Supporting information

Questionnaire 1

**Investigation letter of experts on elements of safety culture construction system in small and medium-sized enterprises 1**

Dear expert,

Recently, we have been researching "Construction of safety Culture in small and medium-sized enterprises", and we have learned that you are an expert in the industry and would like to hear your opinions. The content of this survey is a bit complicated, involving all aspects of your daily work, which may take some time. Because of your rich experience, your opinions are precious to us, thank you very much for your help!

Combined with "Guidelines for Enterprise Safety Culture Construction" AQ/T9004-2008, "Guidelines for Chemical Process Safety Management" AQ/T3034-2022, "Notice on Triggering the Implementation Plan of Safety Culture Construction in 2023 of New Material Industrial Park (Trial)", and our understanding of enterprises in the park. To ensure that the construction of safety culture does not conflict with the existing system and work content, we integrate the construction of safety culture with the existing system and work content, and construct the element system of safety culture, as shown in Table 1.

**Table 1. Element system for the safety culture construction in small and medium-sized enterprises**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Serial Number | Primary Element | Serial Number | Secondary Element | Description |
| 1 | Safety culture construction institution | 1.1 | Safety culture construction institution | It is suggested to rely on the existing safety management organization of the enterprise (not referring to the safety and environmental protection department) to determine the personnel and responsibilities of safety culture construction. |
| 1.2 | Leadership system and working mechanism | Clarify the leadership mechanism for leaders to organize, participate in, and supervise the whole process of safety culture construction, organize relevant training and meetings regularly, deploy and promote the work of enterprise safety culture construction, and guarantee financial investment in enterprise safety culture construction. |
| 1.3 | Construction planning | Clarify the tasks, methods and measures, division of labor, timeframe, and assessment requirements for the construction of safety culture. |
| 1.4 | Investment capital | Clarify funding for safety and culture on the basis of construction planning. |
| 2 | Safety culture concept | 2.1 | Policy | The safety policy is the programmatic document for the construction of an enterprise's safety culture, reflecting the safety values shared by the enterprise. |
| 2.2 | Targets | Safety targets guide the direction of safety culture construction, and subdivided goals, such as zero injuries, zero hidden danger, etc. It is recommended that all employees, from leaders to employees, formulate their own safety goals. |
| 2.3 | Leaders’ safety commitment | Sensational leadership is demonstrated by leaders who value and personally practice their commitment to safety, set an example for their employees (this can be combined with safety accountability), make it clear that safety has the highest priority within the organization, insist on conservative decision-making, and state that excellence is being pursued in all important activities related to corporate safety. |
| 2.4 | Employees and related parties’ safety commitment | Make all employees and related parties understand and recognize, and consciously practice. (It can be combined with a safety responsibility system). |
| 3 | Safety norms of conduct | 3.1 | Safety management regime | Ensure that the management of production safety is carried out by the system, including the equipment safety management system, the hazardous safety management system, the emergency management system, and the risk management system. It is recommended that all leaders and grass-roots employees participate in the development of the system, and the development of the safety management system should reflect the idea of professional safety. |
| 3.2 | Job operation procedures (Best practices are job operating procedures, not stand-alone safety procedures) | Make the employees' operating behavior standardized to guard against and prevent unsafe factors. It is recommended that middle-level leaders and front-line employees work together to develop operating procedures. (Risk management and control measures need to be incorporated into job operating procedures). |
| 3.3 | Safety risk grading control and hidden risk detection and rectification dual prevention mechanism | Employees participate in risk identification, grading control, and hidden danger investigation for their jobs, equipment, work activities, and processes. Risk grading control and hazard identification need to be integrated into daily work. |
| 3.4 | Contractor safety management | Regulate contractors' safety behavior and strengthen their safety awareness. |
| 3.5 | Safety behavior observation and improvement | Conducting special safety activities in response to special inspections. The implementation of the corporate behavioral observation and improvement tool is recommended for continuous improvement of personnel behavior and fostering of a safe atmosphere |
