Research and Application of Environmental Protection Standardization System for Energy and Power Companies

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Abstract. At present, the national environmental protection is showing a high-pressure and strict management situation, environmental protection requirements are getting higher and higher, environmental protection supervision factors are increasing, and environmental protection law enforcement standards are becoming more and more stringent. Energy and power companies have problems such as weak awareness of environmental protection and law-abiding, imperfect environmental protection management system, inadequate construction and operation management of environmental protection facilities, lack of systematic environmental risk investigation and assessment, and inability to effectively identify and avoid enterprise environmental protection risks. The environmental protection situation faced by enterprises and companies is unprecedentedly severe. Based on the PDCA cycle theory as the theoretical basis for constructing the environmental standardization system of Energy and power companies, and drawing on national standards as the basis for the preparation of the environmental standardization system of Energy and power companies, the "double pre-control" involving ecological and environmental protection, institutional mechanism, daily management, compliance management, ecological protection and restoration governance, air pollution prevention and control (organized), air pollution prevention and control (organized), air pollution prevention and control (unorganized), water pollution prevention and control, Solid waste pollution prevention and control, other pollution prevention and control (noise pollution prevention, gas) and other 10 first-class elements and a number of standards required by the energy and power companies environmental protection standardization system, and invite experts in the field to hold seminars, through experts to view materials, on-site questions, exchange opinions and other methods to improve and improve the environmental protection standardization system of Energy and power companies. based on Analytical Hierarchy Process (AHP), the system elements are reasonably assigned, the scoring criteria of the standardized system are developed, and the final weight scores are obtained through the application in energy and power enterprises to provide energy and power enterprises with ideas of risk self-examination and risk warning to avoid the risk of environmental penalties.

1. Introduction

The contradiction between the construction level of the environmental governance system of the Energy and power companies and the current high-pressure environmental protection supervision situation of the country has become increasingly prominent, and there is still a big gap between it and the goal requirements of the state to fight the battle against pollution. As large central enterprises in the power energy industry, the five major power groups, such as Huadian and Datang, are facing an unprecedentedly severe environmental protection situation. In recent years, environmental public opinion incidents such as environmental protection penalties and environmental protection notices of group companies have occurred from time to time, mainly due to: (1) the weak awareness of environmental protection and law-abiding in some enterprises, there is even a fluke mentality between production and environmental protection, and the construction and operation management of environmental protection facilities are not in place; (2) the environmental protection management system of grassroots enterprises is not perfect, the enterprise supervision and management institutions and personnel are insufficient, and the professional level of operation personnel is uneven. (3) Enterprises lack systematic environmental risk investigation and assessment, and cannot effectively identify and avoid enterprise environmental protection risks, so as to ensure the legal compliance of enterprise environmental protection production.

In terms of the establishment of the environmental protection standardization system, some scholars have used hierarchical analysis to evaluate the importance of environmental protection standards. For example, Chen Jinfeng et al [1] used hierarchical analysis to assign weights to the environmental standards of an electric

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power enterprise to clarify the importance of each environmental standard and to provide guidance for the development and optimization of the environmental standardization system. Similarly, Wang, J. et al [2] used hierarchical analysis to evaluate the environmental criteria of a chemical enterprise and made suggestions for optimizing the environmental standardization system of this enterprise. In addition, some scholars have tried to use hierarchical analysis to evaluate the difficulty and effectiveness of the construction of an enterprise's environmental standardization system. For example, Sun, Weiwei et al [3] used hierarchical analysis to evaluate the difficulty of environmental standardization system construction and made corresponding recommendations. These studies provide theoretical and methodological support for enterprises to develop and optimize their environmental protection standardization systems. [4-6].

A more common mention abroad is environmental audit [7], in the 80s of the 20th century, the Environmental Impact Assessment (EIA) Center of Manchester University in the United Kingdom carried out relevant research work on post-environmental impact assessment, and there were reports of research results in this field [8]. In 1988, the Economic Commission for Europe (ECE) proposed the use of post-environmental impact assessment and the relationship between post-environmental impact assessment and environmental impact assessment through a case study and determined the classification and implementation procedures of post-environmental impact assessment.

