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MSHA Advance Notice of Proposed Rulemaking: Comments to Key Issues

General Questions:

1. *MSHA is seeking information concerning dam safety practices at metal and nonmetal mines. What measures do mine operators currently take to design, construct, operate, and maintain safe and effective dams? For mine operators with dams, please provide your experiences.*

- All dams are designed by a Professional Engineer (P.E.) with expertise in dam design.
- Design reported containing pertinent dam design information are prepared and submitted to state dam safety officials, where required.
- Design is based on hydrologic(Probable Maximum Precipitation(PMP), 100-yr storm, etc.) and geotechnical data for the specific area, in combination with the Hazard Potential Classification(HPC).
- Anticipated operation of the dam is part of the design. Any changes in operations are reviewed by a P.E. competent in dam design to verify adherence to dam parameters and to identify any changes required.
- Instrumentation placement and monitoring of the dam is outlined in initial design. Data collected is reviewed by a P.E. on a regular basis to review performance of the dam.
- Our dams are fully inspected on a regular basis, based on their HPC, by staff engineers. Inspection reports are approved by a P.E. and submitted to the State dam safety officials, where required.
- Miners working in the area of dams have basic knowledge of hazardous conditions and warning signs.
- Emergency action plans are developed for High HPC dams along with emergency call out sheets which are located at the mine control and dispatch centers.
- We staff engineers to directly manage construction and operation of our dams at each of our mining operations. Additional engineers are also staffed to provide long term planning for dam operation and maintenance, working with the design P.E.
- Strict quality control and assurance is provided on all dam construction materials used.

What measures do mine operators currently take to safely abandon their dams? For mine operators with dams, please provide your experiences.

Engineering plans and specifications for dam abandonment must be prepared by a P.E. and submitted to the state for permit approval. Abandonment plans should include details on dewatering, new hydrology and drainage, vegetation, outlet works, spillways, etc with the basis of the plan to reduce the downstream hazards as much as is practical.

2. *MSHA is required to inspect every mine in its entirety, which includes dams of all sizes and hazard potential. A common approach for dam safety is to have tiered requirements based on a dam's size and hazard potential. How should MSHA determine safety requirements based on a dam's size and hazard potential? Please include specific recommendations and explain your reasoning.*

In Michigan, there are different required design criteria based on the HPC. For Low HPC, dams shall be capable of passing the 100-year flood or flood of record, whichever is greater. Significant HPC dams must be capable of passing the 200-year flood or flood of record, whichever is greater. High HPC dams below 40 feet in height shall be capable of passing the 200-year flood or flood of record, whichever is greater. High HPC dams 40 feet or greater in height shall be capable of passing the half probable maximum flood.

For containment ponds, such as tailings impoundments, dams should be able to hold, rather than pass, the required design flood.

Detailed inspections must be completed at intervals based on HPC and a report must be submitted to the state every 5 years for Low HPC, 4 years for Significant HPC, and 3 for High HPC dams.

Reference the MN Hazard rating guidelines

3. *What non-Federal authority regulates the safety of dams at metal and nonmetal mines in your state, territory, or local jurisdiction? Please discuss the specific requirements, including the principles they address. If possible, please provide information about relevant non-federal dam safety requirements through a hyperlink or other means.*

In Michigan, the Department of Natural Resources and Environment(DNRE), has a dam safety program which regulates dam permitting, construction, modification, abandonment and inspection frequency based on HPC. The program is outlined on the state's website at: www.mi.gov/damsafety

Minnesota also has a dam safety program and regulations. More information on this program can be found at the state DNR website:
www.dnr.state.mn.us/waters/surfacewater_section/damsafety

4. *What records should be kept of activities related to the safety of dams? Please be specific and include your rationale.*

- Original design documentation reports and drawings
- Company and name of design P.E. and Engineer of Record, current and historical
- Application for permits and current permit documentation
- Construction documentation reports and as-built drawings
- Photographic records
- Instrumentation monitoring data
- Dam safety inspection reports

Together, all of these items keep a history of the dam in review. Maintaining these records verifies the validity of the original design and operational adherence to the design parameters and regulatory standards. The instrumentation monitoring tracks performance of the dam along with the dam safety inspection reports. Documenting the original design engineer and changes to the current reviewing P.E., or Engineer of Record, tracks any design or operational changes and makes sure the original design criteria are taken into account if a redesign is needed or preferred.

