A GUIDE TO DEVELOPING A BEST MANAGEMENT PRACTICES (BMP) PLAN FOR SPENT LIQUOR—PART I

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PRACTICAL TIPS TO HELP ACHIEVE CLUSTER RULE COMPLIANCE

Best Management Practices (BMP) is the first element of the Cluster Rule regulation that bleached papergrade kraft and papergrade sulfite mills will need to comply with (*1*). Under BMP, mills are required to prevent or contain unintentional losses of spent pulping liquor, turpentine and soap, and to control any related intentional losses. The objective of the regulation is to reduce discharges of organic material in mill effluent, by decreasing the amount and fluctuation of organic loading to mill effluent treatment systems.

There are a number of specific requirements that must be met to comply with the BMP regulation. These can be grouped as follows:

1. An Engineering Analysis, which is essentially a review of the equipment in spent pulping liquor, turpentine, and soap service, to identify the potential of this equipment for spills and appropriate spill avoidance or containment
2. A BMP Plan to document the equipment, systems, spill event reporting, and monitoring programs the mill will use to meet regulatory requirements;
3. A system of monitoring and alarms to alert operators of situations that could lead to a loss of spent liquor, turpentine, or soap
4. Equipment and procedures which enable containment, recovery, or diversion of spent liquor losses
5. A monitoring and reporting program to provide daily measurement of organic material leaving the mill operations and entering effluent treatment, for reporting to government
6. An annual BMP training program for mill employees on their roles in using the above components to meet regulatory requirements.

ROLE OF THE ENGINEERING ANALYSIS

The foundation for meeting BMP requirements is the "Engineering Analysis" (*2*).

The BMP regulatory text itself is fairly straightforward. Generally speaking, mills already have in place many of the components to meet the BMP regulation. In completing the Engineering Analysis to identify needs for additional monitoring and alarms (Item 3 above) and equipment and procedures (Item 4), certain items may be required to meet the regulation, such as full containment of turpentine storage or a critical standard operating procedure (SOP), and certain items may be recommended to better meet the regulation, such as a more rational spent liquor spill collection strategy, i.e., recommended items may help a mill reduce overall losses, but are not specifically required for compliance.

Modifying existing liquor loss control strategy and systems creates opportunities to optimize mill processes, reduce chemical losses, reduce water use, and reduce operating costs. Certain improvements can often be implemented at a minimum cost by slightly modifying operating practices. These practical considerations should be taken into account in the Engineering Analysis when evaluating recommended items.

Beyond the practical aspects of the Engineering Analysis, it is an important document in addressing the due diligent nature of the BMP regulation. Should a spill of spent liquor, soap or turpentine result in an out-of-compliance event in meeting effluent quality objectives, then the Engineering Analysis is the record of a systematic review of the process that shows the mill made a reasonable effort at identifying potential spill scenarios.

It has become apparent that the more effort a mill can spend completing the Engineering Analysis (EA), the more cost-effective and duly diligent their basis will be for the BMP Plan. An effectively executed Engineering Analysis will lead to a system of equipment and procedures that operators are comfortable implementing, and that mill management are confident supporting (*3*).

KEY BMP ISSUES

While the BMP regulation itself is not proscriptive, there are a number of key issues mills need to address that are critical for a successful spill collection program. These include in particular the following items:

- *Environmental exposure*—the program must be duly diligent, in the case that a permit exceedence occurs and the BMP Plan is reviewed in detail in the context of litigation
- *Capital spending exposure*—the capital spending requirements committed to in the BMP Plan must be clearly enumerated and explicitly approved for implementation, so the Plan reflects the actual systems the mill has in place to meet the regulation
- *Production loss exposure*—the program must be flexible enough to allow a continued focus on maintaining production targets, minimizing the risk for a required production curtailment due to inappropriate BMP recommendations.

BMP is part of an environmental regulation; however, it requires developing systems focused on in-plant operations. The BMP Plan should be based upon sound process evaluation of the pulping, recovery, and effluent treatment operations at the mill. The team that appropriately addresses these concerns while building a solid BMP program should include strong process engineering skills coupled with sound environmental engineering capabilities. It is with a clear process engineering understanding of in-plant operations and procedures that a flexible, cost-effective program can be developed that minimizes environmental exposure for the mill.

