DESIGN AND ANALYSIS OF PNEUMATIC PEDAL PUSHER AT TOYOTA KIRLOSKAR MOTORS

[1]Darshan Sharanappa.Ballari, [2]Praveen M.P

[1]M.Tech in PDM, [2]Associate Professor, East Point College of Engineering & Technology Bangalore-560049

Abstract: **A well-defined and Systematic methodology is essential to reducing extra man movement (MURA) and deleting the overburden (MURI), which in turn has considerable influence on the cost reduction of industry. Pneumatic Pedal Pusher is the equipment used for the operation, Break Oil Leakage checking in function inspection area at Toyota Kirloskar Motors. The equipment is used for the confirmation of brake oil leakage as by operating the pneumatic cylinder and pushing the brake and accelerator pedals of car, and then the equipment is taken off after completion of process. In this paper the Pokayoke design and development is done in the Kaizen area at Toyota Kirloskar Motors to eliminate the extra process (MURA) and idle time of worker.**

Keywords: **Poka-yoke, MURA, MURI, Kaizen, Pneumatic Pusher.**

1. INTRODUCTION

Work plays a central role in the majority of adult lives at many social economic levels. It maintains income and contributes to individual identity and social status. There is emerging evidence that continued participation in a work role has therapeutic benefits. From the point of view of employment, the term “extra movement” refers to that the process which takes a lot of time to maintain a suitable job and to progress within that job are remarkably lower than the general processes due to some abnormality in working area.

At Toyota Kirloskar Motors, In Quality Inspection area at the function line brake oil leakage checking process takes place, where one of the Team Member should stay in the vehicle as to press the Break and Clutch for the brake oil leakage confirmation. This process leads to extra moment (MUDA) of Team member and also need extra member to do this process. To eliminate these problems more trails are done with different methods and finally the problems are reported as for my study paper and got concluded with relevant designs as per TKM working Standards.

2. LITERATURE SURVEY

2.1 Poka-Yoke

The Poka-Yoke (a Japanese word that means mistake-proofing) technique was first developed in 1961 by Shigeo Shingo. Poka-Yoke uses devices on process equipment to prevent the human or machine errors that result in defects, or to inexpensively inspect each item produced to determine whether it is acceptable or defective. Poka-Yoke-designed manufacturing devices are one of the bases of Shingo’s zero quality control concepts, which mean that the defect rate in a production system is zero. Poka-Yoke design can dramatically decrease the risk of producing defectives products (Shingo, 1986). The Poka-Yoke philosophy also aims to make work easier and prevent errors caused by monotony or other process-related causes.

In many productive environments, there is a tendency to equate speed with productivity. Traditional engineering processes are designed to increase the efficiency of an operation by enabling people and machines to work faster, and processes are usually complicated to achieve greater speed; yet it is these complications which cause many of the errors people and equipment make, resulting in more defective products.

By contrast, the Poka-Yoke philosophy aims to increase productivity by simplifying processes, making them more efficient, reducing the number of errors that need to be corrected, and increasing the overall efficiency of the system. Poka-Yoke can be used wherever errors can occur and can be applied to any type of processes and helps workers to be “right first time”, enhancing the quality of the product and the overall output of the process. Poka-Yoke supports efforts to eliminate waste caused by: over production, inventory, waiting, transportation, motion, over processing, quality defects, reprioritization and also waste caused by people's skills. Most importantly, Poka-Yoke was developed with the aim of making work easier for workers without disabilities, and as such demonstrate the value of often simple adaptations tailored to the job at hand.

It is often assumed that adaptations to support the diversity of situations faced by disabled workers present a huge challenge for designers. In fact, the extra intellectual effort needed to overcome disability often results in a better final design for both the disabled and non-disabled users.

Poka-Yoke represents a suite of simple and relatively inexpensive ways of improving access to work and the productivity and performance of disabled and non-disabled workers, and a powerful tool for implementing Universal Design in the workplace. [7]. Universal design of workplaces through the use of Poka-Yokes: Case study and implications

Cristobel Miralles.

2.2. Introduction to Symbols of Pneumatic Valves

Directional air control valves are the building blocks of pneumatic control. Symbols representing these valves provide a wealth of information about the valve it represents. Symbols show the methods of actuation, the number of positions, the flow paths and the number of ports.

