as % change)
5. Ratio of reporting years production to previous year's production
6. Techniques used by the industry to identify source reduction opportunities
7. Amounts of waste released to the environment from accidental releases, catastrophic event, remedial actions taken, or other one time event and not associated with the production process.

I-5- DEVELOPMENT OF INSTITUTIONAL CAPACITY FOR PP IN THE STATE OF QATAR:

The term institution denotes the organizational structure responsible for management of various functions and programs. Traditionally, PPPs are undertaken internally by the industry. However, due to inadequate environmental capacities in some industries in Qatar, ED should establish a small PPP office to setup the needed PP regulations, provide technical assistance and guidance to the local industries, and follow-up on their gradual implementation of PPP. This PPP office can be attached to the environmental management and impact assessment department at ED. In addition, it is advisable that an advisory board or a commission should be established to provide technical assistance and to promote education, training, and possibly raise funds to support activities related to the implementation of PPPs.

II- DEVELOPMENT OF A PPP FOR INDUSTRIES IN THE STATE OF QATAR

It is important to note that the establishment and implementation of a PPP (as it will be required by ED in its projected PPA) will be the prime responsibility of each individual industrial enterprise in the country. The **envisaged role of ED** will be as follows:

1. In the short-term: The role of ED will be purely catalytic in nature and focus on assisting and guiding each industry initiating and establishing its own PPP.
2. In the medium-term: Following a reasonable grace period (to be agreed upon with each specific industry), the role of ED will include technical assistance, follow-up and possibly participation in the gradual implementation of the PPP and PP projects.
3. In the long-term: The role of ED will be the enforcement of PPP execution, maintenance and insuring proper reporting and compliance by all industries.

The logical succession of activities needed to execute a successful PPPs will be divided into four distinctive phases, namely, (Phase 1) initiation and organization of PPP, (Phase 2) preparation of PPP Plan (PPPP), (Phase 3) development of PP Projects, and (phase # 4) implementation of PP Projects. The following sequence of steps will lead to the formulation of a PPP in the various industries in Qatar:

II-1- PHASE # 1: INITIATION & ORGANIZATION OF PPP (Fig. 1):

II-1-1- STEP # 1: ESTABLISH THE PPP:

Due to the lack of national environmental legislation in Qatar requiring industries to develop their own PPPs, the following non-commanding approach might be utilized by ED. Once ED develops and issues its PPA, a much more aggressive approach might be used if needed. The advised procedure and means to establish a PPP can follow the following sequence:

1. Identify the industry you want to prepare a PPP for: ED should use the available information (such as INTERA waste auditing report for The State of Qatar) to identify the heavy polluting industries responsible for generating large volume of waste. It is most probably in these industries where you can find cost-effective and valuable opportunities for waste minimization.

2. Conduct a brief pre-assessment investigation (i.e. prepare your case): The main purpose of conducting a pre-assessment is to demonstrate the validity of your argument to the higher management of the facility. ED with the assistance of the technical staff at the intermediate level in the industry should perform a very brief pre-assessment to gather relevant information on only one or two waste generating

areas of the facility. It will also be very useful to identify several low cost, quick-payoff PP techniques that can be implemented readily.

3. Take the initiative to the executive levels. In most companies and due to the potential financial obligations associated with PPPs, the initiative for setting up a PPP should be taken to the executive level. ED management should start by approaching the executive levels to demonstrate (using pre-assessment information) that PP cost effective opportunities do, actually, exist and should be explored. Emphasis should be given to the benefits associated with the implementation of PPP (as provided in chapter I of the present report) and the serious intention of ED in issuing a mandatory PPA. Potential reduction in future operating cost should also be highlighted.

4. Solicit commitment. Once the senior managers decide on the establishment of a PP, they should convey their official commitments to ED and to their employees.

II-1-2- STEP # 2: ORGANIZE THE PPP:

Once you have the commitments made by the executive levels of the industry, perform the following:

1. Constitute PP Task Force (PPTF) Within the Industry. PPPs should be directed by a PPTF will have the overall responsibility for developing PPP Plan (PPPP) and directing its implementation. The capabilities and attitude of PPTF towards the effort will be major determinants of how successful it will be. All individuals named in PPTF should have technical, business and communication skills as well as thorough knowledge of the industry.

2. Nominate the PPP team leader: The team leader should be from highest level possible in the industry. He must have the authority and the influence necessary to keep PPP on track and to ensure that PP becomes an integral part of the overall corporate plan.

3. Nominate other team members: PPTF team members should be selected for nothing other than their specific technical and/or business expertise. ED should propose its technical involvement by appointing a non voting representative to the PPTF. Environmental and plant process engineers, production supervisors, and experienced line-workers are good candidates for membership in PPTF. Other potential members include quality assurance staff and outside consultants may be retained to work with the in-house team.

4. Identify responsibilities of each team member: The responsibilities and authority of each individual should be established during the organizational stage.

5. State the industry's goals in PP: The PPTF leader should formulate the long-term direction of the PPP. The goals should coincide with the broad-lines of ED requirements depending on the content of the expected PPA. They can be qualitative such as "achieve a significant reduction of toxic substance emissions to the environment" or may be quantitative such as "achieve zero discharge of toxic substance emissions". However, in order to avoid future disappointment and to be more realistic, the goals should be flexible and adaptable. As the PPP becomes more focused and the aspects become better known, the goals can be refined further more.

II-1-3- STEP # 3: CONDUCT PRELIMINARY ASSESSMENT:

At this stage a slightly deeper examination will be needed. The preliminary assessment will help the PPTF review the data that are already available and begin defining ways to process the information. The main purpose of data collection and site surveying is to enable the PPTF to **establish priorities** and procedures for the preparation of much more detailed assessment. The preliminary assessment can be conducted as follows:

(1) Collect Data:

PPTF should keep in its mind that the goal of the PPP is to prevent pollution not to collect irrelevant data. Depending on the nature and size of the industry, the data sources for the PPP includes the following:

Regulatory Information:

- Waste shipment manifests
- Emission inventories
- Hazardous wastes reports
- Environmental audit reports
- Permits and permit applications

Raw Material/Production Information:

- Product consumption and batch sheets
- Material application diagrams
- Material safety data sheets
- Product and raw material inventory records
- operator data log
- operating procedures
- Production schedules

Process Information:

- Process flow diagram
- Design and actual material and heat balance for production processes and pollution control processes.
- Operating manuals and process descriptions
- Equipment specifications and data sheets
- Piping and instrument diagrams

Accounting Information:

- Waste handling, treatment, and disposal costs
- Water and sewer costs, including surcharges
- Cost for non-hazardous waste disposal
- Product, energy and raw material costs
- Operating and maintenance costs

Other Information:

- Environmental policy statements
- Standard procedures
- Organization charts

(2) Visit to the Industrial Site:

The site visit during the preliminary assessment will provide the information needed to accomplish the prioritization and to designate the detailed assessment teams, who will be selected for their expertise in particular areas. In order to utilize limited resources, PPTF will need to prioritize the processes, operations and wastes that will be addressed during the subsequent detailed assessment phase. During this visit, PPTF will target the most important waste problems, moving on to lower-priority problems as resources permit.

