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Safety of Machinery and Special Scheme of Inspection's Requirement towards Industry Competitiveness in Malaysia

Rozanah Ab. Rahman[1] & Mohd Zahlul Azizi Abdul Malek[2]

[1] Faculty of Economics and Management, Universiti Putra Malaysia, Malaysia

[2] RPS Australia Asia Pacific, Western Australia, Australia

Correspondence: Rozanah Ab. Rahman, Department of Management and Marketing, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia. Tel: 6038-947-2047. Fax: 6038-947-2046. E-mail: rozanah@upm.edu.my

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Abstract

The amendment of the Factories and Machinery Act 1967 (FMA) in 2006, with the inclusion of the new provision on special scheme of inspection takes into account of the development and advancement of technology, particularly on the latest procedure of inspection of plant and machinery in the Malaysian industries. The FMA since 1967 is the safety at work legislation applicable in Malaysia that provides for the control of factories with respect to matters relating to safety, health and welfare of person therein, the registration and inspection of machinery and for matters connected therewith. Inclusion of such provision provides an option to the industry to conduct its special scheme of inspection that analyzes the likelihood of failure and the consequence of the same in its work. This is obviously important for the economic benefits as the implementation of the scheme safeguards the integrity of the plant that will eventually increase the industry productivity and competitiveness. This paper discusses the importance of the inclusion of the special scheme of inspection provision into the statute and how it regulates the implementation of the system in the light of the development of technology in the industry. Analysis was made based on the latest legal documentation enforced relating to special scheme of inspection and with the coming into force of the Factories and Machinery (Special Scheme of Inspection) (Risk-Based Inspection) Regulations on June 1, 2014, the provision under the Factories and Machinery (Amendment) Act 2006 on special scheme of inspection shall now be fully implemented to see the effectiveness of the inspection approach for plant equipment using 'risks analysis'.

Keywords: Safety, Machinery, Special Scheme of Inspection

1. Introduction

Ensuring safety and health is practiced at the place of work fall under the duty of the employer or occupier of the workplace, and the occupational safety and health legislation have been enacted to provide for the specific provisions to govern safety and health of workers and other persons in the Malaysian industries. The provisions under the legislation encompass matters relating factory and machinery to inspection. In ensuring the safety or reliability of machinery, a mechanical inspection is usually carried out, particularly the testing during the use of such machinery to address the risk of breaking in service. Instances of solid object having the risk of damage or flaws from use are pressure vessels developing cracks in welds, corrosion and erosion in pipelines and pipes carrying products, and concrete structures weakened due to inner reinforcing steel corroded. Thus, inspection is essential as formal evaluation exercise to measure, test and gauge object or activity, using various technologies to analyze materials for either inherent flaws or damage from use.

2. Provisions for Inspection under the Factories and Machinery Act 1967

The important legislation which regulates matters relating to the operation of factory, the installation of machinery, certificate of fitness for certain machineries and the periodical inspections of all machineries is the Factories and Machinery Act 1967 (FMA). Before a person can occupy or use any premises as a factory and install any machinery in a factory, including machinery, which requires certificate of fitness, he must obtain a written permission or approval from the Inspector (s. 34(2) (a), s. 36(1)). In relation to machinery, which requires a certificate of fitness (certificated machinery), the occupier or owner of the factory must serve a written notice

to the Inspector or a licensed person who will make an inspection of the machinery (s. 36(3)). Upon inspection and satisfied with the finding, the Inspector shall issue a certificate of fitness specifying that the machinery has passed the inspection on the date of the inspection (s. 36(4)).

Under the FMA, the types of machinery that requires certificate of fitness are steam boilers, pressure vessels and hoisting machines. The certificate of fitness issued under the FMA 1967 shall be valid for fifteen (15) months from the date of inspection unless in cases where the certificated machinery is out of service for a long period immediately after the inspection by reason of dismantling or repair of any defect. In such case, the Inspector may issue a certificate of fitness effective from the date when the machinery is replaced in service (Regulation 10, Factories and Machinery (Notification, Certificate of Fitness and Inspection) Regulations, 1970). The FMA provides for periodical inspections of factory or machinery including all certificated machineries, which is the essential requirement where the Inspector or a licensed person shall inspect the factory, or machinery at the prescribed periods. There are initial inspection and regular inspection to be carried out by the authority. 'Initial inspection' is an inspection of any machinery or factory carried out by the Inspector subsequent to service of notices to the Inspector in respect of premises to be first used as a factory, or an inspection of any machinery for which a certificate of fitness is required (Regulation 2, Factories and Machinery (Notification, Certificate of Fitness and Inspection) Regulations, 1970).

