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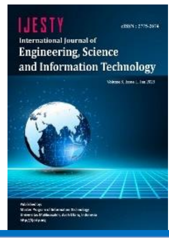


# JSA and HIRADC Analysis Of Mold Replacement Process On Inject Stretch Blow Machine

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**Abstract**

In plastic packaging companies using the Inject stretch blow machine (ISBM) process, changing molds is an activity that has the potential for work accidents. This is based on work activities carried out involving equipment that is quite heavy and has enormous dimensions. The purpose of this research is to find out the hazard factors of work accidents that occur and provide the development of solutions to avoid work accidents. This study uses the Job Safety Analysis (JSA) method and the Hazard Identification Risk Assessment and Determining Control (HIRADC) method. The results of this study are the factors that cause work accidents in the mold-changing process at the Inject stretch blow machine (ISBM). The stages carried out in this study are hazard identification, risk assessment, risk control, and residual risk assessment. The results obtained from this research are in the form of designing SOP (Standard Operating Procedure) for production activities and installing warnings on each machine, which will be used as a proposal for appropriate work risk control to prevent work accidents in this company. In addition, personal protective equipment that workers can use is the use of gloves, head protectors, and the use of safety shoes. In addition, workers are always required to check the working tools' condition before starting work. This will be used as an appropriate work risk control proposal to prevent work accidents in this company. In addition, personal protective equipment that workers can use is the use of gloves, head protectors, and the use of safety shoes. In addition, workers are always required to check the working tools' condition before starting work. This will be used as an appropriate work risk control proposal to prevent work accidents in this company. In addition, personal protective equipment that workers can use is the use of gloves, head protectors, and the use of safety shoes. In addition, workers are required to always check the working tools' condition before starting work.

***Keywords**: Mold, HIRADC, Job Safety Analysis, Work Accidents.*

## 1. Introduction

In the current industrial development, Indonesia has a relatively high level of development. Results in the industrial sector can be seen from the increase in the types of industries on a small, medium, and large scale. This industrial progress raises new challenges and problems, including the risk of work accidents in the corporate environment. The risk of this accident can impact the company, which can harm or reduce the company's productivity because employees or workers are inseparable from production equipment and machinery. These factors will help the process and production results. The overall costs of occupational accidents and diseases are often much more significant than immediately perceived. Conversely, investing in occupational safety and health (OSH) reduces direct and indirect costs, decreasing insurance premiums while improving performance and productivity. It also reduces absenteeism and increases worker morale. Nationally, reduced social security and health care costs mean lower taxes, better economic performance, and enhanced social benefits. The study considers 19 occupational risk factors, including exposure to long working hours and workplace exposure to air pollution, asthma, carcinogens, ergonomic risk factors, and noise. The critical risk was exposure to long working hours – linked to approximately 750,000 deaths. Workplace exposure to air pollution (particulate matter, gases, and fumes) was responsible for 450,000 deaths. The report warns that work-related diseases and injuries strain health systems, reduce productivity, and can affect household incomes. Globally, work-related deaths per population fell by 14 percent between 2000 and 2016. This may reflect improvements in workplace health and safety, the report says. However, deaths from heart disease and stroke associated with exposure to long working hours rose by 41 and 19%, respectively. This reflects an increasing trend in this relatively new psychosocial occupational risk factor. This first WHO/ILO joint global monitoring report will enable policymakers to track work-related health loss at country, regional and international levels. This allows for more focused scoping, planning, costing, implementing, and evaluating appropriate interventions to improve workers' population health and health equity. The report shows that more action is needed to ensure healthier, safer, more resilient, and socially just workplaces, with a central role played by workplace health promotion and occupational health services [1]. Occupational safety and health is a form of effort that aims to raise and maintain the highest degree of physical, mental, and social health for workers in all states of work. Occupational safety and health can also be interpreted as a form of protection for workers in their work from risks due to causes that are detrimental to health (World Health Organization). Occupational safety and health is the key as a benchmark for performance in job security for companies that want to protect employees in the work environment, such as general regulations that provide instructions to minimize accidents and provide protection for company assets.