(3) Establish Priorities:

The priorities set in this stage will guide the selection of areas for detailed assessments. Areas may also be targeted based on the volume of the waste produced, its toxicity, or the costs of its disposal. The typical considerations for prioritizing waste streams for further investigation include:

- Compliance with anticipated regulations
- Costs of waste management (pollution control, treatment, disposal)
- Potential environmental and safety liability
- Quantity of waste

- Hazardous properties of the waste such as its toxicity, flammability, corrosivity, ignitability, and/or reactivity.
- Other safety hazards to workers
- Potential success for PP
- Potential for removal of bottlenecks in production or waste treatment
- Potential recovery of valuable by-products
- Available budget for PPP
- Minimizing waste water discharges
- Reducing energy use.

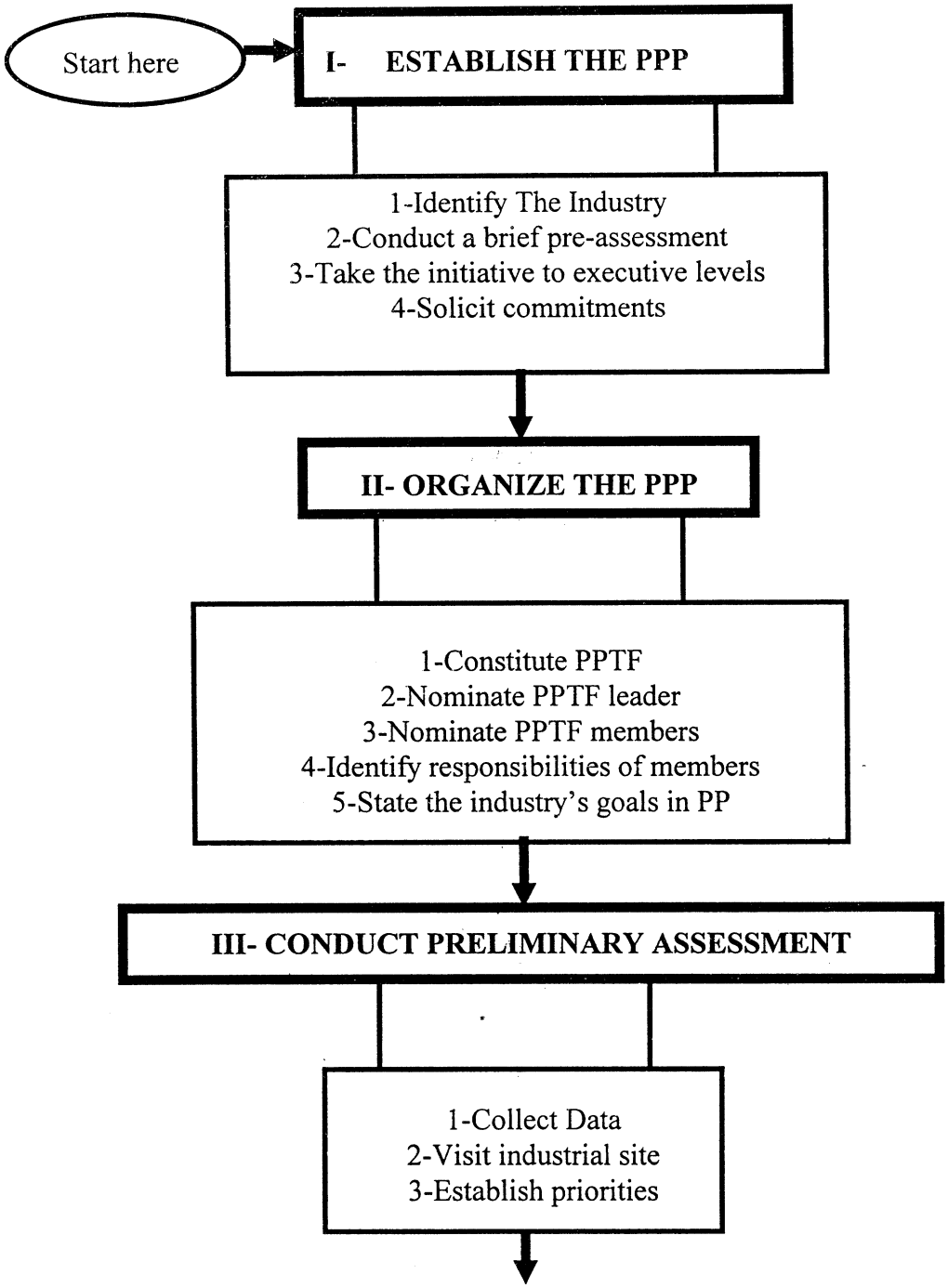

Fig. 1: Flow diagram for Phase # 1 "Initiation and Organization of PPP".

II-2-PHASE # 2: PREPARATION OF PP PLAN (Fig.2):

Phase # 2 is dedicated towards the preparation of a plan for the sole purpose of implementing the PPP. Once the preliminary assessment has been conducted and priorities were established, the PPTF will develop their plan based on the established PPP. PPTF will address the level of involvement of ED at MMAA, identify PPP objectives, identify the potential obstacles and their solutions, and define the data collection and analysis procedures that will be used.

II-2-1- STEP # 1: DEFINE THE LEVEL OF ED INVOLVEMENT IN IMPLEMENTING PPP:

In addition to securing transparency, the involvement of ED can provide its perspective on environmental protection issues, legislative aspects associated with PPP, and can also provide first hand information on ED's future plans in enforcing PPPs.

II-2-2- STEP # 2: DEFINE THE PPP OBJECTIVES:

During the preliminary assessment phase, the PPTF will have identified opportunities for PP and will have established priorities. These will be the starting point for defining short- and long-range objectives. Objectives are the specific tasks that will be necessary to achieve the goals of PPP. For instance, in order to reach a goal of minimizing a certain waste, the objectives might be defined as reducing solvent by a specific amount over a stated period of time.
It is important to note that the objectives should be stated in quantitative terms and should have target dates.

II-2-3- STEP # 3: IDENTIFY THE CONSTRAINTS LIKELY TO IMPEDE THE IMPLEMENTATION OF PPP:

As the PPTF begins to implement the PPP, they are likely to encounter a number of constraints that will complicate the process. These constraints need to be recognized, and the means to overcome them need to be identified.

1. **Identify the Economic Constraints:** Economic constraints include relatively complex cost analysis requirements and the need for capital improvements funding. Many proposed PP opportunities will have start-up costs. For instance, replacement of equipment may need to be purchased, staff training may be required, or alternative raw materials may cost more. Some of these additional costs can be justified readily because they clearly will be cost-effective and will have short pay-back times. However, many will not be so clear-cut and will need more sophisticated analysis. Furthermore, limited financial resources for capital improvements may also be a problem, even for options that will ultimately be profitable. PPTF should investigate the availability of and conditions for funding assistance or low interest loans.

2. **Identify Technical Constraints:** **(1)** Availability of technical information may pose a real constraint in defining the proper PP options. **(2)** Limited flexibility might pose an additional constraint. A proposed PP option may necessitate modifying the work-flow or the product of installing new equipment; implementation could also require retrofitting with shut-down and loss of production time. These technical barriers can be overcome by having design and protection personnel take part in the planing process and by using tested technologies or setting up pilot operations.
3. **Identify Institutional Constraints:** As is the case with any new program, general resistance to change might lead to friction among elements within the industrial facility. It is important for PPTF to analyze these constraints in order to understand these concerns, Management main concern is production costs, efficiency productivity, return on investment, and present and future liability. Workers are concerned about job security, pay, and workplace safety and health.

II-2-4- STEP # 4: DEVELOP A SCHEDULE FOR PP ACTION PLAN:

The final aspect of planning the PPP is to list the milestones within each of the stages from detailed assessment through implementation and assign realistic target dates.