After an initial inspection every factory and machinery shall be inspected at regular intervals by the Inspector so long as the factory remains in operation or the machinery remains in use. The 'regular inspection' shall be carried out during the fifteen (15) months following the month in which the last inspection was made, subject to an extension not exceeding thirty six (36) months, as may be authorized by the Chief Inspector. In cases of extension allowed by the Chief Inspector, the regular inspection shall be carried out during the month following the expiry of the extended interval (Regulation 14, Factories and Machinery (Notification, Certificate of Fitness and Inspection) Regulations, 1970). Postponement of regular inspection is allowed under Regulation 15 upon the owner's request, with good and sufficient reason. However, the postponement period allowed is not more than three (3) months after the date due or the date on which certificate of fitness expires. There are certain fees charged for these inspections.

Apart from the initial and regular inspection, there is also supplementary inspection and special inspection provided under the Factories and Machinery (Notification, Certificate of Fitness and Inspection) Regulations (1970). Supplementary inspection is in addition to the initial and regular inspections of a steam boiler and unfired pressure vessel, and shall be made by the Inspector within a period of three (3) months subsequent to the date of the initial and regular inspection (Regulation 19, Factories and Machinery (Notification, Certificate of Fitness and Inspection) Regulations, 1970). For special inspection, it is made by the Inspector upon written request of a prospective purchaser of any machinery (Regulation 20, Factories and Machinery (Notification, Certificate of Fitness and Inspection) Regulations 1970).

3. What Involve in the Preparation for Inspection?

As far as the preparation for inspection is concerned (under Regulation 17 of the Factories and Machinery (Notification, Certificate of Fitness and Inspection) Regulations, 1970), the owner of any machinery must ensure that the machinery is prepared for inspection in accordance with the regulations.

For steam boiler, it must be emptied, cooled and dried and has been thoroughly cleaned inside and outside; all firebars and firebridges have been removed; all smoke-tubes, exterior of water-tubes, furnaces, smoke-boxes and external flues have been thoroughly cleaned; all manhole, handhole and sighthole doors and cleaning plugs have been removed; all cocks and valves have been dismantled, cleaned and ground where necessary. The steam boiler must also has been effectively disconnected from any other steam boiler and source of steam or hot water; and other special requirements in respect of the drilling of any plates, the removal of any lagging, brick-work or masonry, the preparations for a hydrostatic test of the steam boiler, or its mountings and associated piping, the withdrawal of tubes, the verification of the pressure gauge, and the dismantling for inspection of any part of any associated steam engine (Regulation 17(a), Factories and Machinery (Notification, Certificate of Fitness and Inspection) Regulations, 1970).

For unfired pressure vessel, the preparations are almost the same like for the steam boiler (Regulation 17(b)). In respect of hoisting machine, the occupier or owner must make arrangements to enable the hoisting machine to be tested under conditions of maximum safe working load and so as to cause all safety devices to function (Regulation 17(c)). In respect of other machinery, the occupier or owner must make arrangements so far as practicable to operate any driven machinery under maximum load and to have all safety devices in proper working order (Regulation 17(d)).

Hence, where above inspection is concerned, if the machinery is not prepared for inspection on a visit by the Inspector, he may refuse to make or complete the inspection and shall inform the occupier or owner in writing of his reason for such refusal and appoint other date and time for inspection (Regulation 18(1)). This is very much related to the safety matter of the machinery or equipment involved, as well the safety of the Inspector having the duty to inspect them.

