

An assessment of NRM-20 as a guideline and as an enforcement tool to mine closure in Brazil

Avaliação da NRM-20 como diretriz e como instrumento de implemento do fechamento da mina no Brasil

<http://dx.doi.org/10.1590/0370-44672014670170>

Hernani Mota de Lima

Prof. Associado da Universidade Federal de Ouro Preto - Escola de Minas, Departamento de Engenharia de Minas Ouro Preto - Minas Gerais - Brazil
hernani.lima@ufop.br

José Cruz do Carmo Flores

Prof. Adjunto da Universidade Federal de Ouro Preto - Escola de Minas - Departamento de Engenharia de Minas
jcruzflores@demin.ufop.br

Jardel Carvalho Dias

MSc. em Engenharia Mineral pela Universidade Federal de Ouro Preto. Departamento Mineral de Produção Mineral (DNPM/Brasília)
Brasília - Distrito Federal - Brazil
jardelcdias@yahoo.com.br

Abstract

This paper assesses the effectiveness of the NRM-20 as a guideline and an enforcement tool to mine closure in Brazil; assesses the analysis criteria and approval procedures adopted by DNPM to base their decisions on mine closure issues, and looks for gaps in the NRM-20 regarding technical, legal, environmental and socio-economic issues. The study was based on administrative mining proceedings deposited DNPM of Minas Gerais. Were assessed 32 mining proceedings. The study shows clear evidence that DNPM does not have specific criteria to guide the technical analysis of the closure plans required for, which makes the analysis subject to a personal interpretation. This study supports the conclusion that after twelve years of its publication, the NRM-20 lacks in proper regulating and guiding mine closure in Brazil.

Keywords: mine closure; NRM-20; DNPM.

Resumo

Esse artigo avalia a eficácia da NRM-20 como uma diretriz e um instrumento de execução do fechamento de mina no Brasil. Avalia os critérios de análise e procedimentos de aprovação adotados pelo DNPM, para basear suas decisões sobre questões de fechamento de minas, e procura por falhas na NRM-20, em relação a questões técnicas, legais, ambientais e socioeconômicas. O estudo baseou-se em processos administrativos de mineração depositados no DNPM de Minas Gerais. Foram analisados 32 processos de mineração. O estudo mostra que o DNPM não tem critérios específicos para orientar a análise técnica dos planos de fechamento, o que torna o tema de análise uma interpretação pessoal. Esse estudo permite concluir que, após doze anos de sua publicação, a NRM-20 carece de protocolos de análises e de diretrizes que orientem o fechamento de minas no Brasil.

Palavras-chave: fechamento de mina; NRM-20; DNPM.

1. Introduction

Mine closure characterizes the permanent cessation of operations by a company at a mine site after ore reserve depletion and encompasses the completion of the decommissioning and rehabilitation process. However, mine closure is also temporarily considered

with the suspension of mining operations at an indefinite time in function of economic and environmental problems, among other reasons (RESENDE e LIMA, 2009; SÁNCHEZ, 2011).

Mine closure is seen as an inevitable and problematic consequence of

the nature of the mining industry. The public image of mining is still one of abandoned mine sites and lasting environmental liabilities. In addition to this legacy, mine closure has caused social and economic disruption in mining regions. Responsible planning for mine

closure and rehabilitation of mine sites are major on-going issues for the mining industry around the world. Many countries have developed regulatory systems and guidelines which now require mining companies to deal with the challenge of controlling environmental and legal liabilities associated with closure (AUSTRALIA, 2011; SÁNCHEZ *et al.*, 2013).

In Brazil, before 2001, the basic obligation imposed on the mining concession holder, related to mine closure, was to rehabilitate the mined area according to Plan for Rehabilitation of Degraded Areas (PRAD) approved by the competent environmental agency. Generally, statutory requirements are generic and narrow. Those required for a PRAD state: “the PRAD must consider the suitable technical solution visualized by the mining company to rehabilitate

the area, eventually degraded by mining activity, for future use” (LIMA *et al.*, 2006). However, the scope of issues that is being considered in mine closure has expanded beyond the more traditional view of site rehabilitation. A comprehensive programme for mine closure would address the following six major areas of mining impacts: on physical resources, on biological and ecological resources, on alternate use values, on quality of life, on social and cultural values, and on sustainable economic development.

The Brazilian Mining Code defines mining as the set of operations required for mining a mineral deposit. In order to obtain a Mining Permit, such operations should be presented in an Economic Exploitation Plan (PAE, Portuguese Acronym), which should demonstrate the technical and economic feasibility of mining a deposit. In the year 2001, the

DNPM's Director enacted the Mining Regulation Norms (NRM), which are called NRM-20, and deal with mining suspension and closure (FLORES e LIMA, 2007). Since 2002, the inclusion of a mine closure plan in the PAE has been a requirement, as the NRM-20.