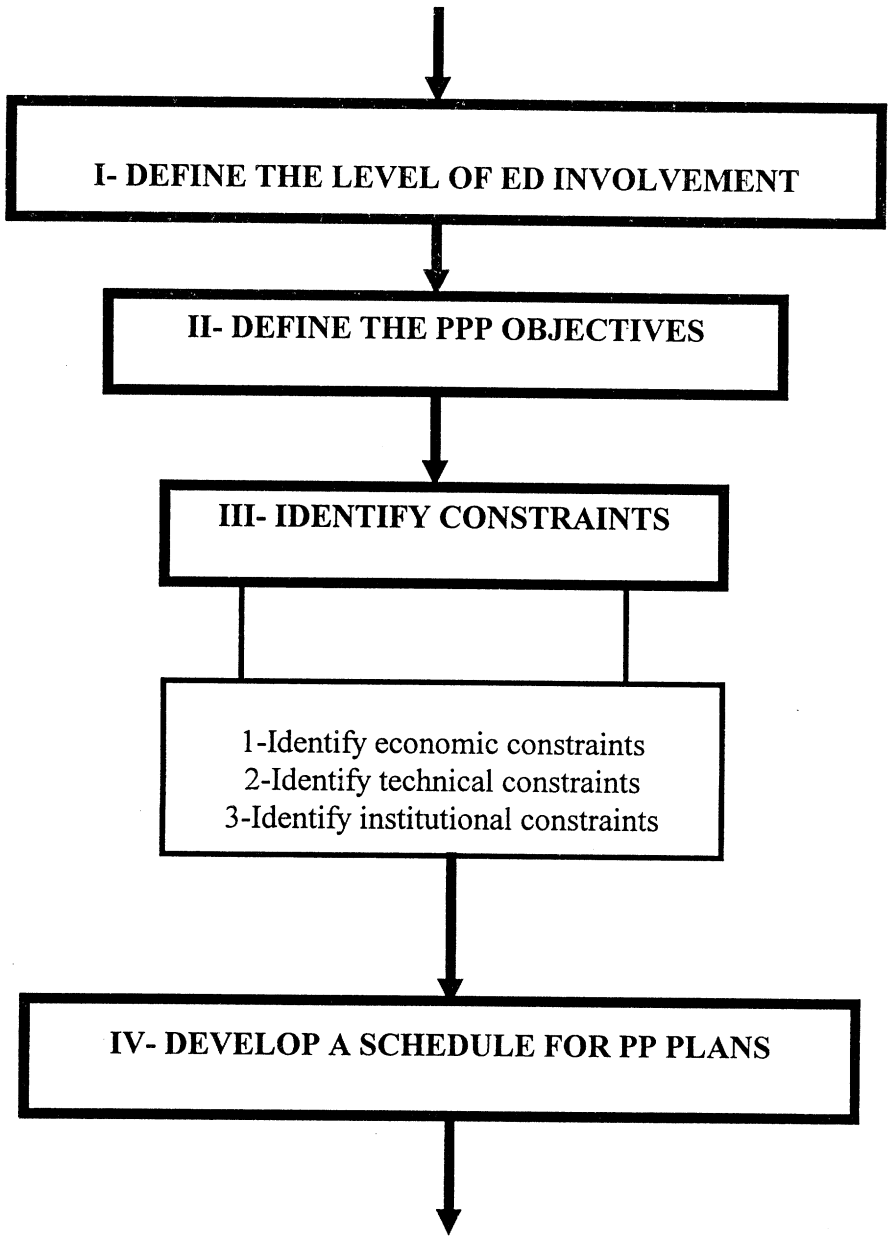

Fig. 2: Flow diagram for phase 2 "Preparation of PP Plan".

II-3- PHASE # 3: DEVELOPMENT OF PP PROJECTS: (Fig. 3)

This phase outlines the methodology to execute PPP Plans resulting from the activities conducted in Phase # 1 and 2. In this phase, PPP Plans should be translated into PP project or a series of projects for implementation depending on the scale and complexity of the industrial facility.

As with the other stages, the degree of formality should be catered to the scale of the industry and the diversity of its product lines. Thus a small company may need to do only one detailed assessment and prepare one implementation plan for a single PP project. Other larger industries might require several detailed assessments and a multitude of PP projects to address waste minimization from various production processes. If multiple projects are to be developed and implemented, it will be fundamental to examine how these projects will fit together for resolving any conflicts and prioritizing them to fit available resources.

II-3-1- STEP # 1: CONDUCT A DETAILED ASSESSMENT:

Apart from the preliminary assessment conducted in phase # 2 to identify areas of opportunity for PP, a much more focuses and detailed assessment will be required in this phase to converge on specific areas targeted by the preliminary assessment.

In this phase, assessment teams will be assigned to each operational area of the facility to gather information for later analysis and interpretation. As was the case in the preliminary assessment, they will use existing written materials and sites evaluations to guide their missions. However, they will delve much more deeply into each production process, interviewing workers and compiling necessary data that may not have been collected before.

During this process, experienced teams might be able to identify some options that can be implemented quickly and with little cost or risk. It is likely, however, that many options will be more complex and will require in-depth analysis later.
The procedure to conduct a detailed assessment should include the following sequence of activities:

(1) Designation of the Detailed Assessment Teams (DATs):

The PPTF in "which ED is represented" should be in a position to nominate the detailed assessment team or teams based on the scale and the complexity of the processes in this particular industry. If the industry is too small, then PPTF can assume the role of DAT. Ideally, at least one member of PPTF should be included on each DAT to facilitate communication.

The focus of DAT is relatively specific and well defined. It is customary to find that three to six people are the appropriate number of DAT members. It is advisable that DAT members should be people with direct responsibility for and knowledge of the specific waste streams and production areas of the industry under consideration. The areas

of expertise to consider for DATs include environmental scientists, engineers, supervisors, production workers, health and safety, accounting and administration, quality control officer etc.

For each DAT, a team leader who has day-to-day operations responsibility and experience should be appointed by PPTF.

(2) <u>Review Data and Sites</u>:

Numerous of the data sources have been already identified during the preliminary assessment as identified in Step # 3 of Phase # 1 of the present report. The DAT for that site will search for additional sources of data that will be useful in studying the targeted processes, operations, or waste streams. However, most of DAT efforts will be dedicated towards performing a thorough site review and interviewing workers. Before conducting site review, it is strongly recommended for DAT to review existing documentation, such as operator manuals and purchasing and shipping records. This will enable the team to focus on the topics of interest.

In order to conduct a fruitful site review the DAT should perform the following:

1. DAT leader should prepare an agenda in advance that covers all points that still require clarification. Provide DAT members with the agenda several days before the site review.
2. Schedule the site review to coincide with the particular operation that is of interest and represent the center of DAT focus. e.g. startup, shutdown, bath dumping etc.
3. Monitor the operation of interest at different times during all shifts, and if needed during all three shifts, especially when waste generation is highly dependent on human involvement.
4. Follow the process from the beginning to end, from the point where input materials enter the work-site to the point where products and waste exit. This will help identify all suspected sources of waste.
5. Interview the operators, shift supervisors, and work leaders in the assessed area. It is very possible that they may have valuable suggestions on reducing the wastes generated in their areas.
6. Photograph or videotape the areas of interest, if warranted. Pictures are very valuable in the absence of plant layout drawings. Many details can be captured in pictures that otherwise could be forgotten or inaccurately recalled at a latter stage.
7. Note the housekeeping aspects of the operation. Check for signs of spills or leaks. Visit the maintenance workshop and inquire about problems in keeping the process "under consideration" leak-free.
8. Assess the overall cleanliness of the site. Pay attention to odors and fumes.
9. Assess the organizational structure if available and level of co-ordination of environmental activities among the various departments.
10. Assess administrative controls, such as costs accounting procedures, material purchasing procedures, and waste collection procedures.