Based on the current research situation at home and abroad, there is no clear complete architecture and calculation of corresponding weights, in view of this problem, a comprehensive method of establishing system elements based on PDCA cycle theory and calculating weights based on AHP analytic hierarchy method is proposed, and it is specifically applied in energy company.

2. Theoretical and methodological basis

2.1 PDCA cycle theory

PDCA cycle is the fundamental operation mode of all modern management systems, and its core content is based on the principles of system management theory, which establishes a dynamic and periodic management process framework for Energy and power companies. The idea of continuous improvement is also an important management method given by the theory to Energy and power companies, which can be used to guide the establishment of environmental standardization system in 10 major aspects, including "double pre-control" and institutional mechanisms, and the specific implementation steps are:

(1) P (plan) stage: the goals and factors of establishing the environmental standardization system of Energy and power companies, and the measures to achieve the goals and factors. Generally speaking, it contains the following issues: first, determine the current management status of Energy and power companies, and improve the environmental protection level of Energy and power companies by identifying, evaluating and controlling the hazards encountered by Energy and power companies in production; Secondly, the action guidelines for the establishment of the environmental standardization system, and the principles and objectives of the establishment of the system; After that, an action plan is formulated, the target elements and specific standard schemes are formulated in line with the environmental protection policy of Energy and power companies, the influencing factors or production activity processes related to the environmental protection system are determined, and the procedures and operating modes are specified for these activities or processes.

(2) D (Implementation) phase: The implementation of the plan is the focus of this step, ensuring that all activities are carried out by specifying procedures and operating modes for various activities or processes and providing assurance support in terms of organizational responsibilities, resource allocation, etc.

(3) C (inspection) stage: correct the existing deviation against the plan to achieve the purpose of testing the implementation effect of the action. By monitoring the implementation of the environmental protection standard system of Energy and power companies, the operation of the system is effectively guaranteed.

(4) A (review and improvement) stage: according to the actual problems and needs, regularly review the environmental standardization system of Energy and power companies, adjust and improve according to the results, and transfer to a new dynamic cycle, so that the system can be continuously improved. Based on PDCA cycle theory, the environmental protection standardization operation mode of Energy and power companies is obtained, and the first-level elements of the environmental protection standardization system of Energy and power companies are obtained. It is shown in Table 1 and numbered A_1-A_{10}.

Table 1. Primary elements of the standardized system of environmental protection in energy and power enterprises

Target layer	Number	Level 1 Elements (Criteria Layer)
Elements of standardized system for environmental protection in energy and power enterprises	A_1	Ecological and environmental protection "double pre-control" (A_1)

A_2	Institution-building (A_2)
A_3	Day-to-day management(A_3)
A_4	Compliance Management (A_4)
A_5	Ecological Restoration and Soil and Water Conservation(A_5)
A_6	Air pollution prevention and control (organized) (A_6)
A_7	Air pollution prevention (unorganized) (A_7)
A_8	Solid Waste Pollution Prevention (A_8)
A_9	Water Pollution Prevention (A_9)
A_{10}	Other Pollution Prevention (A_{10})

2.2 AHP analytic hierarchy

The AHP analytic hierarchy method can be used qualitatively and quantitatively for analytic hierarchies [9, 10], which was proposed by the American scholar T.L. Saaty. The whole analysis process of the method can be qualitatively and quantitatively analyzed, that is, it can be calculated with rational thinking mode and rationality, because the method can effectively and practically deal with some complex decision-making problems, so that the method is rapidly promoted and applied in all walks of life. The AHP analysis method generally includes four steps: clarifying the hierarchy, evaluating the comparison factors, checking the consistency and formulating the planning scheme

3. Construction and solution of standardized system model for environmental protection of energy and power enterprises

3.1 AHP weight calculation and solving

(1) Construct a judgment matrix: The judgment matrix represents the importance of this level factor compared to the higher level factor. A total of 9 people, including 3 people engaged in environmental standardization review, 4 experts and 2 environmental protection specialists of power plants, will be interviewed, and they will be asked to fill in the questionnaire as required, collect the data, conduct statistical analysis of the data, obtain the judgment matrix of each element compared with each other, and obtain the corresponding characteristic values in turn.