What records should be provided to miners if hazardous conditions are found?

In Michigan, copies of the Emergency Action Plans and call out sheets are kept in the mine/plant control room. By contacting the appropriate persons listed, the situation can be evaluated by a competent engineer and further action can then be determined. For non-emergency hazards, miners have general contact information for staff engineers who are on site daily or are available on short notice. The operators documentation listed above is available to miners, as it is submitted to state regulatory agencies and becomes public documents.

Design and Construction of Dams:

5. *How should mine operators assure that dams are safely and effectively designed? Please suggest requirements that MSHA should consider for safe design of dams. Please be specific and include your rationale.*

All dams should be designed by a P.E. competent in dam design. Geotechnical testing and evaluation, hydrological data per HPC, seepage and stability analysis, and pre-determined factors-of-safety should all be a part of the initial design and included in design documentation and reports.

6. *Please suggest requirements for review of dam designs by mine operators and MSHA and include your rationale for specific recommendations and alternatives.*

The HPC of each dam should be reviewed and compared to the design criteria. A review of the geotechnical and structural analysis to determine stability of the dam should be completed. MSHA inspectors should have a background in dam safety and

design standards, preferably having a degree in engineering with a focus on geotechnical and structures and holding a P.E. certification. Mine operators should also employ engineers with strong knowledge of dam design and operations and a minimum level of experience and education to oversee dams.

7. *With new standards, operators may need to evaluate and upgrade existing dams. Please elaborate on how the safety of existing dams should be addressed.*

All dams should be first evaluated to determine if the HPC has changed as this can change design crieria significantly. Any new construction must adhere to the new standards and previously existing structures should be re-evaluated. If an existing dam is no longer within standards, a remedial design must be developed and adopted. The time allowed to complete a remediation must reflect the amount of work involved and the current level of deficiency.

8. *MSHA's existing standards for dams at metal and nonmetal mines do not address whether a dam is constructed as designed. What measures are necessary to ensure that mine operators construct dams as designed?*

Mine operators should maintain design and construction documentation reports and drawings. Dam safety inspections should include the comparison of in field observations with the expected design and current documented construction. Instrumentation monitoring data can be reviewed to verify that a dam is being constructed and operated as designed.

9. *How should MSHA verify that dams have been constructed as designed? Please explain your rationale.*

MSHA should review the design of the dam prior to the site visit. During a site inspection, MSHA can then verify whether dam construction is consistent with the design. All documentation maintained by the mine operator, as stated in prior comments, should be available for MSHA to review. Again, MSHA inspectors should have education and experience related to dam safety, geotechnical design of dams, and structural engineering.

Operation and Maintenance of Dams:

10. *What should a mine operator do to operate and maintain a safe dam?*

Mine operators should employ experienced engineers who are designated the responsibility to operate dams and review instrumentation to verify that dam performance is within designed parameters. Any operational changes should be reviewed by the Engineer of Record.

How should MSHA verify that dams are safely operated and maintained? Please be specific.

MSHA can review original permits and permit modifications along with mine records including documentation reports of design, construction, and instrumentation monitoring, as defined by state regulations. During site visits, MSHA can verify that dams have been built according to the design and that current operations are within the permit and design parameters. Working with other regulation agencies that have reviewed the dams will help pass on knowledge of previously inspected dams.

11. *What measures should mine operators take to assure that dams are adequately inspected for unusual conditions and signs of instability?*

At the end of any inspection, any concerns or deficiencies should be fixed immediately. During routine inspections or other observations, any concerns (i.e. sloughs, rutting, washouts, etc.) should be brought to the attention of the staff engineer and then reviewed with the Engineer of Record.