11. Examine the methods of storing, handling, loading, unloading, transporting, and feeding of raw materials and production intermediates.
12. Make follow-up visits as missing or unclear data are identified during the analysis stage.

Typical questions to be addressed by DAT during site reviews might include the following:

1. What is the composition of the waste streams and emissions generated in the industry? and what are the quantities ?
2. From which production processes or treatments do these waste streams and emissions originate?
3. Which waste materials and emissions fall under local environmental regulations?
4. What raw materials and input materials in the production process generate these waste streams and emissions?
5. How much of the specific raw or input material is found in each waste stream?
6. What quantity of materials are lost in the form of volatile emissions?
7. How efficient is the production process and the various steps of that process?
8. Are any unnecessary waste materials or emissions produced by mixing materials - which could be otherwise reused with other waste materials ?
9. Which good housekeeping practices are already in force in the factory to limit the generation of waste materials?
10. What process controls are already in use to improve process efficiency?

To make sure that the data collected is rigorous, complete, and compatible with the compilation and analysis stage described later, data forms (known as worksheets) should be designed prior to site reviews. Appendix A is providing examples of data sheets employed by US-EPA in conducting their rigorous PPPs. The worksheets provided in Appendix-A are generic in nature and can be used for data collection. However, DAT might decide to customize them and create entirely new ones to conform to the nature of the specific site or production line.

(3) <u>Organize and Document Process Information</u>:

A material and energy balance for a given substance will reveal quantities lost to emissions or to accumulation in equipment's. The material balance is based on the fact that " **Mass out = Mass in** ".

In order to prepare a mass or energy balance, draw a process diagram, which is a visual means of organizing the data on the energy and material flows and on the composition of the streams entering and leaving the system. Such a diagram shows the system boundaries, all streams entering and leaving the process, and points at which wastes are generated.

The DAT has to recognize that the inputs should ideally equal the outputs but in practice this will rarely be the case and some judgment will be required to determine what level of accuracy is acceptable. In general, imbalance indicates that the data are inaccurate and should be reviewed, or that fugitive emissions of waste are occurring.

II-3-2- STEP # 2: DEFINE PP OPTIONS:

Once the nature and sources of waste generated have been described, the DAT enters the creative phase of defining what should be done to improve the situation. The basic objectives of the current step # 2 of phase # 3 is to generate a comprehensive set of options, ranked as to priority, that merit detailed feasibility assessment. This step can be materialized by conducting the following two activities:

(1) Propose the PP Options or Opportunities:

The best result can be achieved if each member of the DAT is given the opportunity and encouraged to think creatively and independently. The team should be encouraged to look first at true source reduction options, such as improved operating procedures, better housekeeping, and changes in technology, materials, and products. Then, options that involve reuse, or closed-loop recycling, would be examined. Finally, and as a last resort, DAT would consider off-line and off-site recycling and alternative treatment and disposal methods.

(2) Discuss These Options in Brainstorming Sessions:

Organize brainstorming sessions for DAT and PPTS to discuss the proposed options. Brainstorming sessions will encourage creative thought because they provide a non-judgmental and synergetic atmosphere in which innovative ideas can be shared. Then these ideas can be developed by means of group decision techniques.

(3) Screen the Proposed PP Options:

Some of the PP options resulting from the brainstorming sessions will be found to have no cost or risk attached; these can be implemented immediately. Others will be found to have marginal value or to be impractical; these will be dropped from further consideration. The remaining PP options will generally be found to require feasibility assessment.

Screening does not require detailed costly studies. Screening procedures can range from an informal review with a decision made by either the program manager or a vote of the team members to the use of quantitative decision-making tools. In case of complicated situations, DAT may use the **weighted sum method** provided in Appendix B as a quantitative tool for selecting the best-proposed PP option.
Option screening should consider the following questions:

- Which options will best achieve the goal of waste reduction?
- What are the main benefits to be gained by implementing this option? (e.g. financial compliance, liability, workplace safety, etc.).
- Does the necessary technology exist to develop the option?
- How much does it cost? Does it appear to be cost effective, meriting in-depth economic feasibility assessment?
- Can the option be implemented within reasonable amount of time without disrupting production?
- Does the option have a good "track record"? If not, is there convincing evidence that the option will work as required?
- What other areas will be affected?

II-3-3- STEP # 3: PERFORM FEASIBILITY ANALYSIS:

The final product of Step # 2 of Phase # 3 is a prioritized list of PP options. These options now should undergo an examination to determine which are technically, environmentally and economically feasible and to prioritize them for implementation. The following is providing the methodology of evaluating the options.

(1) Perform A Technical Evaluation for the Proposed PP Options:

The DAT will perform a technical evaluation to determine weather the proposed PP option is likely to work in a specific application. The following criteria should be used to technically evaluate the proposed options.

- Will the proposed PP option reduce waste?
- Is the system safe for the workers?
- Will the product quality be improved or maintained?
- Is there space available to accommodate the proposed PP option?
- Are the new proposed equipment, materials, or procedures compatible with the regular operating procedures, work flow, and production rate
- Will the industry need to hire additional labor to implement the proposed PP option?
- Will the industry need to hire personnel with special expertise to operate and maintain the proposed system?
- Are the utilities needed to operate the new proposed systems available? Or, must they be installed at increased capital cost?
- How long will production be stopped during system installation?
- Will the vendor provide acceptable service for the proposed PP option?
- Will the system create new environmental problems?

If after the technical evaluation the proposed PP option appears impractical or can be expected to lower product quality, disregard it. In certain cases, a bench-scale or pilot-scale demonstration may be needed to confirm the findings.

(2) Perform An Environmental Evaluation for the proposed PP Option:

In this step, the DAT will weigh the advantages and disadvantages of each option with regard to the environment. To make a sound environmental evaluation, DAT should gather information on environmental aspects of the relevant product, raw material or constituent part of the process. The criteria to be considered in environmental evaluation should include the following:

- Effect on number and toxicity of waste streams
- Risk of transfer to other media
- Environmental impact of alternate input materials
- Energy consumption

(3) Perform An Economic Evaluation for the Proposed PP Option:

Estimating the costs and benefits of some of the proposed PP options is straightforward, while others prove to be complex. If a PP option has no significant capital costs, the decision is relatively simple. Its profitability can be judged by whether or not it reduces operating costs and/or prevents pollution. If it does, it can be implemented quickly.
Proposed PP option with significant costs attached to it will require more detailed analysis. In this case DAT should resort to an environmental economists who is experienced in the field of environmental valuation.

II-3-4- STEP # 4: WRITE A REPORT ON ASSESSMENT & EVALUATION OF PP OPTIONS:

(1) Write the Assessment Report:

The DAT in co-ordination with PPTF will write a report that summarizes the results of the PP assessment of the industry. If the industry is large and several DAT were formed for different production lines, then, each DAT should report on the following:

(1) results of the assessment efforts,
(2) PP options proposed,
(3) Results of PP options screening,
(4) Results of feasibility analysis "technical, environmental and economic", and
(5) Project proposal for each selected option.