Determine the relative importance of features at each level, use the scale value notation in the table above to create a judgment matrix, and compare calculations and analysis to verify the consistency of the judgment matrix. After many comparisons, adjustments and tests, a reasonable judgment matrix A can be obtained

$$\begin{matrix} A_K & B_1 & B_2 & \cdots & B_n \\ B_1 & 1 & a_{12} & \cdots & a_{1n} \\ B_2 & a_{21} & 1 & \cdots & a_{2n} \\ \cdots & \cdots & \cdots & 1 & \cdots \\ B_n & a_{n1} & a_{n2} & \cdots & 1 \end{matrix} \quad (1)$$

By solving the maximum feature root and corresponding feature vector of matrix A, the normalized feature vector is found, that is, it is defined as the weight vector of each evaluation element ω.

3.2 Solve the judgment matrix

Through the given judgment matrix, the relative weights of the elements can be calculated, and the algorithm is as follows:

(1) Using the square root method, calculate the product of each row of features and convert it to a power of n

$$\omega^* = \sqrt[n]{\prod_{j=1}^{n} a_{ij}}, \quad i = (1, \ 2, \ \cdots\cdots, \ n) \quad (2)$$

(2) Solve for weights:

$$\omega_i = \frac{\omega_i^*}{\sum_{j=1}^{n} \omega_i^*}, \quad i = (1, \ 2, \ \cdots\cdots, n)\# \quad (3)$$

(3) Sum each column element of the A matrix:

$$S_j = \sum_{i=1}^{n} a_{ij}, \quad n = (1, \ 2, \ \cdots\cdots, n) \quad (4)$$

(4) Solve the maximum feature root of the judgment matrix λ_{max}:

$$\lambda_{max} = \sum_{i=1}^{n} \omega_1 s_1, \quad i = \left(1, \ 2, \ \cdots\cdots, \ n\right) \quad (5)$$

(5) Pass the consistency check CI:

$$CI = \frac{\lambda_{max} - n}{n-1} \quad (6)$$

(6) Calculate the consistency ratio CR:

$$CR = \frac{CI}{RI} \quad (7)$$

(7)The scores of experts and environmental protection specialists can be calculated according to the established model, and the first-level weight of the environmental standardization system of Energy and power companies can be obtained and rounded, as shown in Table 2.

Table 2. Standardization system level 1 element weighting table

First-level elements	Weight value
A_1	16%
A_2	11%
A_3	10%
A_4	13%
A_5	11%
A_6	9%
A_7	9%
A_8	9%
A_9	9%
A_{10}	3%

4. Application in an energy company

Applying the environmental protection standardization system to an energy company, the environmental protection site assessment was conducted in June, and the coal mine had a total of 70 environmental problems with an assessment weight score of 77.7. Due to the serious environmental risks and failure to fulfill the environmental assessment procedures and complete environmental acceptance procedures as required, the coal mine currently does not have the basic ecological environmental protection standardization to meet the standards, the specific results are shown in Table 3.

Table 3. Total environmental weighting score of an energy company

Evaluate the profession	Standard score	Weight	Base score	Weighted score
A_1	100	16%	100	16
A_2	100	11%	46	5.06
A_3	100	10%	59	5.9
A_4	100	13%	73	9.49
A_5	100	11%	99	10.89
A_6	100	9%	99	8.91
A_7	100	9%	80	7.2
A_8	100	9%	67	6.03
A_9	100	9%	58	5.22
A_{10}	100	3%	100	3
Total			781	77.7

5. Conclusion

In summary, through the research of this topic, a comprehensive, systematic and scientific technical specification for the standardized management and evaluation of ecological and environmental protection can be established, and standardized evaluation content, evaluation basis, evaluation method and rating standard can be formed to apply to the evaluation of ecological and environmental protection standardization construction of Energy and power companies. The establishment of environmental risk grading and enterprise rating methods can better help coal enterprises pay attention to the risk of environmental penalties, so as to effectively avoid relevant environmental protection penalties. Including weight assignment, it is possible to more clearly see the environmental protection weaknesses of enterprises, so as to strengthen relevant parts in a targeted manner and avoid environmental protection penalties.

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