The company that will be doing this research is a plastic packaging company whose main process is an Inject stretch blow machine (ISBM) to produce bottles for medicine, cosmetic bottles, eye drop bottles and so on. In the Inject stretch blow machine (ISBM) process, there is a mold replacement activity where the frequency is quite frequent, namely an average of 2 times per day, where this activity has a high potential for danger. This potential is because quite a lot of equipment is used, including cranes, large locks, clamps, etc. Apart from the equipment used, the molds that were replaced weighed more than 500 kg and were machined about ½ meter, and were made of iron. The causes of work accidents in this case study are very diverse, such as a foot or hand caught in a mold, hit by a wrench, shot by a crane hook, and so on. Seeing that there is a significant potential for workplace accidents in the mold-changing activity, it is necessary to carry out a potential hazard analysis, risk assessment, and risk control by applying the Job Safety Analysis (JSA) method and Hazard Identification Risk Assessment and Determining control (HIRADC).

With the existence of an Occupational Safety and Health Management System (OSHM) that companies have implemented by government standards, it can reduce the risk of a company in terms of work accident rates which can later affect costs. Job Safety Analysis (JSA) is a form of identifying hazards in a working condition as well as controlling and mitigating efforts to minimize illness or accidents caused by accidents and work-related illnesses that may arise from a job [2]. Hazard Identification Risk Assessment and Determining control (HIRADC) is a form of the process of identifying hazards, measuring, and evaluating risks that arise from something that can pose a risk of occupational hazards after that calculating the adequacy of existing control measures and deciding which chances are acceptable or not [3]. JSA and HIRADC are essential elements in the occupational safety and health management system because they are directly related to mitigating and controlling hazards used to determine objectives and work safety and health plans.

Several previous studies on work accidents were mainly carried out using the method of job safety analysis (JSA) and Hazard Identification Risk Assessment and Determining control (HIRADC) regarding the results obtained from his research in the application of job safety analysis as an effort to prevent work accidents and also improve work safety at PT Shell Indonesia [4]. The results obtained from this study by providing refreshments every week about the risks of hazards that exist in the workplace. Research conducted by [5] Based on these problems, the researchers offer suggestions for improvements to reduce the number of work accidents using the Job Safety Analysis (JSA) method. The purpose of this research is to plan a strategy to reduce work accidents and apply the Job safety analysis (JSA) method and Hazard identification, risk assessment, and determine control (HIRADC). Severity and frequency of occurrence of the hazard. Control measures must follow Control Techniques (Elimination, Substitution, Engineering, Administration, PPE) and their implementation in Injection stretch blow machine which has not been discussed in previous studies.

## 2. Literature Review

Risk Assessment according is an important systematic process that aims to assess the impact, occurrence, and consequences of human activities in systems with hazardous characteristics and is also a tool that companies want for policies regarding company security [6]. Risk assessment defining the criteria like hood and consequences (severity) [7]. The likelihood criterion used is based on the company's track record within a certain period. The Consequences (severity) bar used is what the worker will receive as a result which is defined qualitatively and takes into account the lost working days [9]. The risk rating is the result of multiplying the value of the likelihood level with the Consequences value of each hazard. Determination of the value of the likelihood and severity of each hazard risk is conducted using interviews with the K3 section. After the likelihood and consequence values have been obtained, the next step is to look for the risk rating value by matching the likelihood value with the resulting Consequences value.

### 2.1. Job Safety Analysis (JSA)

Job Safety Analysis (JSA) is a way of identifying hazards in an environment or working conditions as well as a form of control and prevention in order to avoid illness or accidents caused by accidents and work-related illnesses that may arise from a job [8].

Job Safety Analysis (JSA), which is a hazard and risk identification process based on each stage in a work process.

1. Identification of hazards associated with each step of the work that has the potential to cause serious harm, before an accident occurs.
2. Determine how to control hazards or reduce injury rates.
3. Create written tools that can be used to train other staff

   The advantages of making a Job Safety Analysis are as follows [9]:

1. Provide individual training in safety and efficient work procedures.
2. Establish worker safety contacts.
3. Prepare for planned safety observations.
4. Entrusting work to new workers.
5. Provides pre-job instructions for great jobshere.