The above requirements show that the preparation for inspection involves shutdown of plant or machinery, stop of production or downtime and a break of continuity in business operation. In the practice of preparing the factory or machinery particularly the certificated machinery, for inspection, it does involve costs (tangible and intangible loss) during the period of shutdown of the factory or machinery. For example, the steam boiler needs to fulfill all the requirements under Regulation 17 and thus, the direct costs would include stop of work production, contracting out of works to contractors for shutdown purposes, inclusive of but not limited to cleaning, replacing parts of the machinery, repairing and maintaining the machinery. The direct costs for the shut down of plant or machinery may vary from RM5,000 to RM500,000 daily or RM20,000 to RM50,000,000 in total.

4. Why Special Scheme of Inspection?

Notwithstanding the importance of inspection for machinery used in the industry, the time-based inspection or conventional inspection (for minimum compliance of the rules and regulations for inspection) may involve business interruption inclusive of operational costs, unplanned shutdowns, equipment damage, and cause serious disruption in plant operations. For industry like oil and gas, nuclear power generation, and in refineries and petrochemical plant, the change from conventional or traditional inspection methods is a cost effective alternative that offers safer results and more reliable plant operations (SGS Group, 2008). Managing the integrity of plant and planning inspection from assessments of the risks of failure of the plant is the duty of owner and user of the plant. The responsibility is to implement the risk assessment and inspection planning processes effectively and in an appropriate manner (Wintle et al., 2001). An optimization formulation involves maximizing the expected service life and minimizing the expected total life-cycle cost consisting of inspection and maintenance costs; and the optimum inspection and maintenance types and times are gained through this formulation. This is crucial in inspection and maintenance planning of deteriorating structures (Kim et al., 2013).

This cost effective alternative refers to the ‘special scheme of inspection’ (SSI) provided under the Factories and Machinery (Amendment) Act 2006, whereby the provision for SSI takes into account the effective method of inspection for plant and machinery in the industry. This approval by the Chief Inspector for the use of SSI was made possible during the amendment to the FMA 1967, which was gazetted on 14 September 2006 and enforced on 1 January 2007. Under the FMA (Amendment) Act (2006), the additional provision Section 40(5) on SSI provides for the factory owner or occupier to make application to the Chief Inspector for an approval to conduct SSI. The approval of the application must be satisfied to have fulfilled the prescribed requirements relating to SSI, and upon approval, the inspection of the machinery shall be conducted according to the SSI (s. 40(7)).

By inserting the above provision, an option is thus provided to the industry to conduct its special scheme of inspection that analyzes the likelihood of failure and the consequence of the same in its work. This will provide the economic benefits and safeguard the integrity of the plant in the industry that will eventually increase the productivity and competitiveness of the industry. Malaysia, as a small and highly open economy is vulnerable to developments in the external environment. Real GDP is expected to register a growth of 4.5%-5.5% in 2015 supported by resilient domestic economic activity and by expansion in all economic sectors. Construction-related is expected to remain favorable and despite some investment cutback in upstream oil and gas activities, the mining sector is anticipated to expand, supported by higher crude oil output (Economic Report 2015/2016).

The purpose of the SSI is thus to provide economic benefits in terms of fewer inspections, minimum duration of shutdowns, longer run length and less frequent shutdowns, to safeguard integrity and improve reliability and availability of the plant equipment, and to move from a reactivate to proactive maintenance regime. This is opposed to the time-based or conventional inspection where the machinery has to be shut down every fifteen (15) months for regular inspection, which is not economical for the industries in terms of spending costs particularly for the oil and gas industry. One of the SSI approaches that are widely used by the oil and gas industries is known as the Risk-Based Inspection (RBI); an inspection approach for plant equipment using ‘risks analysis’. Most often, RBI is used in engineering industries and predominant in oil and gas industry.

RBI is a technique used to reduce direct inspection costs for genuine cost saving. RBI is a combination of technologies, providing industries with a risk-based method towards evaluating and developing inspection plans (Kallen, 2002). The focus is on critical plant and it identifies priorities for inspection based on its failure risk.

RBI recognizes that there is little point to spending good money on very frequent inspection of something that is very unlikely to fail, or if it fails would have little financial or safety consequence (IET, 2007). RBI is thus a systematic and standard method for prioritizing inspection activities to focus first on 'high-risk' assets. Risk is the likelihood of occurrence and the consequence of failure. The likelihood and consequence will produce an estimate of risk and the risk factor can then be ranked and used to govern inspection schedules (Ramesh, 2005). It means the consequences and likelihood factor is used to identify which equipment poses the greater risk and therefore demands the most inspection attention in order to effectively manage the associated risk. The 'risk' in RBI refers to the need to prioritize the schedule of inspections that include various forms of non-destructive testing (Wiseman, 2008). In other words, RBI is a tool to firstly select which items require attention and next is to plan on inspecting the component or system, especially the high-risk components which had been identified (Kallen, 2002).