| 4 | Safety education and training | 4.1 | Third-level safety education | Basic requirements for safety training and education. |
| 4.2 | Safety knowledge and skills | Job operating procedures, job risk grading control, hidden danger investigation ability, process safety, professional safety knowledge, etc. |
| 4.3 | Emergency response capability | Strengthen employees' emergency response knowledge and capabilities to ensure timely incident reporting, proper response, and handling of emergencies in unexpected situations. |
| 4.4 | Typical cases | Attempted accidents and cases of accidents and improvements in similar jobs within or at other companies. |
| 4.5 | Safety laws and regulations | Allow leaders and employees to understand their obligations and authority concerning safety. |
| 5 | Safety behavior incentives | 5.1 | Leaders’ safety target and commitment assessment | Provide tangible examples for employees and data references for higher management's assessment. |
| 5.2 | Employee safety target and commitment assessment | Ensure that safety goals are accomplished and employees' responsibilities are implemented. |
| 5.3 | Evaluation of employees’ job performance | Evaluate employees' safety performance and work performance, identify problems, offer rewards or penalties (rewards mainly, penalties according to the actual situation), and provide data reference for targeted safety education and training. |
| 5.4 | Safety role models | Reward employees or groups who have made safety commitments, accomplished safety goals well, behaved safely and set them up as safety role models to motivate employees to learn and improve independently. |
| 6 | Safety environment culture | 6.1 | Visual management | Safety Signs, Significant Safety Risk Area or Safety Risk Warning Signs, Signs Informing of Larger or Larger Safety Risks, Signs Displaying PPE Wearing, Signs Displaying Safety Instructions for Entry, Public Notices of Safety Production, and Maps Delineating Areas of Safety Responsibility, etc. |
| 6.2 | Emergency facilities | Maintenance of emergency equipment。 |
| 6.3 | On-site safety inspection | Safety inspections should be conducted by leaders and safety managers within the enterprise. The focus should be on conducting all-weather and all-around safety inspections with full participation, especially in job-specific, departmental, and specialized inspections. |
| 7 | Safety information dissemination | 7.1 | Safety information dissemination system | Constructing hardware for secure information dissemination such as telephone, SMS, email, information platform, and meeting rooms to provide a secure foundation for information dissemination within and outside the enterprise. |
| 7.2 | Accident alarms and risk hidden danger reporting | Establishing protocols for reporting safety risks, hazards, and accident alarms to ensure seamless information flow. There should be no restrictions on reporting accident alarms to higher levels. It is recommended that accidents be reported with careful attention, and concealed accidents be severely punished. |
| 7.3 | Safety news | Internal safety role models, safety accidents, safety incidents related to corporate production, the latest safety technologies, safety policies, standards, as well as national serious accidents, etc. |
| 7.4 | Safety activities | Organizing regular activities for group, departmental or all-employee safety exchanges, disseminating safety information and exchanging safety experiences. |
| 8 | Review and evaluation | 8.1 | Regular review and evaluation | Review the construction of an enterprise's safety culture regularly and carry out stage-by-stage evaluations for continuous improvement. A combination of quantitative departmental evaluation and overall fuzzy comprehensive evaluation of the enterprise can be considered, and the frequency of evaluation is once a year. |
| 8.2 | Safety culture construction report | Organize reports on the building of a culture of safety to facilitate inspections and prepare for the next phase of work. |
| 8.3 | Continuous improvement measures | Propose improvement measures for unreasonable and imperfect areas and implement them in the following year to realize continuous improvement. |

Questionnaire 2

**Investigation letter of experts on elements of safety culture construction system in small and medium-sized enterprises 2**

Dear expert,

Our team of researchers working on the “Construction of Safety Culture in Small and Medium-sized Enterprises” is making initial adjustments to the “Guidelines for the Construction of Safety Culture in Enterprises” based on the specific conditions of the enterprises and the key elements outlined in the “Guidelines for the Safety Management of Chemical Processes” AQ/T3034-2022. Additionally, we are taking into account the notice regarding the initiation of the “Implementation Plan for the Construction of Safety Culture in the New Material Industrial Park in 2023 (Trial Implementation)”. We have refined the elements of the system and would appreciate it if you, as experts, could use the 1-9 scale method to score the system's elements based on your professional experience. This will provide a foundation for the development of safety culture in small and medium-sized enterprises. We kindly request your assistance despite your busy schedule. Thank you very much!