Here is a brief breakdown of how to read a symbol:

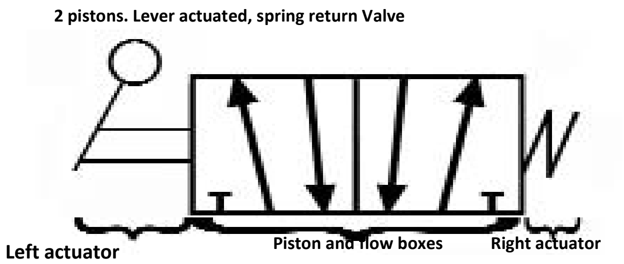

Fig 1: Symbol Representation

Every symbol has three parts (see figure to right). The Left and Right Actuators are the pieces which cause the valve to shift from one position to another. The Position and Flow Boxes indicate how the Valve functions. Every valve has at least two positions and each position has one or more flow paths. When the Lever is not activated, the Spring Actuator (right side) is in control of the valve; the box next to the actuator is the current flow path. When the Lever is actuated, the box next to the Lever is in control of the valve. Each position occurs when the attached actuator is in control of the valve (Box next to the actuator). A valve can only be in on “Position” at a given time. The number of boxes that makes up a valve symbol indicates the number positions the valve has. Flow is indicated by the arrows in each box. These arrows represent the flow paths the valve has when it is that position (depending upon which actuator has control over the valve at that time). The number of ports is determined by the number of end points in a given box (only count in one box per symbol as the other boxes are the just showing different states of the same valve). In the example, there are a total of 5 ports.

NOTE*:* Sometimes a port (such as exhaust) goes directly to atmosphere and there is no port to attach to. To spot this, the actual ports line will extend beyond the box, while the ports you cannot attach to will not.

A Port is blocked with this symbol: **T**

[8]. Introduction to Pneumatics and valves, by Juan A. Marin-Garcia.

2.3 Common Types of Cylinders

There are many different cylinder types. The most common are listed below:

a. ***Single acting cylinder:*** a cylinder in which air pressure is applied to the movable element (piston) in only one direction.

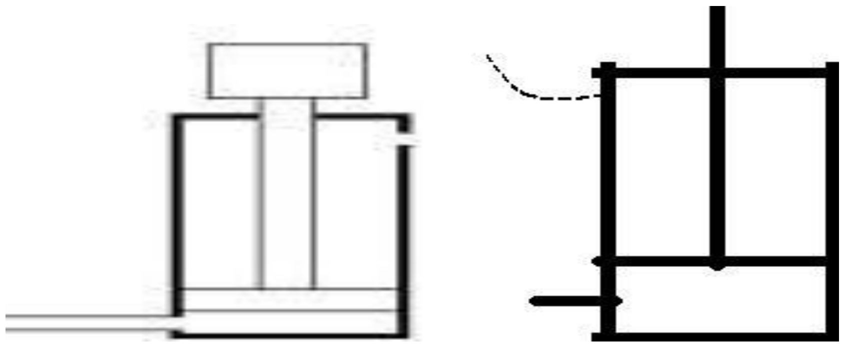

Fig 2: Single acting cylinder

b. ***Spring return cylinder:*** a cylinder in which a spring returns the piston assembly.

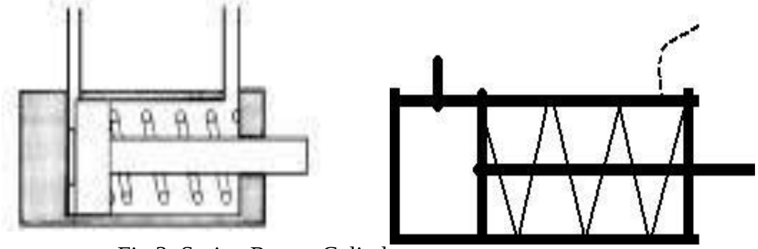

Fig 3: Spring Return Cylinder

c. ***Ram cylinder:*** a cylinder in which the movable element is the piston rod.