12. *How often are routine inspections of dams conducted?*

Currently, we have observers at the dams on a weekly basis with no formal routine inspections being completed. Any concerns that are noted during regular observations are reviewed by staff engineers and monitored and repaired as required.

How often should they be conducted? Please be specific and include your rationale.

Formal routine inspections should be completed annually. This minimum requirement would maintain awareness of dam safety and allow for additional documentation within yearly construction or operation reports.

What determines the frequency? Please be specific and include your rationale.

The annual routine inspection would serve as a baseline. Additional inspections should be done after major events such as extreme weather, construction, changes in process, personnel, or instrumentation readings, etc. The additional inspections may be more focused on a specific area or section of dam based on the type of event.

Who conducts the routine inspections? Please be specific and include your rationale.

A staff engineer familiar with the site, design, and operation of the dam should conduct the routine inspections. Having the understanding of the design and current operations is vital to picking up on concerns or deficiencies during an inspection. Being familiar with the site makes planning and executing the inspection safer and more efficient and aids in identifying small or slow progressing changes in the dam.

13. *Instruments, such as weirs, provide information on the performance of a dam. How frequently should mine operators monitor dam instrumentation? Please provide your rationale.*

Instrumentation monitoring should occur a minimum of twice a year for records. The frequency should increase if data is outside the general trend, during some seasonal events, or during construction activities. Watching the instrumentation more closely will allow for a better understanding of any situation which may be developing.

14. *What information should be documented during routine dam inspections? Please provide your rationale.*

- Current dam height and elevation
- Elevation of water pond and stored solids
- Visual condition of outlet works and spillways
- Access to site
- Vegetation condition
- Presence of sloughs, ruts, washouts, seepage, etc.
- Review of recent instrumentation monitoring data
- How inspection was made (i.e. walking, driving)

These items provide the basic information to verify dam performance. More comprehensive observations would be made during a detailed dam safety inspection.

15. *Does a competent engineer inspect your mine's dam? If so, at what frequency? Please explain the rationale for these inspections and what is evaluated.*

Yes. In Michigan, our Engineer of Record conducts detailed inspections at intervals based on the HPC, every 5 years for low hazard, 4 years for significant hazard, and 3 years for high hazard dams. In Michigan, this is part of the state dam safety inspection program, which includes a report submitted to the state that must be approved by a P.E. registered with the state. During these inspections, comprehensive observations are made with the intent of finding possible failure modes and identifying any current deficiencies.

In Minnesota, annual detailed inspections are completed by a P.E., generally the Engineer of Record.

16. *How often should detailed inspections be conducted? Please include your rationale.*

Detailed dam inspections should be completed at an interval determined by their HPC. This ensures that higher hazard dams are inspected in detail on a regular basis. Routine inspections and observations performed in off years can follow-up on areas of concern and any repairs that were completed.

17. *What information and findings should be documented during detailed dam inspections? Please be specific and include your rationale.*

Detailed dam inspections and reports should include an evaluation of the dam's condition, spillway capacity, operational adequacy, and structural integrity and a determination of whether deficiencies exist that could lead to the failure of the dam including recommendations for maintenance, repair, or alterations to eliminate deficiencies. Basic report information should include:

- Dam name and I.D. number(if assigned one)
- State, County, and stream or watershed where dam is located
- Name, address, and telephone number of owners and operators
- Hazard Potential Classification
- Name of dam inspectors
- Date(s) of inspection
- Name, address, registration number, and signature of licensed P.E. who prepared the report
- Description of the dam, outlet, spillway and other principal features
- Purpose of dam(i.e. reservoir, tailings basin)
- Summary of available design, geotechnical, maintenance, construction, repair, alterations, and operating history
- Field inspection summary describing the observed physical condition of principal dam features and appurtenant structures including the impoundment level
- Structural stability review and summary including current available data, inspection operations, and results of calculations
- A hydrologic and hydraulic review and summary that includes spillway capacity, hydrological design data, drainage area, floods of record, and previous evaluations
- An assessment of operating equipment and procedures
- Evaluation of the current maintenance plan
- Conclusions and recommendations including
    - An evaluation of the dam's overall condition, field inspection findings, and analysis within the report
    - Identification of any deficiencies, that if let uncorrected, could lead to the failure of the dam
    - Prioritization of deficiency corrections, maintenance, and operation items
    - Recommendations for further studies or investigations including the assessment of the current HPC
- A map of the dam and its location
- Engineering plans of the dam and its principal parts including a plan view and cross sectional views of pertinent features
- Photographs of the dam, downstream channel, and deficiencies noted in the report
- Calculations or computer data referenced within the report