Thus, the various standard engineering calculations and models of corrosion rates would determine the decisions to be made. The calculations provide estimated time to reach an unsafe condition and a safe schedule for the next inspection (Wiseman, 2008), based on the consequences of possible failures and the likelihood of the failures as highlighted above (Kallen, 2002). There is RBI methodology commonly used within the chemical, petrochemical, and the oil and gas refinery that assesses risk to support the inspection planning. The risk-based inspection methodology shall provide recommendation on what, when, where and how to inspect, and also what should be documented based on the risk value calculated (Selvik et al., 2011). The international engineering standards and practices that relate to RBI include API RP 580 and 581, and ASME PCC-3. API RP 580 is the minimum guidelines in implementing effective and credible RBI program, and API RP 581 is the example of RBI methodology's technical basis.

The benefit of RBI is the minimization of potential losses in terms of safety, environmental impacts, equipment damage, and business interruption (Quest, 2008). Its utility is based on the rough premise that 10% of the equipment in a process contributes 90% of the risk. Consequently, if this 10% of the equipment can be identified, testing and inspection can be focused on it rather than low-risk items. This approach is clearly preferable to the usual method of treating all equipment equally, notwithstanding its risk contribution. Therefore, RBI permits companies to prioritize their equipment for inspection, optimize inspection methods and frequencies, and develop specific equipment inspection plans. As there are fewer forced shutdowns and reduction in operational costs, it hence resulted in improved safety (PrimaTech, 2008). Effective implementation of RBI program also extends the operating life of equipment and it is accepted as good engineering practice for the implementation of inspection and maintenance programs (Ramesh, 2005).

Since the probability that any component of the facility fails during operation is there, a risk-based inspection planning is crucial where RBI approach takes basis in a quantification of risk, thus different strategies, effort, quality of inspection and costs will give different impact on the risk (Faber, 2000). In the risk-based inspection planning for offshore production facilities for instance, engineering systems are designed to ensure an economical operation throughout the service life, to comply with the acceptance criteria, which are related to the safety of personnel and risk to the environment. In carrying out a piping inspection effectively, both a qualified Non-Destructive Examination (NDE) Inspector and right inspection procedures are essential requirements, and relies on highly skilled inspectors who are familiar with the environment in the workplace (Chang et al., 2005). Hence, RBI is carried out to ensure that the physical condition of the installation remains within design limits and continue in operation safely during its lifetime and risks to personnel and the environment are maintained as low as reasonably practicable (Goyet, 2000).

5. Application for Risk-based Inspection Scheme under the Regulations

The new Factories and Machinery (Special Scheme of Inspection) (Risk-Based Inspection) Regulations 2014 made by the Minister had came into force on June 1, 2014 in furtherance to the new SSI provision being inserted in the Factories and Machinery (Amendment) Act 2006, to give heavy industry operators options for a risk-based inspection of their machineries under a special scheme of inspection. The implementation of this scheme meant that the statutory inspection interval of fifteen (15) months for certificated machineries would be extended and would bring cost saving in the long run, especially to the oil and gas and power sectors.

Under the Regulations, "risk-based inspection" is defined as means of inspection on the interior and exterior parts of a pressurized machinery the interval of which is determined based on the category of risk associated with the pressurized machinery, and "risk-based inspection scheme" means a special scheme of inspection which is based on a risk-based inspection. Pressurized machinery includes a steam boiler and an unfired pressure vessel used for processing or storage purposes, and this pressurized machinery comprises of "time-based pressurized

machinery" which holds a time-based certificate of fitness and "risk-based pressurized machinery" which holds a risk-based certificate of fitness (s.3).