Unlike similar sorts of regulations, BMP is not an emergency spill control program; it is a day-to-day liquor loss control system that requires a detailed understanding of the day-to-day operations within the mill pulping and recovery areas, to be effective.

DEVELOPMENT OF THE BMP REGULATION

Losses of black liquor, turpentine, and soap have been identified as being a potential contributor to pulp mill effluent chronic toxicity (*4*). Various investigators (*5, 6, 7, 8*) have indicated that upgrading chemical pulping and recovery operations to prevent black liquor spills from entering the effluent treatment system should be a high priority to reduce the environmental impact of mill effluents on receiving waters. In addition, a number of authors (*9, 10, 11*) have identified effluent treatment system operational benefits from minimizing losses of spent pulping liquor to sewer.

In the document produced to support the development of the BMP regulation, the Environmental Protection Agency (EPA) cites four reasons for controlling losses of spent pulping liquor (*2*):

1. To increase the efficiency of effluent treatment systems and decrease system upsets
2. To decrease untreated nonchlorinated material
3. To increase process energy efficiency and reduce sludge formation, through a "pollution prevention mechanism"
4. To effect an incidental decrease of total reduced sulfur (TRS) and hazardous air pollutants (HAPs).

When initially proposed in 1993, the BMP regulation applied to all types of chemical cooking liquors across the mill. Among its more proscriptive requirements, the regulation included full secondary containment as the only alternative for minimizing liquor losses to the sewer from bulk liquor storage tanks, and required mills to develop their BMP Plan for certification by a professional engineer within six months of promulgation. At that time, the EPA specified how the wastewater treatment influent organic loading "Action Levels" should be determined, which would require investigation and/or action by the mill.

The final version of the regulation, promulgated on April 15, 1998, changed the focus to spent pulping liquor, turpentine, and soap, and removed requirements for other liquors. Mills were also given an alternative to the requirement for secondary containment of bulk spent liquor storage tanks: tank integrity testing combined with the use of constructed diversion systems. The timeline for developing a BMP Plan was extended to one year from the date of promulgation, and later for mills with permits expiring after that time. Certification by a registered professional engineer is no longer required; however, the requirement for mill manager approval was retained. In addition, EPA provided mills with more flexibility in statistically developing Action Levels.

OVERVIEW OF BMP REQUIREMENTS

The promulgated BMP regulation includes a series of 10 "best management practices," summarized from the regulation as follows:

1. Divert and recover spent pulping liquor losses to the extent practicable;
2. Implement a program of visual inspection and repairs;

> ***BMP Program Development Tip #1***
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> Within these requirements, the intent of the regulation is for mills to design a practical program that serves to achieve the following basic spills management strategy:
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> 1. Avoid spills occurring from process;
> 2. Contain spills if they do occur;
> 3. Once contained, address the ability to either recover them back to the liquor recovery system or meter them in a controlled fashion to the effluent treatment system.
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> This hierarchy comprises a logical approach for using the results of the Engineering Analysis to design a cost-effective BMP program that maximizes the use of existing procedures and equipment. It does, however, require a thorough initial evaluation of the existing mill systems to optimize BMP system design.

3. Implement a system of monitoring and alarms
4. Implement annual BMP training
5. Prepare a spill event report upon occurrence of a liquor loss event
6. Implement a program for review of impacts from site modifications and construction
7. Provide secondary containment or a combination of tank integrity testing plus diversion structures for bulk spent pulping liquor storage tanks
8. Provide secondary containment for turpentine storage tanks
9. Use curbing and diking to contain soap and turpentine processing areas (resulting in their "isolation" from process sewer)
10. Monitor organic loading of the influent to wastewater treatment to track BMP performance and detect trends.

The BMP systems will be evaluated for effectiveness through an "organics monitoring program" of the influent to the mill wastewater treatment system. There is significant flexibility in designing this program, in terms of the following:

1. Selecting the parameter to monitor, e.g. total organic carbon (TOC), chemical oxygen demand (COD), etc.
2. Identifying the specific location(s) where the monitoring will be performed, e.g., at the influent to effluent treatment, or other points further upstream in the mill;
3. Choosing the monitoring equipment and/or test protocol to be used
4. Selecting a statistical analysis method for data analysis and determination of Action Levels.

Schedule

Most mills are assembling their BMP Plans, establishing initial Action Levels, and providing BMP training for mill personnel to meet the first target date of April 15, 1999, or when their effluent permit is renewed.