18. *How should MSHA verify that mine operators conduct routine and detailed inspections? Please explain how your suggestion would work.*

MSHA could coordinate with states that have a dam safety inspection program in place for review of detailed inspection reports. For mines in states without dam safety programs and for routine inspections, all reports compiled by mine operators would be available to MSHA inspectors during a site visit or upon request.

Qualifications of Personnel:

19. *What qualifications do mine operators currently require of persons who design dams?*

A design engineer must be a P.E. registered in the state of the dam location. They must have a strong education, preferably a M.S. degree, in civil, geotechnical, and/or structural engineering and a minimum of 10-15 years of experience related to dam design.

...inspect dams?

An inspection team should be comprised of competent engineers, preferable a P.E., and experienced inspectors with technical training, such as an Associates degree in a related, technical field. For detailed inspections, the design P.E. or Engineer of Record should participate in the inspection.

...operate and manage dams?

A competent engineer, familiar with the original design and operation of the dam, should be the manager. This includes overseeing construction, operations, and being involved with both routine and detailed dam safety inspections.

In what capacities are engineers used? Please be specific in your response.

Engineers are involved in some degree with all aspects of dam design, construction, planning, operation, inspection, maintenance, reclamation and abandonment.

20. *The Guidelines recommend that dams be designed by competent engineers. What specific qualifications or credentials should persons who design dams possess? Please include your rationale.*

Dam designers should have 10-15 years of experience in dam design, be a P.E. registered in the state of the dam location, have some post graduate degree in a field such as geotechnical, structural, or hydrology, must understand the dam operations, and the intended life of the dam structure. The design P.E. must stay up-to-date with the project and act as Engineer of Record. If a change in engineers occurs, the original designer must provide all information and design parameters to the new Engineer of Record to establish a consistency in documentation and design and provide a smooth transition.

21. *The Guidelines recommend that a dam be constructed under the general supervision of a competent engineer knowledgeable about dam construction. What specific qualifications or credentials should a person have who verifies that a dam is being constructed as designed. Please provide your rationale.*

A construction supervisor should be a P.E. with 5-10 years experience in dam construction or other heavy civil projects. They must be able to interpret design documents and drawings and determine if construction is per design. This includes a understanding of materials, equipment, and techniques used in dam construction.

22. *What training should personnel receive who perform frequent, routine inspections and who monitor instrumentation at dams? In your response, please suggest course content and the frequency of training, including the rationale for your recommendations.*

These personnel should have a high technical expertise in order to understand the design parameters of the dam and know how to properly read, interpret and discuss instrumentation monitoring data. To maintain technical knowledge, annual training programs should be attended that relate to monitoring and dam safety. Some examples of training would be programs developed by FEMA, ASDSO(Association of State Dam Safety Officials), state highway/transportation departments, etc.

23. *What qualifications or credentials should be required of persons who perform detailed inspections to evaluate the safety of a dam? Please be specific and include you rationale.*

Detailed inspections should be overseen and reviewed by the Engineer of Record. An inspection team should be comprised of competent engineers, preferable with a P.E., and experienced inspectors with technical training, such as an Associates degree in a related, technical field along with the Engineer of Record. The inspection team should be people who are all familiar with the particular dam in review. Depending on the size of the dam, it is unrealistic for one person to inspect the whole area. Also, having a variety of people participate can bring up items that may have been previously overlooked. The inspection itself is also good experience and a review for those working with the dam in management, operations, quality control, and construction supervision.