The lack of government guidelines for the evaluation of PAE focused on a mine closure plan has been studied by (RESENDE *et al.*, 2010).

The main purposes of this paper are: to present an assessment on the effectiveness of the NRM-20 as a guideline and a enforcement tool for mine closure in Brazil; to evaluate the analysis criteria and approval procedures adopted by DNPM to base their decisions on mine closure issues; and to look for gaps in the NRM-20 regarding technical, legal, environmental and socio-economic issues.

2. Methodology

In order to assess the compliance of the mine closure plans presented by mining companies to DNPM when

applying for mining rights and the procedures adopted by DNPM to base their decisions on mine closure issues, a

checklist was prepared based on NRM-20. The methodology used for this study comprised of creating a checklist based

Municipality	Total (100%)*	Total (65%)
NOVA LIMA	119,419,514.10	77,622,684.17
ITABIRA	118,150,100.79	76,797,565.51
MARIANA	98,812,313.42	64,228,003.72
SÃO GONÇALO DO RIO ABAIXO	90,828,126.72	59,038,282.37
ITABIRITO	59,489,357.32	38,668,082.26
BRUMADINHO	53,806,448.15	34,974,191.30
CONGONHAS	52,644,913.57	34,219,193.82
ITATIAIUÇU	24,690,096.78	16,048,562.91
OURO PRETO	22,238,936.23	14,455,308.55
BARÃO DE COCAIS	22,144,903.11	14,394,187.02
SANTA BÁRBARA	13,929,007.24	9,053,854.71
SABARÁ	8,768,162.93	5,699,305.90
CATAS ALTAS	8,655,719.30	5,626,217.55
SARZEDO	5,117,672.42	3,326,487.07
MATEUS LEME	4,563,053.86	2,965,985.01
ITAÚNA	3,178,799.79	2,066,219.86
SÃO JOAQUIM DE BICAS	3,152,046.59	2,048,830.28
IGARAPÉ	2,099,018.93	1,364,362.30
BELO VALE	746,409.06	485,165.89
CONSELHEIRO LAFAIETE	619,330.37	402,564.74
BETIM	418,401.64	271,961.07
IBIRITÉ	418,353.46	271,929.75
CAETÉ	374,934.91	243,707.69
RIO ACIMA	334,633.65	217,511.87
SANTA LUZIA	241,879.15	157,221.45
BELO HORIZONTE	181,818.70	118,182.16
ESMERALDAS	99,086.80	64,406.42
MÁRIO CAMPOS	40,323.95	26,210.57
RIO MANSO	705.57	458.62
TOTAL:	715,164,068.51	464,856,644.53

Table 1
Ranking of the most important mining municipalities located in the Quadrilátero Ferrífero based on the mining royalties (CFEM) of 2011.

on NRM-20 requirements and compare these with the information presented in the selected mine closure plans. This assessment considered technical, legal, environmental, social and economics issues regarding mine closure.

The study was conducted on administrative mining proceedings deposited in the 3rd District of National Department of Mineral Production (DNPM)

located in the Minas Gerais State. To select the mine closure plans for this study, a ranking of the most important mining municipalities located in the *Quadrilátero Ferrífero* based on the mining royalties (CFEM) of 2011 was created (Table 1) and then the municipalities that had revenues over R\$10 million in this year were selected. In these municipalities, the mines with the greatest contri-

bution to mining royalties and whose mining rights were granted after the enactment of Mining Regulation Norms (NRM) in 2001 were chosen. The time span adopted for this assessment was from 2001 to 2011. A qualitative and quantitative data analysis was conducted for the 32 selected mining proceedings, which consisted of 25 open pit mines and 07 underground mines (Table 2).