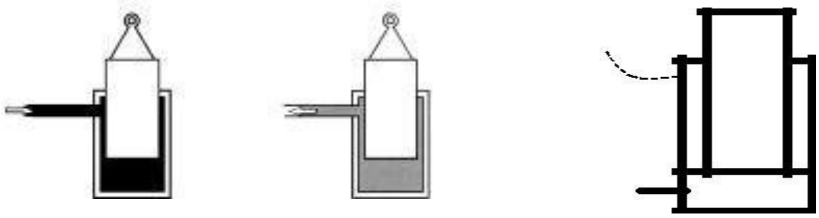

Fig 4: Ram Cylinder

d. ***Double acting cylinder:*** a cylinder in which air pressure may be alternately applied to the piston to drive it in either direction.

Fig 5: Double acting Cylinder

e. ***Double acting: double rod cylinder:*** Double acting cylinder with a piston rod extending forms each end. The piston rods are connected to the same piston. Double rod cylinders provide equal force and speed in both directions.

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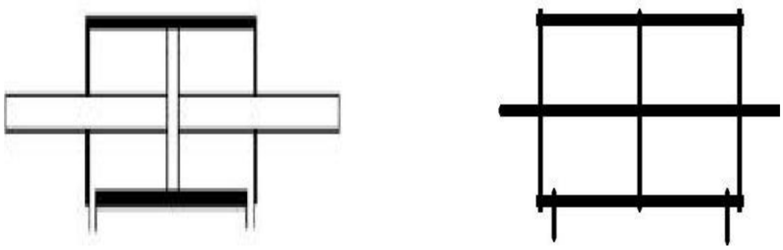


Fig 6: Double acting- Double Rod Cylinder

3. EXPERIMENTATION & METHODOLOGY

3.1 Concept Selection

Concept selection is the process of evaluating concept with respect to customer needs and other criteria, comparing the relative strengths and weakness of the concepts, and selecting one or more concepts for further investigation or development.

- We use some method, implicit or explicit, for selecting concepts, Decision techniques employed for selecting concepts range from intuitive approaches to structured methods.
- Successful design is facilitated by structured concept selection. We recommend a process called ***Concept Screening Matrix***.
- Concept screening uses a reference concept to evaluate concept variant against selection criteria and it uses a coarse comparison system to narrow the range of concepts under consideration.
- Concept selection is applied not only during concept development but throughout the subsequent design and development process.
- Concept selection uses matrix as the basis of six-step selection process. The six steps are:
    1. Prepare the concepts.
    2. Rate the concepts.
    3. Select one or more concepts.