1. Scoring instructions

The purpose of this questionnaire is to ascertain the weights of the various elements across all tiers of the safety culture construction element system for small and medium-sized enterprises. We employ the expert scoring method to identify the experts' perspectives. If any experts have additional modifications or suggestions to offer regarding this questionnaire, kindly append them after the form. Your valuable opinions and insights will significantly contribute to the effective establishment of the safety culture construction element system, thereby fostering the further development of safety culture within small and medium-sized enterprises.

2. Scoring standard

2.1 The construction of a hierarchical model

Taking the construction of safety culture in Small and Medium-sized Enterprises as the target layer (Z), eight first-level elements as the indicator layer, and 32 second-level elements as the program layer, we have devised a hierarchical model for enterprise safety culture construction. This model is depicted in Table 2.

**Table 2.** **Element system for the safety culture construction in small and medium-sized enterprises**

|  |  |  |  |
| --- | --- | --- | --- |
| Target level | Primary Element | Serial Number | Secondary Element |
| Element system for the safety culture construction in small and medium-sized enterprises  Z | Safety culture construction institution  (A1) | 1.1 | Safety culture construction institution (B1) |
| 1.2 | Leadership system and working mechanism (B2) |
| 1.3 | Construction planning (B3) |
| 1.4 | Investment capital (B4) |
| Safety culture concept  (A2) | 2.1 | Policy (B5) |
| 2.2 | Targets (B6) |
| 2.3 | Leaders’ safety commitment (B7) |
| 2.4 | Employees and related parties’ safety commitment (B8) |
| Safety norms of conduct  (A3) | 3.1 | Safety management regime (B9) |
| 3.2 | Job operation procedures (B10) |
| 3.3 | Safety risk grading control and hidden risk detection and rectification dual prevention mechanism (B11) |
| 3.4 | Contractor safety management (B12) |
| 3.5 | Safety behavior observation and improvement (B13) |
| Safety education and training  (A4) | 4.1 | Third-level safety education (B14) |
| 4.2 | Safety knowledge and skills (B15) |
| 4.3 | Emergency response capability (B16) |
| 4.4 | Typical cases (B17) |
| 4.5 | Safety laws and regulations (B18) |
| Safety behavior incentives  (A5) | 5.1 | Leaders’ safety target and commitment assessment (B19) |
| 5.2 | Employee safety target and commitment assessment (B20) |
| 5.3 | Evaluation of employees’ job performance (B21) |
| 5.4 | Safety role models (B22) |
| Safety environment culture  (A6) | 6.1 | Visual management (B23) |
| 6.2 | Emergency facilities (B24) |
| 6.3 | On-site safety inspection (B25) |
| Safety information dissemination  (A7) | 7.1 | Safety information dissemination system (B26) |
| 7.2 | Accident alarms and risk hidden danger reporting (B27) |
| 7.3 | Safety news (B28) |
| 7.4 | Safety activities (B29) |
| Review and evaluation  (A8) | 8.1 | Regular review and evaluation (B30) |
| 8.2 | Safety culture construction report (B31) |
| 8.3 | Continuous improvement measures (B32) |

2.2 Construction of judgment matrices

Hierarchical analysis is employed to create a judgment matrix by comparing n elements within the same level, thereby determining the relative importance of a given element with respect to the preceding level's objective/indicator. Experts are invited to assign weights to the element system using the 1-9 scale method, and the judgment matrix is constructed utilizing aij to signify the outcomes of comparing the elements in the i-th row to those in the j-th column. The meanings associated with the 1-9 scales are outlined in the accompanying Table 3.