Mining Proceedings	Proceedings' Status (July 2012)	Annual Production (t)	Expected Mine Life (years)	Expected year for Closure
1	Requirement for temporary closure waiting for DNPM decision	600.000	Not Available	MCP not submitted
2	Operation	3,720	23	MCP not submitted
3	Operation	235,000	20	MCP not submitted
4	Operation	2.3 x 106	34	MCP not submitted
5	Operation	26 x 106	24	2027
6	Operation	5 x 106	Not Available	MCP not submitted
7	Operation	3.5 x 106	64	2034
8	Operation	2.5 x 106	30	MCP not submitted
9	Operation	8 x 106	18	2021
10	Operation	50 x 106	Not Available	2022
11	Operation	24 x 106	41	2059
12	Operation	66 x 106	10	2024
13	Operation	9.6 x 106	Not Available	Not Available
14	Requirement of Mining Group* waiting for DNPM decision	2 x 106	10	Still not in operation
15	Requirement of Mining Group* waiting for DNPM decision	23 x 106	Not Available	Still not in operation
16	Operation	54,000 m ³	Not Available	MCP not submitted
17	Requirement of Mining Group* waiting for DNPM decision	2 x 106	7	MCP not available and still not in operation
18	Requirement of Mining Group* waiting for DNPM decision	37.5 x 106	Not Available	Still not in operation
19	Requirement of Mining Group* waiting for DNPM decision	10.6 x 106	19	Still not in operation
20	Requirement of Mining Group* waiting for DNPM decision	588,000	8	MCP not submitted
21	Operation	37.5 x 106	Not Available	2023
22	Operation	25 x 106	36	2029
23	Operation	500,000	18	2030
24	Closure phase	15 x 106	29	2002
25	Requirement for temporary closure waiting for DNPM decision	450,000	Not Available	MCP not submitted
26	Operation	36 x 106	30	Not Available
27	Operation	6.3 x 106	Not Available	MCP not submitted
28	Requirement for temporary closure waiting for DNPM decision	50,487	Not Available	MCP not submitted
29	Operation	1.2 x 106	Not Available	Not Available
30	Operation	300,000	Not Available	MCP not submitted
31	Operation	468,000	8	2017
32	Requirement for temporary closure granted by DNPM	-	Not Available	Not Available

Table 2
Mining Proceedings' Status
in terms of the Mine Closure Plan

MCP = Mine Closure Plan

For this study, 32 mining proceedings from the Mining Register of DNPM/MG were selected and analysed. Of these proceedings, only 19 filed the closure plan

3. Results and discussions

The general characteristics of the presented mine closure plans were assessed by applying a checklist composed

Closure Plan Update

The NRM-20 states that the closure plans should be updated periodically, as appropriate, and be available for inspection at the mine sites. However, the standard does not set the deadline

Does the plan include the socioeconomic impacts of mine closure?

Only 5 plans presented an estimate of mine closure costs.

They can be categorised as: Mining Proceeding number 5 (R\$ 68 M),

Does the plan include the socioeconomic impacts of mine closure?

The NRM - 20 does not require studies of the socioeconomic impacts of mine closure. However, 5 of the assessed processes mentioned economic and social goals they hope to achieve at the end of the mine closure process. The remaining mining proceedings showed no consideration under the socioeconomic aspects of mine closure.

For the approved mine closure processes, has DNPM conducted on-site visits to check and monitor the implementation of the closure plan?

From the 19 mining proceedings that contain a mine closure plan according to NRM-20, 11 had the closure plan assessed by DNPM. However, in only one area (number 24) has DNPM conducted an analysis for verification of the compliance of the submitted closure plan. It also found occurrence of a DNPM survey at number 32. Nevertheless, the objective was to conduct a preliminary inspection for the issuance of temporary suspension of their mining activities. However, the closure plan for this Mining Proceeding (number 32) had not yet been approved. The lack of enforcement denotes the lack of DNPM infrastructure to fulfil its responsibility as the agency responsible

Report on mine closure activities performed (point a)

Two mining proceedings whose mines are already in the closure stage presented reports of the

as required by DNPM NRM-20. Table 2 summarizes the status of the proceedings/mines at the time of this study regarding: the mine production, the expected life as

of items such as cost estimates, updating the plan and socio-economic impacts of mine closure among others require-

for the review and the level of detail of these plans.

The update details of the plans and mine closure are at the discretion of the entrepreneur only. According to

number 7 (R\$ 8 M for the last year of life of the mine), number 15 (US\$ 78 M), number 21 (R\$ 21 M) and number 24 (R\$ 42 M).

for mining control in the country.

As for the answers to the questions: Is the preparation of the final design for the closure of the mine expected? And what is the expected time for the monitoring and maintenance work in the post-closure? The checklist allowed identifying gaps in NRM-20, which should be addressed in a future revision of the regulatory norm regarding mine closure that emanates from the Federal Government Agency.

a. The NRM-20 does not distinguish between the conceptual closure plan – to be presented at the time of application for mining – and the final closure plan to be submitted to DNPM near the end of the mine life.

b. The NRM-20 does not establish when the final design for mine closure should be presented.

c. The NRM-20 does not establish a minimum time period for post-closure monitoring and maintenance activities nor does it present basic guidelines for such a procedure.

d. According to NRM-20, "every mine that does not have a mine closure plan contemplated in its PAE, at the discretion of DNPM Director is required to

activities performed.