The detailed assessment report for each single PP option (each PP project) should discuss the following:

1. Its PP potential
2. The maturity of the technology and a discussion of successful applications
3. The overall project economics
4. The required resources and how they will be obtained
5. The estimated time for installation and startup
6. Possible performance measures to allow the project to be evaluated after it is implemented.

(2) Review The Assessment Report:

The report will provide the basis for obtaining funding for PP projects. It should be made clear that PP projects cannot be sold on their technical merits alone; a clear description of both tangible and intangible benefits can help a PP proposed project obtain funding from the industry.

Before the report is issued in its final form, managers and other experienced people in the production units that will be affected by the proposed projects should be asked to review the report. Their review will help to ensure that the projects proposed are well defined and feasible from their perspective.

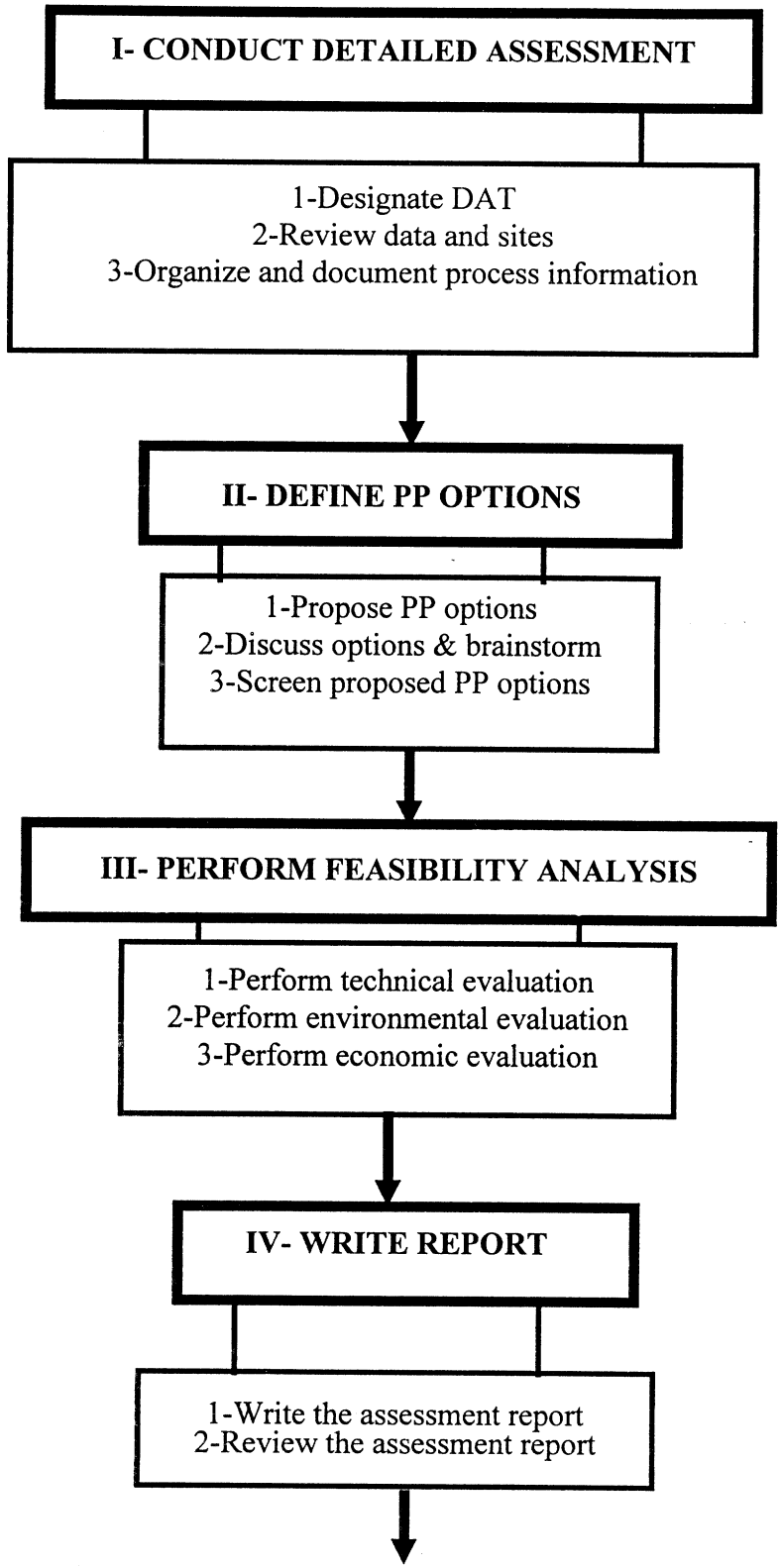

Fig. 3: Flow diagram for phase # 3: "Development of PP projects".

II-4- PHASE # 4: IMPLEMENTATION OF PP PROJECTS: (Fig. 4)

(1) Select The Project To Be Implemented:

Final decisions on which projects will be implemented first and what the schedule will be are made at this point.

(2) Obtain Funding To Implement the Project:

The PPTF will secure the funding for the project or projects that will require expenditures. In case the industry has difficulty raising funds internally for capital investment, Government financing should be made available through soft loans or other mechanisms. The societal benefits associated with the implementation of PP projects are significant and worthy investment by the government.

(3) Install the Selected Project:

Many PP projects will require changes in operating procedures, purchasing methods, or material inventory control. Industry policies and procedures documents and employee training will also be affected by the changes. For projects that involve equipment modification or new equipment, the installation of a PP project is essentially the same as any other capital improvement project.

(4) Review and Adjust the Project:

The PP project does not terminate with its implementation. After PP project is implemented, track its effectiveness versus the claims made - technical, economic, environmental, etc. Options that do not meet the original performance expectations may require rework or modifications.