By the second deadline of April 15, 2000, mills will have implemented the work practices, maintenance, and monitoring systems needed for their BMP systems. By April 15, 2001, the entire BMP system should be up and running, including any required capital equipment modifications.

In some cases, mills will have additional time beyond this, if their permit allows them to exceed one or more of these deadlines.

Nine months after implementing the BMP program, mills must re-assess their organics monitoring data and re-calculate their Action Levels. At this time, it is likely there will be less fluctuation in the data, resulting in a tightening of the initially-calculated Action Levels. However, with a well-designed system, mills should be able to achieve these new levels.

SIX STEPS TO ASSEMBLING A BMP PLAN

The first two steps in a suggested six-step method for preparing a BMP Plan are presented below; the second article in this series discusses the last four steps.

Step 1: Assembling the BMP team

Prior to initiating development of a BMP program, the mill BMP "champion" should be designated to see the process through to completion. The mill environmental engineer is typically responsible for ensuring compliance with the BMP regulation even though in practice, that person may not necessarily be involved with the imple-

> ***BMP Program Development Tip #2***
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> Mills that begin investigating monitoring strategy issues early will be more comfortable with the program put into place and will be able to benefit from this flexibility rather than becoming overwhelmed by the array of data analysis options available, or ending up tied to a end-of-pipe monitoring program that does not relate well to the information being gathered on upstream operations. Mills should start by reviewing current monitoring points and their ability to provide useful information for identifying potential sources of liquor loss.

mentation of the "working elements" of the designed BMP systems. The environmental engineer does, however, typically bring a broad perspective that can help tie these "working elements" together.

The BMP champion should consider involving BMP Plan "stakeholders" from management, engineering, operations, maintenance, and training. These people should be drawn from the pulping/washing, evaporator/recovery, turpentine, and soap processing areas, and each should be prepared to dedicate some time to assist in BMP development over a period of several months.

Step 2: Key issues analysis & BMP terminology

A "key issue analysis" should be carried out as one of the first steps in beginning to design a BMP program, and can be done effectively in a workshop format with BMP team members and mill stakeholders. Key issues that should be addressed at this point, among many others, include identifying the philosophy for spill collection that is currently in used (to provide a basis for the Engineering Analysis), identifying specific process area boundaries for consideration within the scope of the EA, and working through site-specific definitions for all relevant terms in the regulation (e.g., spent pulping liquor, immediate process area, etc.).

Ideally, mill management should be present for the key issues analysis to provide direction to the program at its inception, as well as to improve their own awareness of the total scope, cost, and potential exposure of the regulation. The mill manager must ultimately sign the BMP Plan, so he should be aware of the regulatory requirements and the BMP team's approach for meeting them.

Any number of key issues should be reviewed at this meeting. The following is a list of representative key issues, which has been developed over the course of developing many BMPs. Further issues are discussed in the forthcoming textbook (*12*).

Process Area Boundary Definition–"Battery Limits"

The BMP regulation applies to "spent pulping liquor," soap, and turpentine. However, it is the mill's responsibility to identify specific equipment items to be considered within the Engineering Analysis. These equipment items become the battery limits for the Engineering Analysis and spill risk assessment.

The definition of "spent pulping liquor" can be quantified through a rough steady-state mass balance, using a "fingerprinting" program (*12*) to identify the relative contribution of each of the main spent liquor streams at the area boundaries for each of pulping/washing and evaporator/recovery. This data, combined with the Practicable Recovery Analysis, described below, provide the basis for defining the outer boundary of each process area for BMP.

For example, spent liquor may occasionally back-up in the digester and discharge out of the chip bin seals. This source of liquor discharge to sewer should, therefore, typically be considered within the battery limits for the Engineering Analysis.

Examples of other critical BMP definitions

Although the BMP regulation defines each regulatory term in a general sense, they must be defined precisely at each mill in order to complete the Engineering Analysis. The site-specific definitions need to be consistent with the facility's spill collection philosophy.

Defining a "spill event" or "intentional diversion" would ideally include a quantitative definition of the specific parameter, parameter value, and time for a given loss of liquor, e.g., the conductivity and flow in a defined pulp mill sump exceeds 2000 mS/cm and 200 gal/min respectively, for a period of 30 min. or more. The location of this measurement should inherently be linked to the definition of the "immediate process areas."