<u>Abandonment of Dams:</u>

24. *Some regulatory authorities require that dam owners obtain approval of a plan to cap, breach, or otherwise safely abandon dams. What actions should mine operators take to safely abandon dams? Please include specific suggestions and rationale.*

Permitting for dam abandonment and all plans should be prepared by a licensed P.E. within the state. The main goal of dam abandonment are to reduce the hazard to the downstream area as much as is practical. This can include reducing the pool elevation to the lowest practical level, reclamation or revegetating of the impoundment and dam area, and taking into account natural resources and public safety.

25. *How can MSHA verify that a mine operator has safely abandoned a dam?*

MSHA can review state and local regulatory permits for the design or plan for dam abandonment. For states with an established dam safety program that includes abandonment, MSHA could coordinate efforts, similar to with inspections. During site visits, MSHA can verify that abandonment is continuing as planned and that proper reclamation activities are ongoing or completed.

Economic Impact:

26. *What are the costs of designing a new dam? Please provide details such as hours, rates of pay, job titles, and any contractual services necessary.*

The costs of design varies greatly. The size of the impoundment and location are some of the main determinations of cost. Other variables can include topography, geology, available local borrow, subsoil, and type of impoundment(fresh water, process water, tailings, etc.). Some example 'order of magnitude' rates are:

- Design engineer $200+/hr
- Geotechnical engineer $200+/hr
- Hydrologist $200+/hr
- Wetland specialist $200+/hr
- Lawyers $250+/hr
- Surveyor crew $250+/hr
- Geotechnical drilling crew $200+/hr
- AutoCAD designer $90+/hr

How often is the design of an existing dam changed?

The original design of a dam should extend into planned expansions. A redesign would be necessary when expansions are built at a different rate than originally planned. Also, if the HPC of the dam were to change, a redesign may be necessary to bring the dam into the proper safety design and operating parameters. This can include additional freeboard or spillway capacity to hold or pass a greater precipitation event. In the event that deficiencies are found during an inspection, a redesign may be required to correct the issue.

What are the costs of a redesign?

The cost of a redesign can be more or less than the original design. The rates would be the same, but the overall cost would depend on the scale and degree to which the original design must be altered.

27. *What are the costs of constructing a dam? Please provides details based on: Size of dam; labor costs, including hours, rates of pay, job titles; costs of equipment and materials; and any contractual services necessary.*

Same with design, the cost of constructing a dam can vary greatly and can be drawn out over the life of the mine. Some basic parameters would include, height, length of dam, design parameters, subsoil, material required, and local available borrow sources. Some costs/rates that could be involved are:

- Design engineer $200+/hr
- Principal engineer $150+/hr
- Staff engineer $125+/hr
- AutoCAD designer $90+/hr
- Surveyor crew $250+/hr
- Senior technician $100+/hr

28. *Please describe the oversight you provide during dam construction to assure it complies with the design plan.*

A project engineer is assigned to the overall dam project and works with the Engineer of Record in the review and preparation of contract documents and drawings. During construction, materials testing, instrumentation monitoring, and general quality control is done to ensure the project is constructed per design and contract documents. Many states require a letter from a P.E. be submitted to the state to verify that construction has been completed and has been built to the standards defined in the design and permit.

How much does it cost per year per dam for oversight and quality control?

The yearly cost is based on how much construction is scheduled and the current operating plan. Hourly rates would be similar to those listed previously for dam construction.

What special knowledge, qualifications, or credentials do you require of those who provide oversight?

Quality control technicians must have a strong educational background in materials testing and field construction experience. The project engineer should be a competent engineer, preferably with a P.E., and 5-10 years experience in dam or other heavy civil construction.

29. *How often do you add height to an existing dam or modify it in some other way?*

Several of our tailings basins utilize upstream dike construction, where additional height is added to the dam as required by current mine tailings production. This staged construction is within the original design of the dam and dike system and is planned to a maximum operating elevation, which was aligned with the projected life of mine during design. This construction is ongoing and occurs annually or as required and is laid out within the design.

Dams may also be modified as required if a deficiency is found during a dam safety inspection or if original design parameters become out of code or regulation.