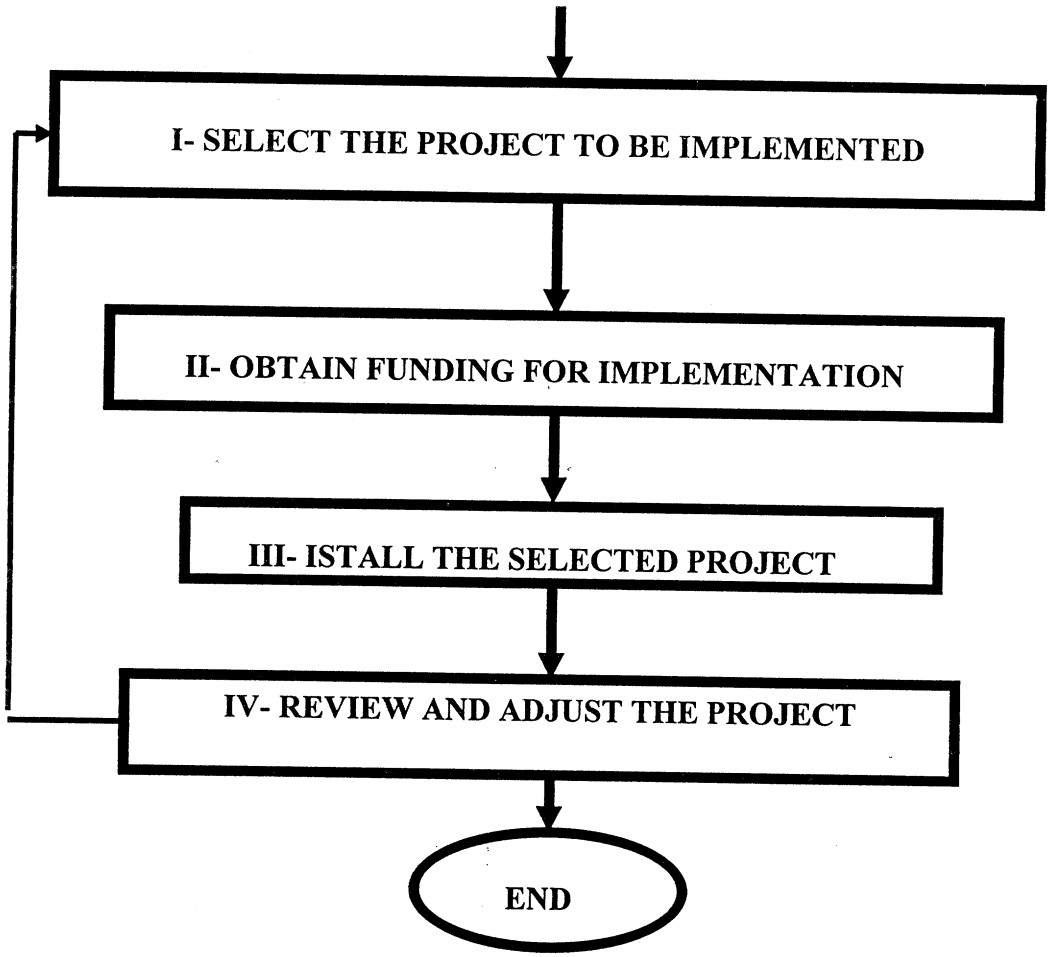

Fig. 4: Flow diagram for phase # 4: "Implementation of PP projects".

III- PP Opportunities at Qatar Steel Company (QASCO)

A short visit was made to QASCO to explore the potential of initiation, organization and possibly implementation of a PP program. The visit was organized by ED and took place on 3/5/1998. Safety and operation engineers attended the meeting to provide the preliminary information and provide their perception and views on the initiation of a PPP at QASCO.

III-1- Iron Making at QASCO:

The iron ore is fed to the Direct Reduction Furnace (DRF). The heated air is forced into the bottom of the furnace through orifices located around the circumference of the furnace. The carbon monoxide, hydrogen and methane gases resulting from the cracking of natural gas reduces iron ore to iron. The acid part of the ores reacts with limestone to produce a slag which is drawn periodically from the furnace. This slag contains unwanted impurities in the ore. It is estimated that the amount of slag produced from QASCO is some 60,000 metric tone/year. When the DFR is tapped, iron is removed through one set of runners and molten slag via another. The molten iron (Sponge iron) is then transported to the steel making furnaces.

III-2- Steel Making At QASCO:

In the Electric Spark Furnace (EAF) iron sponge is fed at high temperature where sponge iron is transformed into steel and separated impurities in the form of slag (around 180 tons/day) and emitted dust and gases. The metal dust is collected in bag houses and the daily amount generated is some 36 tons/day from the two operating furnaces at QASCO.

III-3- Casting and Rolling at QASCO:

The molten steel is casted continuously into steel pellets. The steel pellets are then heated to 1200 C^{o} using natural gas rolled into various thickness and bundles of construction steel bars are made for transportation into the local market. The steel is then acid pickled to remove scale and clean the surface of raw steel by dipping it into a tank of hydrochloric or sulfuric acid.

III-4- Waste Streams Generated at QASCO:

The waste streams generated form the iron making process can be classified as follows:

1. Iron slurry resulting from the treatment of industrial wastewater used in scrubbing. The volume of waste-water is some 2500 m3/hour. A closed loop permitting the reuse of the treated is installed. The amount of water used as a make-up is estimated at 800 m3/hour.

2. The natural gas used as a fuel and a source of reducing gases in the industries is generating some air pollutants. The air pollutants resulting from the cracking process are , CO2, NOx, SOx, dust, VOCs, etc.
3. The natural gas is centrally sweetened before delivery to QASCO, however, in some cases, desulfurization is taking place on site and large volumes of sulfur cake is produced leading to the accumulation of potentially combustible materiel on site. The amount of sulfur cake generated annually is 100 tons.
4. Large amount of oxide fines estimated at 11,000 tons/year, product fines estimated at some 12,000 tons/year, EAF dust estimated at 4000 tons/year; DRF dust generated at 4000 tons/year are emitted from QASCO.
5. Slag resulting from the DRF and EAF is posing a serious challenge to the industry. Piles of slag are currently disposed of on site. The total annual generation of slag from both furnaces is around 60,000 tons/year.
6. A relatively small amount of spent catalyst is generated at the rate of 30 tons/year.

III-5- Pollution Prevention Opportunities at Iron and Steel Plants

The following are very basic pollution prevention opportunities that appeared possible during the two hours visit to the facility. The ideas provided in the following section are very preliminary and should be subject to extensive and detailed assessment using the methodology proposed in the present report.
Most of the pollution prevention activities in the iron and steel industry have concentrated on DRF and EAF, slag, dust, and spent acids used in finishing operations.

III-5-1- The Slag:

The slag is the largest by-product generated from the iron making process and is reused extensively either in roads paving or in the construction industry.
Sintering is the process that agglomerates fines (including iron ore fines), pollution control dusts, waster treatment plant sludge into a porous mass for charging to the DRF. Through sintering operations, a mill can recycle iron-rich material such as mill scale and processed slag. In this case, the input materials are mixed together, placed on a slow moving grate and ignited. Windboxes under the grate draw air through the materials to deepen the combustion throughout the traveling length of the grate. In the process, the fine material are fused into the sinter agglomerates, which can be reintroduced into the DRF along with the ore. Air pollution control equipment removes the particle matter generated during the thermal fusing process. For wet scrubbers, water treatment plant sludge are generally land disposed waste. If electrostatic precipitator or baghouses are used as the air pollution control equipment, the dry particulates captured are typically recycled as sinter feedstock.

III-5-2- EAF Dust:

Dust generation from EAF, and its disposal, have also been recognized as a serious problem, but one with potential for pollution prevention through material

recovery. In USA, steel companies pay a disposal fee of $ 150 to $200 per ton of dust. With an average zinc concentration of 19%, much of the EAF dust is shipped off-site for zinc reclamation. Most of the EAF dust recovery options are only economically viable for dust with the zinc content of at least 15 to 20%. If QASCO is producing dust with less zinc content, it still has the opportunity to recover chromium and nickel from the EAF dust.

III-5-3- Pickling acids:

In finishing, pickling acids are recognized as an area where PP efforts can have a significant impact in reducing the environmental impact of the steel mill.
Large-scale manufacturers commonly recover hydrochloric acid in their finishing operations, however, the techniques used are not suitable for small to medium sized steel plants. The system under development in USA removes iron chloride (a saleable product) from the hydrochloric acid, re-concentrates the acid for reuse, and re-condences the water to be reused as a rinse water in the pickling process. Because the only by-product of the hydrochloric acid recovery process is a non-hazardous, marketable metal chloride, the proposed technology generates no hazardous wastes. This technology is much less expensive than transporting and disposing waste acid, plus it eliminates the associated long-term liability.