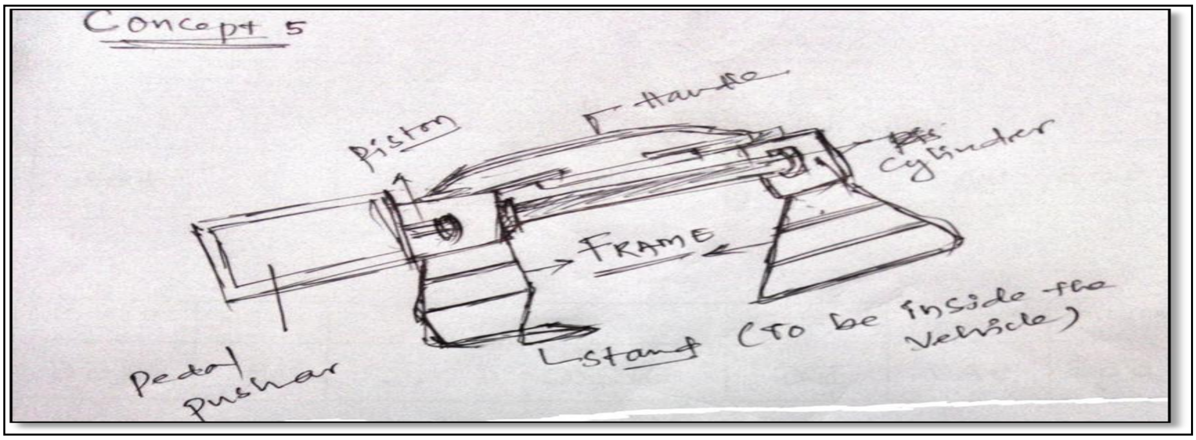


Fig 7: Pedal Pusher Created Concept

3.2 2-D and 3-D full model

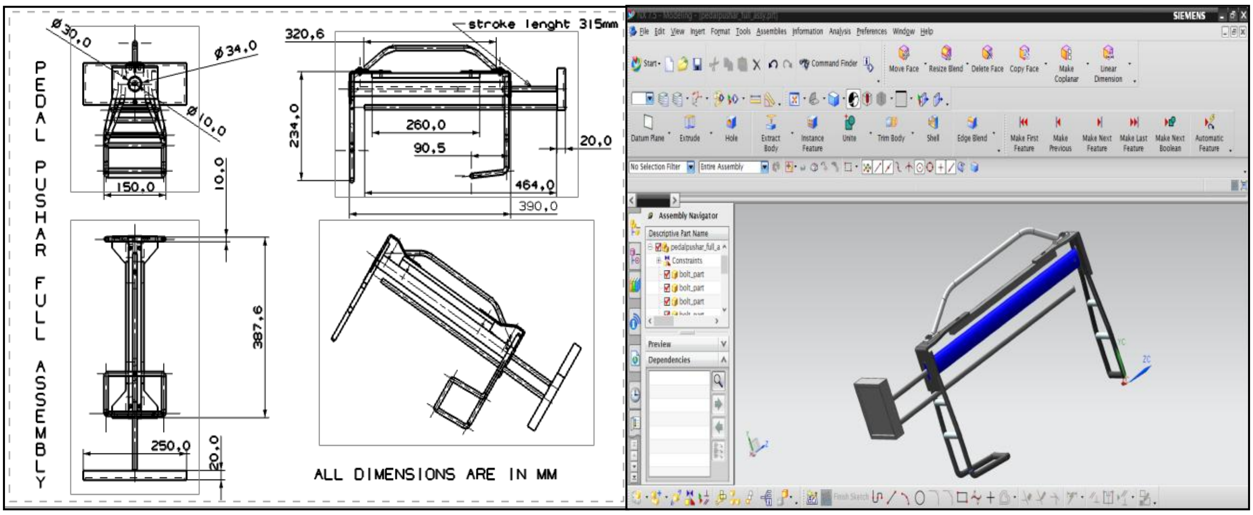


Fig 8: Detail Design of equipment

3.3 Part Analysis Condition

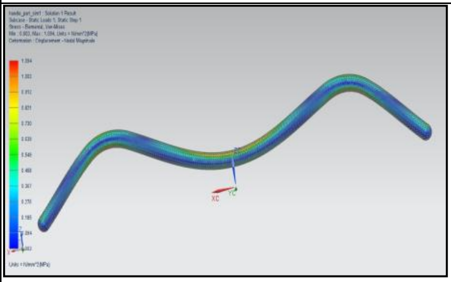
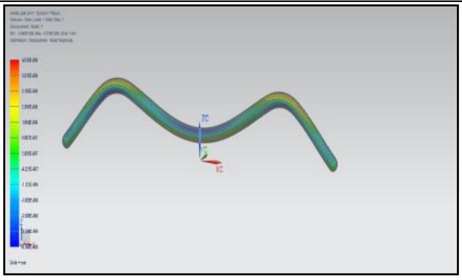
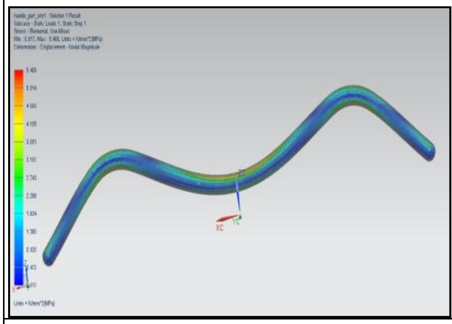
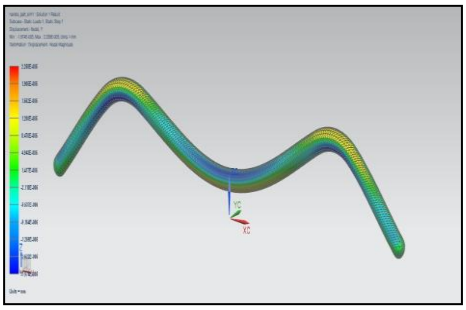
VON-MISES Stress	**Displacement**
Handle part: Load= 10N	
	