Who supervises the design and construction of these modifications, for example, a professional engineer, competent engineer, contractor, etc.? Please be specific and provide rationale for your answer.

The design, construction, and supervision of any dam modifications are performed in the same manner as original design and construction. Please see comments to Question 21 for personnel requirements.

How much does it cost? Please provides details such as labor costs, including hours, rates of pay, job titles and costs of equipment and materials and any contractual services necessary.

Depending on the scale of the redesign and modifications required, costs can be similar to that of the original design and construction. See the comments to Question 27 for some basic rates.

30. *How much does it cost per year per dam for routine inspections?*

Annual inspection costs for small dams, less than 20 feet in height, can range from $3,000 to $5,000. Annual inspection costs for large dams can range from $20,000 to $50,000.

If you incur separate costs for monitoring instrumentation, how much is that cost?

Annual monitoring costs for small dams can range from $5,000 to $10,000. Annual monitoring costs for large dams can range from $30,000 to $50,000.

How often do you have a detailed inspection conducted?

Detailed inspections intervals are based on the HPC of each dam.

How much does it cost per year for these inspections?

Detailed inspection costs for small dams, less than 20 feet in height, can range from $20,000 to $40,000. Detailed inspection costs for large dams can range from $60,000 to $100,000.

31. *Does state or local jurisdiction in which you operate require you to use a professional engineer?*

Yes, both Michigan and Minnesota require the use of a P.E. during design, construction, and inspections of dams, at least of a certain size.

If so, when is a professional engineer specifically required? (if you have dams in more than one state please identify which states require a professional engineer and which do not)

In Minnesota, a dam over 6 feet in height and 15 acre-feet of storage which has a potential for loss of life and any dam over 25 feet in height or 50 acre-feet of impoundment storage requires a permit for construction. To receive a permit a P.E., registered with the state, who has experience in dam engineering, must be engaged by the applicant to prepare the design, plans, and specifications, inspect the construction, and establish operation and maintenance procedures for the structure.

In Michigan, a licensed P.E. must prepare the engineering plans and specifications for the construction of new dams, reconstruction of failed dams, or the enlargement of existing dams and be in charge of and approve all inspection reports submitted to the state for all non-minor projects.

32. *What are the costs associated with training personnel who conduct frequent, routine inspections and monitor instrumentation at dams?*

Personnel attend professional conferences and seminars to obtain up-to-date information on managements of dams. These meetings are organized by professional organizations such as American Society of Civil Engineers(ASCE) and American Concrete Institute(ACI) and government agencies such as FEMA, ASDSO, etc. Annual cost per employee can range from $6,000 to $10,000.

33. *What costs are involved in capping, breaching, or otherwise properly abandoning a dam? Please provide details of you experience and what was involved when you properly abandoned a dam. Describe any impact of a properly abandoned dam.*

A complete abandonment plan must be established. This requires a complete review of the hydrology, topography, draining of pool water if possible, and vegetation of the impoundment area. This is a very comprehensive plan which requires surveys, data collection, and design. Depending on the size of the dam impoundment this cost could range from $100,000 to $1 million dollars.

34. *What are the costs to a mine operator if a dam fails? Please characterize other impacts such as loss of life, environmental damage, etc.*

The cost to a mine owner or operator if a dam fails can vary greatly. A small freshwater reservoir with a low HPC may have minimal impact after a failure while a larger process water and tailings impoundment failure could have much longer lasting and further reaching impacts. Any dam failure would be costly to a mine as it is likely to affect the ability to operate. In addition to this basic cost, the potential loss of life, environmental impact, and property damage could add up to millions of dollars. A dam failure could very well shut down a mine.

35. *Do you have insurance against a dam failure? If so, please specify cost and coverage.*

    Does the insurance carrier require the use of a professional engineer for specific dam activities?

    If a professional engineer is not required, does the insurance carrier give a discount if one is used?

    Does your insurance company have any other requirements related to dam safety?

36. *What quantifiable and non-quantifiable costs and benefits for the downstream community are involved when a dam is properly designed and constructed?*

    In addition, MSHA welcomes comments on other relevant indirect costs and benefits.