### 2.2. Hazard Identification Risk Assessment and Determining Control (HIRADC)

Hazard Identification Risk Assessment and Determining control (HIRADC) is the process of identifying hazards, measuring, evaluating risks that arise from something that can cause harm, then calculating the adequacy of existing control measures and deciding which risks are acceptable or not [10]. HIRADC is an important element in the occupational safety and health management system because it is directly related to efforts to prevent and control hazards that are used to determine objectives and work safety and health plans.

The advantages of using the HIRADC technique include understanding the stages of work and their hazards, knowing work-related hazards earlier, so that the chance of an accident can be quickly reduced or eliminated, efficiency will increase, the HIRADC technique can also influence the purchase of tools that are safer at work [11].

Things that must be considered in implementing HIRADC:

1. Identification of hazards that may occur
2. Determine the type of hazard and who is potentially exposed to the hazard
3. Risk evaluation and determination for hazard and risk control (must consider the hierarchy of controls: elimination, substitution, isolation, engineering control, marking/warning/administrative control, PPE)
4. Changes from HSE management
5. Recording and documentation of HIRADC activities (eg: HIRADC register)

In determining the making of a methodology or way to carry out HIRADC, and the methodology used is in the form of proactive actions including [12]:

1. Direct observation, the way to do this must be direct observation submitted to the organization depending on the needs of the organization to carry out HIRADC, depending on the scope, nature, size of the organization, time, cost and data availability for HIRADC implementation. selected can cover the implementation of HIRADC in the organization.
2. Group Discussion, before carrying out the HIRADC technique, a focus group discussion is needed by people who are competent and involved in the implementation.
3. Imagine, competent people must be able to imagine risks, hazards, and determine strategies in implementing work safety using the HIRADC technique.

The factors assessed in the HIRADC method are the likelihood and impact of these hazards. In addition, what is considered to be lowered is not to the person, but more to the danger posed up to the permissible limithere.
Hierarchy of Control is a risk control system and mechanism that is carried out in a structured manner starting from the simple to the more complex. The control system should and should be done in stages. Structurally, the Hierarchy of Control can be described as follows [13]:

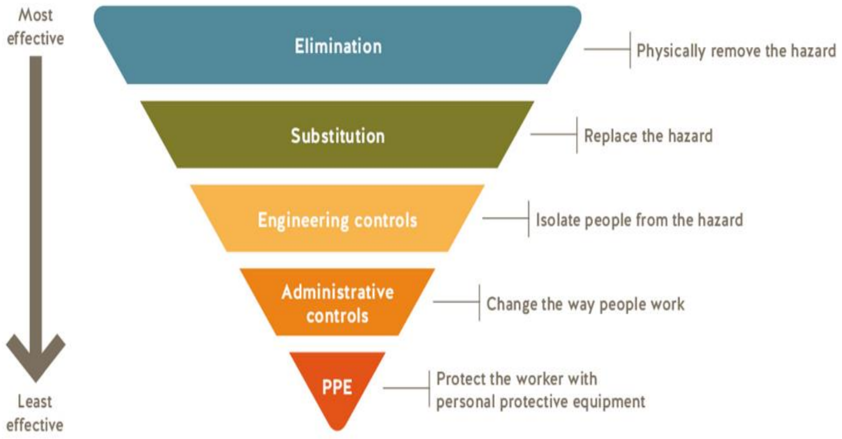


**Fig 1.** Hierarchy of Hazard Control

Elimination is the first stage in the Control Hierarchy. Elimination is an attempt to eliminate the source of danger. Eliminating the source of the hazard is done by eliminating or removing the object or work that is the source of the hazard [14] [15].
Substitution is the second stage in the Control Hierarchy. Substitution is the process of substituting hazardous materials, processes or procedures with less hazardous ones. With this control system, a redesign of a system or mechanism will be required [16] [17].
Engineering is the third stage in the Hierarchy of Control. Engineering is doing hazard segregation to prevent risks from occurring. In engineering, this is usually carried out in the form of modifications in such a way that potential hazards can be minimized or even eliminated [18] [19].
Administration is the fourth stage in the Hierarchy of Control. In the Hierarchy of Control, administration can also be used as a control tool, namely from the side of the person doing the work, namely by implementing procedures that are deemed necessary. With this administrative control, it is expected that people working around can comply and be able to do work safely [20].