Handle part: Load= 50N	
	
VON-MISES Stress	**Displacement**

Fig 9: Testing Condition for Handle part of Pedal Pusher

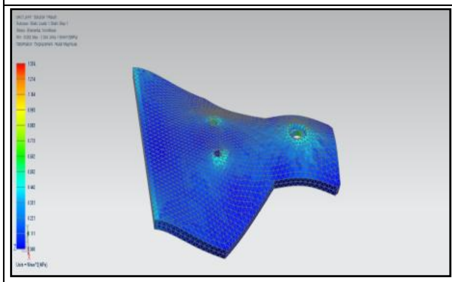
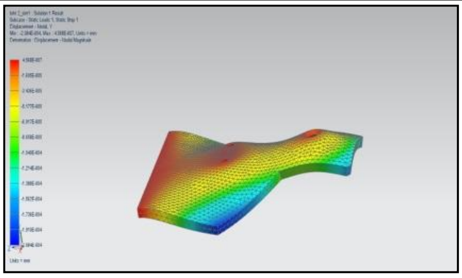
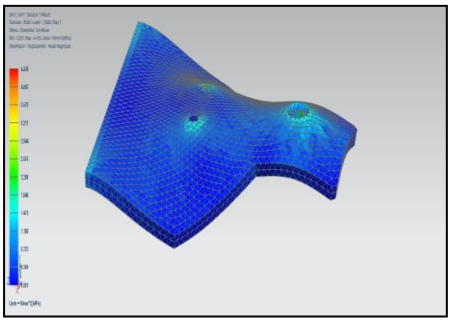
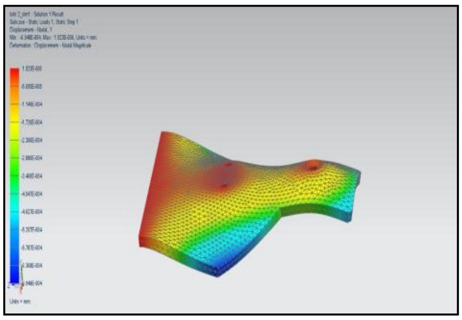
End Bracket Part: 30N	
	
End Bracket Part: 100N	
	

Fig 10: Testing Condition for Mounting End Bracket Part of Pedal Pusher

Results Sheet:

Components	**Load**		**Max stress (Mpa or N/mm^2)**	**Deformation (mm)**	
	N	**Kg**		**Min**	**Max**
Handle part (pedal Pusher)	10	1	1.094E02	-3.95E-06	4.50E-06
	30	3	3.281E02	-1.19E-05	1.35E-05
	50	5	5.468E02	-1.97E-05	1.35E-05
Bracket Part (pedal Pusher)	30	3	1.32E02	-2.08E-04	4.56E-07
	50	5	2.207E02	-3.47E-04	7.61E-07
	100	10	4.415E02	-6.94E-04	1.52E-06

Table 1: Testing Result Table

All above figures will show the structural analysis of Pneumatic Pedal Pusher parts. From the NX-NASTRON results we can see the different loading condition and with respect to that change in maximum stress and displacement conditions as by varying the loading conditions from above table.

For Pneumatic pedal Pusher:

Bracket part: Min load = 30-50N
Max load = 50-100N

Handle part: Min Load = 10-30N
Max Load = 30-50N

4. IMPLEMENTATION RESULTS AND PROCESS FLOW

The pedal pusher product is successfully implemented at Plant # 1, Functional line inspection Area for the Break Oil Leakage Checking Process.

It is noted that during implementation some changes are made at the processes of function line inspection area. Which includes as the process member should keep the pedal pusher inside the vehicle and press the valve to operate and push the pedals. After completion of process, that should be taken out from the vehicle and the process carried out next vehicle as same.

Below represented figure and flow chart will show the implemented condition at plant #1.