**Table 3. Judgment matrix 9-level scale and meaning**

|  |  |
| --- | --- |
| Scal | Meaning |
| 1 | Element i is of equal importance compared to element j. |
| 3 | Element i is slightly more important than element j. |
| 5 | Element i is significantly more important than element j. |
| 7 | Element i is strongly more important than element j. |
| 9 | Element i is extremely more important than element j. |
| 2, 4, 6, 8 | The median value of the above neighboring judgments. |
| Reciprocal | If the ratio of the importance of element i to element j is denoted as aij, then the ratio of the importance of element j to element i is denoted as aji=1/aij. |

The following is a comparison table of the weights of the elements of the system of elements affecting the construction of enterprise safety culture. Table 4 shows the judgment matrix for the target level, and Table 5-12 shows the judgment matrix for the indicator level. Please fill in the corresponding scale on the judgment matrix according to the description of each element and the meaning of the 9-level scale of the judgment matrix.

**Table 4. Judgment matrix of enterprise safety culture construction**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| j  i | A1  (Safety culture construction institution) | A2  (Safety culture concept) | A3  (Safety norms of conduct) | A4  (Safety education and training) | A5  (Safety behavior incentives) | A6  (Safety environment culture ) | A7  (Safety information dissemination) | A8  (Review and evaluation) |
| A1  (Safety culture construction institution) | 1 | 1/5 | 1/7 | 1/5 | 1/3 | 1 | 1/3 | 1 |
| A2  (Safety culture concept) | 5 | 1 | 1/5 | 1 | 3 | 5 | 3 | 5 |
| A3  (Safety norms of conduct) | 7 | 5 | 1 | 5 | 5 | 7 | 5 | 7 |
| A4  (Safety education and training ) | 5 | 1 | 1/5 | 1 | 3 | 5 | 3 | 5 |
| A5  (Safety behavior incentives) | 3 | 1/3 | 1/5 | 1/3 | 1 | 3 | 1 | 3 |
| A6  (Safety environment culture) | 1 | 1/5 | 1/7 | 1/5 | 1/3 | 1 | 1/3 | 1 |
| A7  (Safety information dissemination) | 3 | 1/3 | 1/5 | 1/3 | 1 | 3 | 1 | 3 |
| A8  (Review and evaluation) | 1 | 1/5 | 1/7 | 1/5 | 1/3 | 1 | 1/3 | 1 |

**Table 5. Judgment matrix of safety culture construction institution**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| j  i | B1  ( Safety culture construction institution ) | B2  ( Leadership system and working mechanism ) | B3  ( Construction planning ) | B4  ( Investment capital ) |
| B1  (Safety culture construction institution) | 1 | 1/5 | 1/3 | 1 |
| B2  ( Leadership system and working mechanism ) | 5 | 1 | 3 | 5 |
| B3  ( Construction planning ) | 3 | 1/3 | 1 | 3 |
| B4  ( Investment capital ) | 1 | 1/5 | 1/3 | 1 |

**Table 6. Judgment matrix of safety culture concept**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| j  i | B5  ( Policy ) | B6  ( Targets ) | B7  ( Leaders’ safety commitment ) | B8  ( Employees and related parties’ safety commitment ) |
| B5  ( Policy ) | 1 | 1/3 | 1/5 | 1 |
| B6  ( Targets ) | 3 | 1 | 1/3 | 3 |
| B7  ( Leaders’ safety commitment ) | 5 | 3 | 1 | 5 |
| B8  ( Employees and related parties’ safety commitment ) | 1 | 1/3 | 1/5 | 1 |