## 3. Methods

This Based on the method of data collection, this research is observational in nature, because the data was obtained through observation and no treatment was carried out on the research object during the research. Based on the time of research, this research is cross-sectional in nature, because data collection was carried out all at once. If reviewed based on analysis, this research is a descriptive research that is describing the process without analyzing the relationship of variables [21].
In the activity of changing the mold on the machine, it is carried out by at least 2 people considering the equipment that is unloaded is quite heavy and also the complexity in handling it. In general, the activities carried out and the potential hazards that can occur can be described as follows:

**Table 1**. Changing Mold ISBM analysis activities

| No | activity | Potential hazard | Risk |
|---|---|---|---|
| 1 | Turn off Barrel temperature & hot runner | The skin touches the hot cover barrel | Skin blisters / burns |
| 2 | Unscrew the ejector rod unit mounting bolts | The operator is caught in the machine/tool | Wounds or defects |
| 3 | Lower the Ejector rod unit from the engine | Incorrect body position when lifting the mold without assistance | Sprain |
| 4 | Unscrew the Blow Core fasteners | The operator is caught in the machine/tool | Wounds or defects |
| 5 | Lowers the Blow Core unit from the machine | Incorrect body position when lifting the mold without assistance | Sprain |
| 6 | Reducing heating pot binders, cores, lip cavities | The hand is pinched/cut into the mold/tooling or work tool | Wounds or defects |
| 7 | Lowering bottom Mold & blow mold | The head or limbs hit the mold or machine parts | Wounds or defects |

| | | | |
|---|---|---|---|
| 8 | Placing the blow mold and bottom mold in the trolly | The foot or hand is caught in the mold | Bruises or broken bones |
| 9 | Drain cooling Injection core & Hot runner | Pressurized hot water spray | blisters or burns |
| 10 | Reducing Injection cavity, core and hot runner | Limbs | |
| 11 | Bring trolley molds and old tooling to MTP | The foot or hand is caught in the mold | Bruises or broken bones |
| 12 | Bringing new Molds and Tooling to the machine | Slipping or pulling a load that is too heavy | Sprain |
| 13 | Install injection cavity and hot runner | Pinched finger | Cuts or bruises |
| 14 | Install blow mold, ejector, blow core | Pinched finger | Cuts or bruises |
| 15 | Installing heating pots, heating cores and lip cav | Hot conditions on the hands directly | Blisters |
| 16 | Install Injection core, bottom mold, blow core unit | Pinched finger | Cuts or bruises |
| 17 | Clamping Injection cav, blow mold, lip cav, heating pot and cav | The foot or hand is caught in the mold | Bruises or broken bones |
| 18 | Tighten all mold fixing bolts | Pinched finger | Cuts or bruises |
| 19 | Running the machine without material | Plugging the plug into a wet socket | Electric shock |
| 20 | Take material from MPC | Back pain due to wrong body position when lifting the mold/tooling | Sprain or back pain |
| 21 | Fill Material into the hopper | Fall while climbing stairs or on machinery | Bruises or broken bones |
| 22 | Materials Heating | The limbs were sprayed with liquid material | Scalded skin (Burns) |
| 23 | Raising the temperature of the barrel and hot runner | Hand touched the hot part | Scalded skin (Burns) |

## 4. Results and Discussion

From the results of observing the activity of replacing the mold or mold consisting of 23 work activities both routine and non-routine, the work activity is broadly divided into 4 stages, namely removing the mold or mold, lowering the mold from the machine, raising the replacement mold and installing the mold to the machine.

Hazard identification was carried out in 23 work activities, both routine and non-routine, during mold replacement work using the Job Safety Analysis (JSA) method and continued with the steps of carrying out a risk assessment. In carrying out a risk assessment there are two stages, namely risk analysis and evaluation. The risk assessment carried out in this study uses a semiquantitative risk analysis method which consists of three aspects of assessment [22]. The three aspects assessed and evaluated in the semiquantitative risk analysis method include likelihood [23]. Furthermore, the handling of these hazard risks is carried out using the HIRADC method, where the overall results can be seen in table 2 below.