The Regulations provide the requirement whereby the applicant will have to make a written application to the Chief Inspector for the approval of a risk-based inspection scheme in respect of the time-based pressurized machinery, with a processing fee of RM50, 000, at least six months before the expiry of the time-based certificate of fitness (s.4). Further upon receiving the application, there will be a risk-based audit conducted by an Inspector in the Department of Occupational Safety and Health (DOSH), to verify the requirements for the application (s.6). Once the audit completed, a risk-based inspection shall be conducted on the time-based pressurized machinery. Payment of the prescribed inspection fee shall be made upon completion of the risk-based inspection and upon the applicant being notified by the Inspector (s.7). In any case where the Inspector has refused to make or complete the risk-based inspection due to the reason that the time-based pressurized machinery is not prepared for the risk-based inspection, then the inspection fee shall be charged at the rate of twenty-five (25) per cent of the full amount.

The approval would be granted for the risk-based inspection scheme and the risk-based certificate of fitness would be issued by the Chief Inspector (s.8). The duration granted for the risk-based inspection scheme will last for one hundred and fifty (150) months unless revoked or terminated (s.9), and the risk-based certificate of fitness issued shall be valid for a period to be determined by the Chief Inspector (based on the calculation and evaluation of the risk-based data provided), but shall not exceed seventy-five (75) months (s.10).

6. Requirements for Application for Approval of Risk-Based Inspection Scheme

Among the important requirements to be provided for the application for approval are the establishment of the occupational safety and health (OSH) management system in place; the state of working condition of the time-based pressurized machinery must be satisfactory or fit for service; risk-based data is available in relation to the initial and regular inspection under the time-based inspection; the risk-based data collected is calculated and evaluated to determine the remnant life, category of risk, proposed inspection interval, and proposed inspection plan; the methodology for calculation and evaluation of risk-based data is maintained and applied; the establishment of a risk-based inspection team that consists of a team leader (qualified person who has adequate knowledge and experience to execute all tasks relating to the risk-based inspection scheme), an engineer with corrosion engineering knowledge and expertise, a representative from the process or production department, a representative from the inspection or engineering department, and a safety and health officer or a person in charge of occupational safety and health at the workplace (ss.12-17).

The Regulations also provide provisions for the renewal of the certificate, whereby the scheme user must submit the application three months before the expiry of the risk-based certificate of fitness (s.23). The validity period of the risk-based certificate of fitness shall be determined by the Chief Inspector bur shall not exceed seventy-five (75) months or the remaining duration of a risk-based inspection scheme, whichever is the shorter (s.28).

An application can also be made for new duration of risk-based inspection scheme, to be submitted at least six months before the expiry of the existing duration of the risk-based inspection scheme (s.35). There will also be a risk-based audit to be conducted by the Inspector and if the approval is granted, the new duration of a risk-based inspection scheme shall be for another one hundred fifty (150) months unless the scheme is revoked, deemed to have been revoked or terminated under the Regulations (s.40). During the duration of a risk-based inspection scheme, the Inspector of DOSH may conduct a risk-based audit at any time to verify all the requirements specified have been fulfilled (s.43). The Inspector may also conduct a risk-based inspection at any time during the duration of a risk-based inspection scheme, to ensure the integrity and strength of the risk-based pressurized machinery (s.44).

7. Conclusion

The change from conventional or traditional inspection method to the risk-based inspection scheme is certainly a cost effective alternative for reliable plant operations and minimization of potential losses in terms of safety, environmental impacts, equipment damage and business interruption. In order for the Malaysian industries to remain competitive, in particular oil and gas and power sectors, the development of the legal framework of the Malaysian law relating to safety at work including machinery safety, has provided for the option to the heavy industry operators to implement the special scheme of inspection for their plants. Positively, the economic benefits in terms of fewer inspections, minimum duration of shutdowns, longer run length and less frequent shutdowns should safeguard the integrity and improve reliability and availability of the plant, as the implementation of the special scheme of inspection had made a move from a reactive to proactive maintenance regime. Thus, with the coming into force of the Factories and Machinery (Special Scheme of Inspection)

(Risk-Based Inspection) Regulations on June 1, 2014, the provision under the Factories and Machinery (Amendment) Act 2006 on special scheme of inspection shall now be fully implemented to see the effectiveness of the inspection approach for plant equipment using 'risks analysis'.

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