III-5-4- Sulfur Cake Problem:

First PP Option:

In principle, the best option for the disposal of solid sulfur stored on-site at QAPCO and resulting from gas desulphurization is its removal remelting, purification and then selling it as pure sulfur to end users. However, such an option might be very doubtful for the following three reasons:

1. Elemental sulfur either in its pure or impure form are generated at an unprecedented massive amounts in the Gulf region to fulfill the objective of reducing the sulfur content in oil exports.
2. The environmental control and enforcement in the developed western world necessitate the desulphurization of flue gas emitted from power generation to restraint the levels of SO2 emitted into the ambient environment for the ultimate purpose of curbing acid rain. Transboundry movement of this particular pollutant was the main stimulus for imposing these regulations. Some of the scrubbing methods of SO2 from flue gas are regenerative leading to the recovery of SO2 in the form of elemental sulfur.
3. The local waste generator might not be able or willing to invest in procuring a reactor for the re-melting and purification of the waste sulfur to a commercial grade.

Even though this option is the ideal and recommended one, it is obvious from the three aforementioned reasons that its economic attractiveness has been rendered very doubtful. Techno-economic investigations should be conducted to define the feasibility of this option.

Second PP Option:

Simple mixing of sulfur pillets with kiln flue dust generated from Qatar National Cement Company is another feasible and possibly attractive disposal option. In this option, sulfur pillets can be mixed at the ratio of 1 to 3 sulfur to kiln flue dust and disposed of by burial in the dumping site at Um-Said.

Third PP Option:

Following its mixing with cement, elemental sulfur can be used as building material an for the fabrication of wastewater pipes. However, this option will necessitate the milling of the sulfur pillets into powder by either the recipient of the waste or the generator based on the economic value of the waste.

Fourth PP Option:

Mixing asphalt with sulfur will lead to an improvement in the melting characteristics of the road pavements particularly in the hot summer conditions prevailing in the Gulf region. However, material testing and observation of this option on a pilot scale in repairing streets potholes is strongly recommended for two consecutive seasons at the beginning.

Fifth PP Option:

Elemental sulfur can be used as a fertilizer in its powdered form to improve the soil characteristics for agriculture purposes. Milling and selling of the sulfur to agricultural agencies might be an attractive option to the generator. However, in this case the generator has to mill the sulfur granules and identify the quality and quantity of impurities to certify that application of the waste to agriculture land will not cause any environmental damage to the soil or accumulation of pollutants in the crops.

III-6- Other areas with PP opportunities:

Other areas in iron and steel manufacturing where opportunities may exist for PP are listed below:

III-6-1- In Process Modification:

Redesigning or modifying process equipment can reduce pollution output, maintenance costs, and energy consumption, for example:

- Replacing single-pass wastewater systems with closed-loop systems to minimize chemical use in wastewater treatment and to reduce water use.
- Continuous casting, now used for about 90% of crude steel cast in the USA offers great improvements in process efficiency when compared to the traditional ingot teeming method. This increased efficiency also results in considerable savings in energy and some reduction in the volume of mill wastewater.

III-6-2- Material Substitution:

- Use scrap steel with low lead and cadmium content as a raw material, if possible.
- Eliminate the generation of reactive desulfurization slag generated in foundry work by replacing calcium carbide with a less hazardous material.

III-6-3- Recycling:

Scrap and other materials are recycled extensively in the iron and steel industry to reduce the raw materials required and the associated pollutants. Some of the recommended recycling activities include:

- Recycle or reuse oils and greases
- Recover acids by removing dissolved iron salts from spent acids.
- Use thermal decomposition for acid recovery from spent pickle liquor.
- Use a bipolar membrane/electrodialytic process to separate acid from metals by-products in spent NO3-HF pickle liquor.
- Remove sulfuric acid using low temperature separation of acid and metal crystals.

APPENDIX A

Pollution prevention assessment worksheets

8 pages

Firm _____ Site _____ Date _____	Pollution Prevention Assesment Worksheets Proj. No. _____	Prepared By _____ Checked By _____ Sheet _____ of _____ Page _____ of _____

WORKSHEET 1 **SITE DESCRIPTION**

Firm: _____

Plant: _____

Department: _____

Area: _____

Street Address: _____

City: _____

Province/Postal Code: _____

Telephone: ( ) _____

Major Products: _____

_____

_____

SIC Codes: _____

MOEE Reg 347 Generator Number: _____

Major Units: _____

Product or Service: _____

Operations: _____

_____

_____

_____

_____

_____

Facilities/Equipment Age: _____

_____

_____

_____

_____

Firm _____ Site _____ Date _____	Pollution Prevention Assesment Worksheets Proj. No. _____	Prepared By _____ Checked By _____ Sheet _____ of _____ Page _____ of _____

WORKSHEET 2 PROCESS INFORMATION

Process Unit/Operations: ___ Continuous ___ Discrete
Operation Type: ___ Batch or Semi-Batch ___ Other

Document	Status					
	Complete? (Y/N)	Current? (Y/N)	Last Revision	Used in this Report (Y/N)	Document Number	Location
Process Flow Diagram						
Material/Energy Balance						
Design						
Operating						
Flow/Amount Measurements						
Stream						
Analyses/Assays						
Streams						
Process Description						
Operating Manuals						
Equipment List						
Equipment Spefications						
Piping and Instrument Diagrams						
Plot and Elevation						
Work Flow Diagrams						
Hazardous Waste Manifest						
Emission Inventories						
Annual/Biennial Reports						
Environmental Audit Reports						
Permit/Permit Applications						
Batch Sheet(s)						
Materials Application Diagram						
Product Composition Sheets						
Material Safety Data Sheets						
Inventory Records						
Operator Logs						
Production Schedules						

Firm _____ Site _____ Date _____	Pollution Prevention Assesment Worksheets Proj. No. _____	Prepared By _____ Checked By _____ Sheet _____ of _____ Page _____ of _____

WORKSHEET 3 INPUT MATERIALS SUMMARY

Attribute	Description		
	Stream No.	Stream No.	Stream No.
Name/ID			
Source Supplier			
Component/Attribute of Concern			
Annual Consumption Rate			
Overall			
Component(s) of Concern			
Purchase Price, $ per			
Overall Annual Cost			
Delivery Mode[1]			
Shipping Container Size & Type[2]			
Storage Mode[3]			
Transfer Mode[4]			
Empty Container Disposal Management[5]			
Shelf Life			
Supplier Would			
- accept expired materials?(Y/N)			
- accept shipping charges? (Y/N)			
- revise expiration date? (Y/N)			
Acceptable Substitute(s), if any			
Alternate Supplier(s)			

Notes:
1. e.g., pipeline, tank car, 100 bbl tank truck, truck, etc.
2. e.g., 55 gal drum 100 lb paper bag, tank, etc.
3. e.g., outdoor, warehouse, underground, aboveground, etc.
4. e.g., pump, forklift, pneumatic transport, conveyor, etc.
5. e.g., crush and landfill, clean and recycle, return to supplier, etc.