**Table 2 .** Risk analysis and countermeasures

| No | activity | Potential hazard | Risk | Risk Calculation | Mitigation |
|---|---|---|---|---|---|
| 1 | Turn off Barrel temperature & hot runner | The skin touches the hot cover barrel | Skin blisters / burns | Currently | PPE, with gloves |
| 2 | Unscrew the ejector rod unit mounting bolts | The operator is caught in the machine/tool | Wounds or defects | Low | Adm, by making WI |
| 3 | Lower the Ejector rod unit from the engine | Incorrect body position when lifting the mold | Sprain | Currently | Technically, by using a lifter |
| 4 | Unscrew the Blow Core fasteners | The operator is caught in the machine/tool | Wounds or defects | Low | Adm, by making WI |
| 5 | Lowers the Blow Core unit from the machine | Incorrect body position when lifting the mold | Sprain | Currently | Technically, by using a lifter |
| 6 | Reducing heating pot binders, cores, lip cavities | The hand is pinched/cut into the mold/tooling or work tool | Wounds or defects | Low | Adm, by making WI |
| 7 | Lowering bottom Mold & blow mold | limbs hit by parts of the mold or machine | Wounds or defects | Tall | Technically, by using a lifter |

| | | | | | |
|---|---|---|---|---|---|
| 8 | Placing the blow mold and bottom mold in the trolly | The foot or hand is caught in the mold | Bruises or broken bones | Tall | Technically, by using a crane |
| 9 | Drain cooling Injection core & Hot runner | Pressurized hot water spray | blisters or burns | Low | Adm, by making WI |
| 10 | Reducing Injection cavity, core and hot runner | Incorrect body position when lifting the mold | Sprain | Currently | Technically, by using a lifter |
| 11 | Bring trolly molds and old tooling to MTP | The foot or hand is caught in the mold | Bruises or broken bones | Low | Substitution, using a forklift |
| 12 | Bringing new Molds and Tooling to the machine | Slipping or pulling a load that is too heavy | Sprain | Currently | Substitution, using a forklift |
| 13 | Install injection cavity and hot runner | Pinched finger | Cuts or bruises | Currently | Adm, by making WI |
| 14 | Install blow mold, ejector, blow core | Body crushed by equipment | Wounds or Broken Bones | Tall | Technically, a retaining tool is made |
| 15 | Installing heating pots, heating cores and lip cav | Hot conditions on the hands directly | Blisters | Currently | PPE, with gloves |
| 16 | Install Injection core, bottom mold, blow core unit | Pinched finger | Cuts or bruises | Currently | Adm, by making WI |
| 17 | Clamping Injection cav, blow mold, lip cav, heating pot | The foot or hand is caught in the mold | Bruises or broken bones | Tall | Technically, a retaining tool is made |
| 18 | Tighten the mold fixing bolts | Pinched finger | Cuts or bruises | Low | Adm, by making WI |
| 19 | Running the machine without material | Plugging in a socket in wet conditions | Electric shock | Currently | Adm, by making WI |
| 20 | Take material from MPC | Back pain due to wrong body position when lifting | Sprain or back pain | Tall | Technically, a material suction tool is made |
| 21 | Fill Material into the hopper | Fall while climbing stairs or on machinery | Bruises or broken bones | Tall | Technically, a material suction tool is made |
| 22 | Materials Heating | The limbs were sprayed with liquid material | Scalded skin (Burns) | Currently | Technically, a tool is made to hold the material |
| 23 | Raising the temperature of the barrel, heating pot and hot runner | Hand touched the hot part | Scalded skin (Burns) | Currently | PPE, with gloves |

## 5. Conclusion

In The hazard identification that has been carried out resulted in 23 potential hazards contained in the process of replacing the ISBM machine mold from all work activities that could pose a risk. The results of the risk assessment carried out are 23 risks with a risk rating consisting of 6 risks with high risk rating, 11 medium risk, 6 low risk. Risk control for workers in the ISBM machine mold replacement process has been carried out based on a risk control hierarchy, namely Elimination, Substitution, technical, administrative and use of PPE. Where by carrying out these controls, the risk of workers experiencing work accidents can be minimized and even eliminated as well. Henceforth, the JSA and HIRADC analysis processes must also be applied to other processes and machines, where this will reduce the potential for work accidents which in the end can be detrimental to the company if they occur.

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