The impracticalities and cost of excessive measurement and alarms to rigorously establish spill event definitions in this way typically means this method of definition is not used. Operations personnel should be consulted in developing a practical method to identify liquor losses significant enough to warrant response and be defined as a "spill event." This ideally involves monitoring process parameters normally tracked by operators, e.g., tank overflows.

Note that defining a spill event is independent of whether or not the loss of this amount of liquor would cause an upset to the effluent treatment system. Also note that if a liquor loss is recovered back to the processing areas, it is not considered a spill event in terms of the regulation because it has not left what would be defined as the "immediate processing area."

Defining the "immediate process areas" for a particular mill requires a thorough review of each processing area and identifying the most practical point for measuring a liquor loss event. Normally, a mill would identify several points upstream from effluent treatment, where liquor loss events might be measured. These points form

> ***BMP Program Development Tip #3***
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> Involve representatives from relevant process areas as part of your in-house BMP team—both from the operations and supervisory sides of the operation—from the moment the BMP project is kicked off. Ask them for background data and reports related to the Plan development. Including their perspective throughout the process provides useful input and guidance and results in greater acceptance of the BMP program when implemented.

the boundaries for the corresponding "immediate process areas."

Turpentine and soap can be present at low concentrations in a number of process units, which may lead to confusion as to the definition of turpentine. By defining these compounds within the context of their processing area equipment and their relative purity, area operations personnel will be able to identify their obligations for BMP.

The term "isolation" is fundamentally linked to the design of a practical system operators can use to make sure turpentine and soap do not reach the sewer. Operational issues, such as draining rain water from isolation areas, will need to be incorporated into standard operating procedures for these areas to demonstrate compliance with this component of the regulation.

For example, in the case of soap, the BMP team will need to consider the implications of whether to include tall oil within the definition, as its inclusion leads to increased capital expenditure for process isolation. However, it can also lead to increased assurance of meeting due diligence were a tall oil spill to occur.

Practicable Recovery Level (PRL) Analysis

The BMP regulation specifies that mills should identify the level at which it is practicable to recover a loss of spent liquor. For a given level to be defensible, it should be based on a quantitative analysis that reflects the process equipment in place and the spill control philosophy. Generally speaking, the determination should include the following considerations:

1. The "economic break-even point" analysis for spent liquor recovery (the point below which it is no longer economic to recover spent pulping liquor)
2. The storage and through-put capacity of the evaporator and recovery equipment in place at the mill
3. An "effluent treatment stress point" analysis (the liquor discharge quantity at which the effluent treatment system begins to display characteristics that could lead to exceeding an end-of-pipe permit).

For example, a mill may be able to economically recover losses down to 1% black liquor solids (BLS), but an analysis of the existing recovery boiler capacity may indicate that only spills above 2% BLS should be collected or production would have to be curtailed. Therefore, the mill may be justified in implementing a PRL higher than the 1% BLS.

Capital and operating cost considerations, and capital appropriation process

There are typically certain BMP projects required for compliance with the regulation, and others implemented for due diligence. The former are "the cost of doing business," while the latter can be opportunities for a return on investment.

Various operating cost benefits can be gained through a well-conceived BMP program. Some low-cost BMP projects may rely only on operating judgment (ideally reflected in SOPs, etc.), and others may require new capital equipment be implemented for spill control. Payback and other expectations specific to the BMP program should be established at the program development outset for due diligence projects.

Generally speaking, capital spending associated with BMP compliance is relatively small and expended over several years. Mill management could define an appropriate capital approval process that does not hold up completion of the BMP Plan, and at the same time guarantees that projects specified in the Plan are executed in a duly diligent manner.

For example, once the BMP project review process is defined, a mill may identify during the key issues analysis session that if the total projects cost is under US$ 1 million over 3 years, then a formal approval process will not be necessary until the normal budget planning process. Above this amount would require an immediate capital review process before the BMP Plan is completed.

The final four steps in preparing a BMP Plan will be discussed in the second article in this series. TJ

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BMP Program Development Tip #4

Prior to initiating the Engineering Analysis, hold a one- or two-day "Key Issues Analysis" workshop for the BMP team and mill management. Organize discussion topics to include a list of key issues (*12*), as well as other site-specific issues your team has identified. Final conclusions do not necessarily need to be identified in the workshop; however, afterwards the team members will be more aware of the cost and operational implications that are critical as the issues are resolved.

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