If the mine closure should be understood as an integral phase of the

informed in the PAE, and the expected year of closure. Because of confidentiality, the names of mining companies, location and name of the mines were omitted.

ments of the NRM-20.

The following results were achieved:

the assessment, only 7 of the 19 closure plans filed demonstrate an update schedule planning. Fourteen of the plans mentioned an update, without, however, presenting a schedule of periodicity.

None of the mine closure plans, as listed in the mining proceedings, include the closure costs in the cash flow of the project.

submit the plan ... ", together with a statement to DNPM advising the beginning of the mine decommissioning. As shown, NRM-20 places that requirement very generally. As a result, mining companies may be induced not to consider the mine closure planning in the medium and long term mine planning, which may lead to damaging results – not only for the environment, but also for society and the sustainability of the mining industry.

Given the conceptual nature of the plans submitted, the analysis of processes allowed to observe that companies holding mineral rights on several mines have adopted the same plan for over a mine, even though they are located in different sites, diverse ecosystems and distinct socioeconomic specificities. This fact was observed in the mining proceedings (5 and 21); (9, 11 and 13); and (23 and 29). Under the NRM-20 items that must be included in a mine closure plan are listed in Section 20.4.1, from point "a" to "o". Following is presented a comparative summary of the 11 mine closure plans reviewed and approved by DNPM according to NRM-20 for the points considered by the authors as the most relevant to mine closure.

mine life information about closure activities, it should be part of routine reporting for the mine.

Decommissioning plan and destination given/disposal of wastes (point c)

From the 19 mine closure plans filed in DNPM, only 6 deal with the decommissioning plan of facilities and equipment.

From the 11 cases effectively analysed

and approved by DNPM, 9 showed no such plan.

General map of the mine showing the reclaimed and to be reclaimed areas, disposal sites for organic soil, waste dumps, tailings dams, roads and other mine components (point e)

The majority of submitted plans met this “point e”. This fact is justified since this is a requirement of the Environmental Impact Control Plan. Also observed is a high rate of compliance for questions involving aspects of

environmental control in mining, such as monitoring programmes relating to drainage waters (point f, IV), plan to control the pollution of soil, air and water resources (point g), and control of effluent discharge (point h), among

others. This high rate of compliance reflects the level of demand and the actual practice of surveillance carried out by the environmental agency as well as the best available practices adopted by mining companies.

Measures to prevent access to the mine site of unauthorized people and barriers to restrict access to hazardous areas (point i)

Among the 11 plans reviewed and approved by DNPM, only 2 met

this requirement.

This draws attention to the low

preoccupation with security issues in the stage of mine closure.

Aptitude and intention of future use of the mine site (point l)

Among the 19 cases that presented the Mine Closure Plan, 9 have proposals

for the post-closure use of the mined area. From the 11 cases reviewed and approved

by DNPM only four have submitted proposals for future use.

Physical and financial schedule of proposed mine closure programmes (point o).

Among the 19 cases filed in DNPM, only 3 presented the physical and financial schedule of the mine closure plan, being part of the 11 that were reviewed and not yet approved. Even considering the difficulties of estimating and scheduling at the conceptual phase of a closure plan, a mine closure plan is required to demonstrate that it is technically and economic feasible (LIMA e WATHERN, 1999; AUSTRALIA, 2011).

states that the Mine Closure Plan just having been successfully submitted. However, they do not make a detailed analysis of the content of these plans.

2. In the mining proceedings 7, 9, 23 and 29, the technical analysis makes no reference to the Mine Closure Plan but recommends the approval of the Plan of Economic Exploitation – which implies the tacit approval of the mine closure plan in PAE.

4. In the mining proceeding number 11, a detailed technical analysis of the mine closure plan concerning the remaining ore reserve and the use of the pit for tailings disposal was made. However, an updated PAE was presented but not yet analysed.

5. In the mining proceeding 24, a detailed technical analysis of the Mine Closure Plan was made, and the technical manager suggested the formulation of a demand to the company to improve the statement of the case. Such a requirement, however, was not published for information of the company and the process was not running at the time of this study.

Some aspects observed by this study of the technical criteria adopted by DNPM for assessing the 11 mine closure plans filed are highlighted:

1. In the mining proceedings of numbers 5 and 21, the technical analysis

3. In the numbers 10, 12 and 26, the technical analysis states only parts of the text of the closure plan and lists the process pages dealing with closure. However, there are no opinions about the quality of the plans submitted.