**Table 7. Judgment matrix of safety norms of conduct**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| j  i | B9  ( Safety management regime ) | B10  ( Job operation procedures ) | B11  ( Safety risk grading control and hidden risk detection and rectification dual prevention mechanism ) | B12  ( Contractor safety management ) | B13  ( Safety behavior observation and improvement ) |
| B9  (Safety management regime) | 1 | 1 | 1/5 | 3 | 1/3 |
| B10  (Job operation procedures) | 1 | 1 | 1/5 | 3 | 1/3 |
| B11 (Safety risk grading control and hidden risk detection and rectification dual prevention mechanism) | 5 | 5 | 1 | 7 | 3 |
| B12  (Contractor safety management) | 1/3 | 1/3 | 1/7 | 1 | 1/5 |
| B13  (Safety behavior observation and improvement) | 3 | 3 | 1/3 | 5 | 1 |

**Table 8. Judgment matrix of safety education and training**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| j  i | B14  ( Third-level safety education ) | B15  ( Safety knowledge and skills ) | B16  ( Emergency response capability ) | B17  ( Typical cases ) | B18  ( Safety laws and regulations ) |
| B14  (Third-level safety education) | 1 | 1/5 | 1 | 3 | 3 |
| B15  (Safety knowledge and skills) | 5 | 1 | 3 | 5 | 5 |
| B16  (Emergency response capability) | 1 | 1/3 | 1 | 3 | 3 |
| B17  (Typical cases) | 1/3 | 1/5 | 1/3 | 1 | 1 |
| B18  (Safety laws and regulations) | 1/3 | 1/5 | 1/3 | 1 | 1 |

**Table 9. Judgment matrix of safety behavior incentives**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| j  i | B19  ( Leaders’ safety target and commitment assessment ) | B20  ( Employee safety target and commitment assessment ) | B21  ( Evaluation of employees’ job performance ) | B22  ( Safety role models ) |
| B19  ( Leaders’ safety target and commitment assessment ) | 1 | 3 | 1 | 1 |
| B20  ( Employee safety target and commitment assessment ) | 1/3 | 1 | 1/3 | 1/3 |
| B21  ( Evaluation of employees’ job performance ) | 1 | 3 | 1 | 1 |
| B22  (Safety role models) | 1 | 3 | 1 | 1 |

**Table 10. Judgment matrix of safety environment culture**

|  |  |  |  |
| --- | --- | --- | --- |
| j  i | B23  ( Visual management ) | B24  ( Emergency facilities ) | B25  ( On-site safety inspection ) |
| B23  (Visual management) | 1 | 3 | 1/3 |
| B24  (Emergency facilities) | 1/3 | 1 | 1/5 |
| B25  (On-site safety inspection) | 3 | 5 | 1 |

**Table 11. Judgment matrix of safety information dissemination**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| j  i | B26  ( Safety information dissemination system ) | B27  ( Accident alarms and risk hidden danger reporting ) | B28  ( Safety news ) | B29  ( Safety activities ) |
| B26  ( Safety information dissemination system ) | 1 | 1/5 | 1 | 1/3 |
| B27  ( Accident alarms and risk hidden danger reporting ) | 5 | 1 | 5 | 3 |
| B28  ( Safety news ) | 1 | 5 | 1 | 1/3 |
| B29  ( Safety activities ) | 3 | 1/3 | 3 | 1 |

**Table 12. Judgment matrix of** **review and evaluation**

|  |  |  |  |
| --- | --- | --- | --- |
| j  i | B30  ( Regular review and evaluation ) | B31  ( Safety culture construction report ) | B32  ( Continuous improvement measures ) |
| B30  ( Regular review and evaluation ) | 1 | 3 | 1 |
| B31  ( Safety culture construction report ) | 1/3 | 1 | 1/3 |
| B32  ( Continuous improvement measures ) | 1 | 3 | 1 |

3. Additional expert advice

If you have any additional comments on this questionnaire, please fill in the blanks below. Thank you for your guidance!