Firm _____ Site _____ Date _____	Pollution Prevention Assesment Worksheets Proj. No. _____	Prepared By _____ Checked By _____ Sheet _____ of _____ Page _____ of _____

WORKSHEET 4

PRODUCTS SUMMARY

Attribute	Description		
	Stream No.	Stream No.	Stream No.
Name/ID			
Component/Attribute of Concern			
Annual Production Rate			
Overall			
Component(s) of Concern			
Annual Revenues, $			
Shipping Mode			
Shipping Container Size & Type			
Onsite Storage Mode			
Containers Returnable (Y/N)			
Shelf Life			
Rework Possible? (Y/N)			
Customer Would			
- relax specification?(Y/N)			
- accept larger containers? (Y/N)			

Firm _____ Site _____ Date _____	Pollution Prevention Assesment Worksheets Proj. No. _____	Prepared By _____ Checked By _____ Sheet _____ of _____ Page _____ of _____

WORKSHEET 5 **WASTE STREAM SUMMARY**

Attribute	Description		
	Stream No.	Stream No.	Stream No.
Waste ID/Name			
Source/Origin			
Component of Property of Concern			
Annual Generation Rate (units ____)			
Overall			
Component(s) of Concern			
Cost of Disposal			
Unit Cost ($ per: _____)			
Overall (per Year)			
Methods of Management[1]			

Priority Ranking Criteria[2]	Relative Wt. (W)	Rating (R)	R x W	Rating (R)	R x W	Rating (R)	R x W
Regulatory Compliance							
Treatment/Disposal Cost							
Potential Liability							
Waste Quantity Generated							
Waste Hazard							
Safety Hazard							
Minimization Potential							
Potential to Remove Bottleneck							
Potential By-Product Recovery	(R x W)		(R x W)		(R x W)		
Sum of Priority Rating Scores							
Priority Rank							

Notes:
1. For example, sanitary landfill, hazardous waste landfill, on-site recycle, incineration, combustion with heat recovery, distillation, dewatering, etc.
2. Rate each stream in each category on a scale from 0 (none) to 10 (high).

Firm _____ Site _____ Date _____	Pollution Prevention Assesment Worksheets Proj. No. _____	Prepared By _____ Checked By _____ Sheet _____ of _____ Page _____ of _____

WORKSHEET 6 **OPTION GENERATION**

Meeting format (e.g. brainstorming, nominal group techniques) _____

Meeting Coordinator _____

Meeting Participants _____

List Suggested Options	Rational/Remarks on Option

Firm_____ Site _____ Date _____	Pollution Prevention Assesment Worksheets Proj. No. _____	Prepared By_____ Checked By_____ Sheet _____ of _____ Page _____ of _____

WORKSHEET 7 OPTION DESCRIPTION

Option Name: _____

Briefly describe the Option: _____

_____

_____

_____

_____

Waste Stream(s) Affected: _____

_____

Input Material(s) Affected: _____

_____

Product(s) Affected: _____

_____

Indicate Type: __ Source Reductions

____ Equipment-Related Change

____ Personnel/Procedure-Related Change

____ Materials-Related Change

__ Recycling/Reuse

____ Onsite ___Materials reused for original purpose

____ Offsite ___Material used for a lower quality purpose

___Material sold

Originally proposed by: _____ Date: _____

Reviewed by: _____ Date: _____

Approved for study? _____ Yes _____ No ____ By: _____

Reason for Acceptance or Rejection: _____

Firm _____ Site _____ Date _____	Pollution Prevention Assesment Worksheets Proj. No. _____	Prepared By _____ Checked By _____ Sheet _____ of _____ Page _____ of _____

WORKSHEET 8 PROFITABILITY

Capital Cost

Purchased Equipment: _____

Materials: _____

Installation: _____

Utility Connections: _____

Engineering: _____

Start-up and Training: _____

Other Capital Costs: _____

Total Captial Cost: _____

Incremental Annual Operating Costs

Change in Disposal Costs: _____

Change in Raw Materials Costs: _____

Change in Other Costs: _____

Annual Net Operating Costs Savings: _____

$$\text{Payback Period (in years)} = \frac{\text{Total Capital Costs}}{\text{Annual Net Operating Cost Savings}} = \_\_\_\_\_$$

APPENDIX B

Option rating weighted sum method

2 pages

This appendix offers an approach to ranking and selecting the best of your pollution prevention opportunities based on a numerical weighting system similar to that used for purchasing or reviewing tenders for capital acquisitions reviews.

It is a simple mathematical model that once fine-tuned to your needs and priorities, will efficiently and fairly rank your best value-added opportunities.

OFFICIALS MET:

Qatar Environmental Department:

Mr. Khaled Al-Ali	Director of ED
Mr. Mohamed A. Akbar	Assistant Director
Mr. Niran Bagchi	Senior Environmental Specialist
Mr. Kazem Mansour	Chemical Engineer
Mr. Hassan Ali Al-Qasmi	Chemical Engineer
Mr. Ali Al-Saigel	Environmental Researcher

UNDP: Doha, Qatar

Mr. Sefeldin Abbaro	Resident Representative
Ms. Sahar Kabalawi	Assistant Res. Rep.

Qatar State Department:

Mr. Ali Sultan Al-Zaman	Director of Int. Organizations
Mr. Reyadh Ali Al-Ansary	UNDP-State Department Coordinator

QASCO:

Mr. Khalifa Al-Kubais	Safety Officer
Mr. Aly Hussein	Assistant Safety & Security Manager
Mr. Hussein Al-Mahdi	Asst. Manager, Rolling Section
Mr. Kahlifa Al-Kubaisi	Safety Officer
Mr. Ahmed M. Farid	Electric Arc Furnace

OPTION RATING WEIGHTED SUM METHOD

The Weighted Sum Method is a quantitative method for screening and ranking pollution prevention options. This method provides a means of quantifying the important criteria that affect waste management in a particular facility. This method involves three steps.

1. Determine what the important criteria are in terms of the program goals and constraints and the overall corporate goals and constraints. Example criteria are:

- Reduction in waste quantity
- Reduction in waste hazard (e.g., toxicity, flammability, reactivity)
- Reduction in waste treatment/disposal costs
- Reduction in raw material costs
- Reduction in liability and insurance costs
- Previous successful use within the company
- Previous successful use in industry
- Not detrimental to product quality
- Low capital cost
- Low operating and maintenance costs
- Short implementation period with minimal disruption of plant operations

The weights (on a scale of 0 to 10, for example) are determined for each of the criteria in relation to their importance. For example, if reduction in waste treatment and disposal costs are very important, while previous successful use within the company is of minor importance, then the reduction in waste costs is given a weight of 10 and the previous use within the company is given a weight of either 1 or 2. Criteria that are not important are not included or are given a weight of 0.

2. Each option is then rated on each criterion.
   Again a scale to 0 to 10 can be used (0 for low and 10 for high).

3. Finally, the rating of each option for a particular criterion is multiplied by the weight of the criterion. An option's overall rating is the sum of the products of rating times the weight of the criterion.

The options with the best overall ratings are then selected for the technical and economic feasibility analyses. Table 1 presents an example using the Weighted Sum Method for screening and ranking options.

Table 1. Sample Calculation Using the Weighted Sum Method

ABC Corporation has determined that reduction in waste treatment costs is the most important criterion, with a weighted factor of 10. Other significant criteria include reduction in safety hazard (weight of 8), reduction in liability (weight of 7), and ease of implementation (weight of 5). Options X, Y, and Z are then each assigned effectiveness factors. For example, option X is expected to reduce waste by nearly 80%, and is given a rating of 8. It is given a rating of 6 for reducing and safety hazards, 4 for reducing liability, and because it is somewhat difficult to implement, 2 for ease of implementation. The table below shows how the options are rated overall, with effectiveness factors estimated for Y and Z.

		Ratings for each option		
Rating Criteria	**Weight**	**X**	**Y**	**Z**
Reduce treatment costs	10	8	6	3
Reduce safety hazards	8	6	3	8
Reduce liability	7	4	4	5
Ease of implementation	5	2	2	8
Sum of weight times ratings		166	122	169

From this screening, option Z rates the highest with a score of 169. Option X's score is 166 and option Y's score is 122. In this case, both option Z and option X should be selected for further evaluation because their scores are high and close to each other.