4. Final considerations and recommendations

The Regulatory Standard Mining (NRM-20) has the merit of being a pioneer in the government's decision to regulate the mine closure at the Federal level. In addition, that decision is in line with the emerging trend in the major mining countries all over the world. According to NRM-20, a mining company should communicate to the Ministry of Mines and Energy when a mine is about to enter the closure process, justifying the reasons of closure and presenting a closure plan. Additionally, for new mines, a closure plan must be contemplated in the plan for economic exploitation (PAE) and must be presented along with the application for exploitation.

This study found that mining

companies are using plans drawn up for other mines to guide the development of plans for their mines. For the authors, the mining companies are looking for compliance with the obligation to submit their closure plan and since there is no technical support for the DNPM staff to assess the submitted mine closure plans, these flaws are not perceived and considered by DNPM.

The authors also observed that the assessment of the closure plans in DNPM is based on the discretionary nature of the technician in charge. This allows two interpretations. The first is that, to date, DNPM does not have a qualified and trained staff for assessment of mine closure plans submitted to it; to make

on-site inspection of the mines that are in the closure process, and after closure, to follow through with periodic reports and technical visits to closed sites, the evolution of the reclamation measures and the monitoring and maintenance steps. The second is the absence of guidelines and protocols to guide the technical staff of the agency in analysing the mine closure plans filed. Therefore, the first, or the second, or both interpretations make it difficult to substantiate statements like: “the closure plan has been prepared, submitted and approved successfully according to NRM-20”, or “the mine closure plan meets the basic requirements of the NRM-20”, or “the plan submitted to DNPM was not approved since it

does not meet the basic requirements set by DNPM”.

It was observed, in some cases, that the submission is enough to justify the continuity of a mine operation. Therefore, the NRM-20 is deficient and does not fully meet the current conception of what is understood as technically correct, environmentally safe, socially acceptable and

economically and financially manageable by mining companies, for the time of closure of a mine.

The authors recommend that for the mine closure to be technically feasible, environmentally satisfactory, meeting the principles of sustainable development, and ensuring the sustainability of mining, DNPM needs to implement a policy that

includes the creation of a team dealing with mine closure issues, to adopt guidelines and protocols for assessment mine closure plans. It is also recommended that an agreement between DNPM and the States Environmental Agencies be made in order to avoid duplication of requirement increase of bureaucracy and slowness of the assessment.

5. References

- AUSTRALIA. **Guidelines for Preparing Mine Closure Plans**. DMP e EPA, 2011. 78 p.
- FLORES, J. C. C., LIMA, H. M. Mine closure: legal and socioeconomic issues in Brazil. Mine Closure Seminar, 2007, Santiago, Chile. **ACG Australian Centre for Geomechanics**, p.500-510.
- LIMA, H. M., WATHERN, P. Mine closure: a conceptual review. **Mining Engineering**, v. 51, n. 11, p. 41-45, 1999.
- LIMA, H. M. D., FLORES, J. C. D. C., COSTA, F. L. Plano de recuperação de áreas degradadas versus plano de fechamento de mina: um estudo comparativo. **Rem: Revista Escola de Minas**, v. 59, p. 397-402, 2006. ISSN 0370-4467. Disponível em: < http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0370-44672006000400008&nrm=iso >.
- RESENDE, A. G., LIMA, H. M. D. Análise das concessões de lavra quanto às suspensões temporárias de operação. **Rem: Revista Escola de Minas**, v. 62, p. 539-544, 2009. ISSN 0370-4467. Disponível em: < http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0370-44672009000400019&nrm=iso >.
- RESENDE, A. G., LIMA, H. M. D., FLÔRES, J. C. D. C. Análise do plano de fechamento de mina no plano de aproveitamento econômico de uma jazida - uma exigência da NRM-20. **Rem: Revista Escola de Minas**, v. 63, p. 685-690, 2010. ISSN 0370-4467. Disponível em: < http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0370-44672010000400014&nrm=iso >.
- SÁNCHEZ, L. E., SILVA-SÁNCHEZ, S. S., NERI, A. C. **Guia para o planejamento do fechamento de mina**. Brasília: Instituto Brasileiro de Mineração, 2013. 224 p. Disponível em: < <http://www.ibram.org.br> >.
- SÁNCHEZ, L. E. Planejamento para o fechamento prematuro de minas. **Rem: Revista Escola de Minas**, v. 64, p. 117-124, 2011. ISSN 0370-4467. Disponível em: < http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0370-44672011000100016&nrm=iso >.

Received: 31 August 2014 - Accepted: 25 September 2014.