Results:

1. The pedal pusher is having a length of 250 mm, width of 200 mm and weighs 3 kg is fabricated as by considering all essential data's as required for the process.
2. Specially designed to suit a particular process (Pedal Pushing of the vehicle).

Figure shows the pedal pusher product and it application and the process flow.

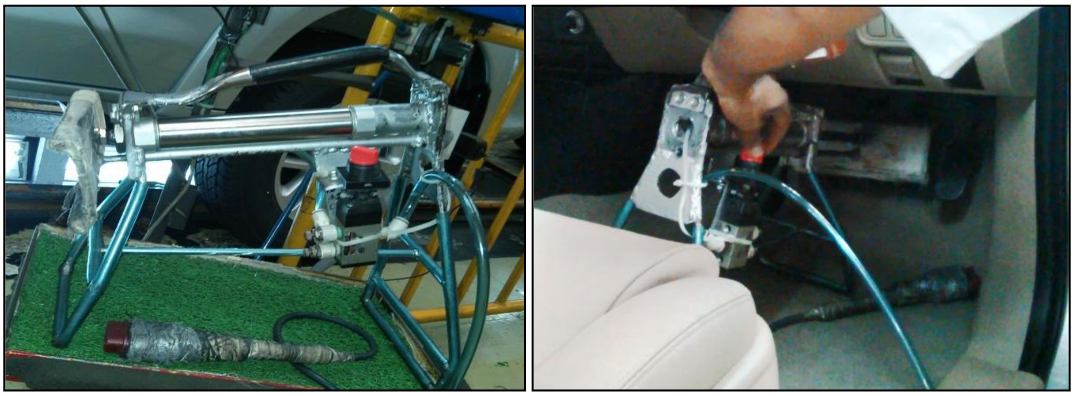
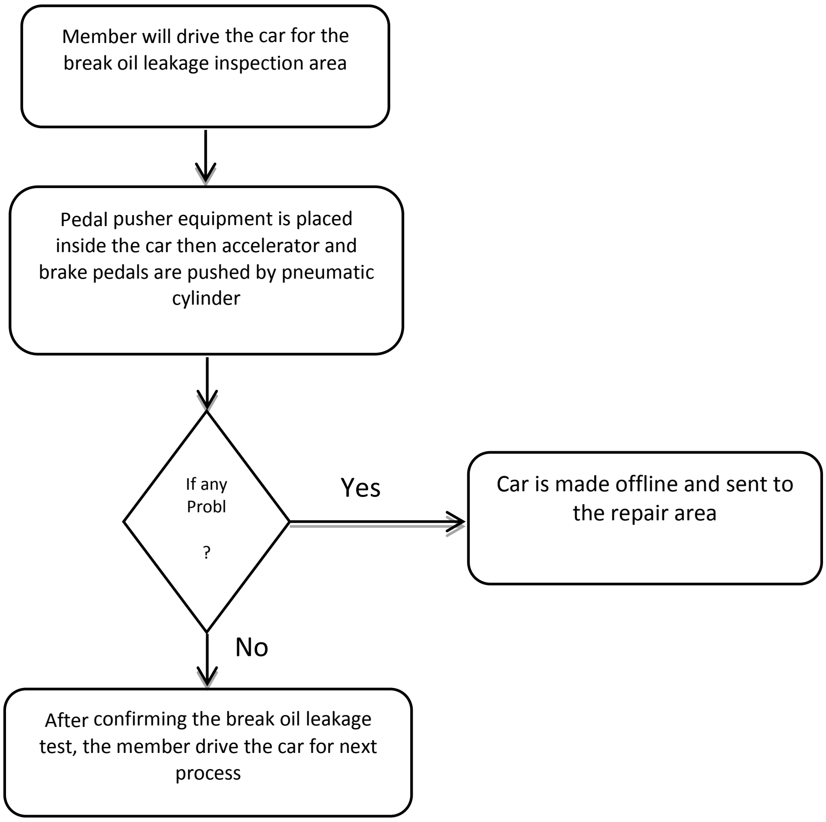


Fig 11: Equipment handling and working condition

Process Flow:



Flow Chart 1: Equipment Handling Process

5. CONCLUSION

Pneumatic Pedal Pusher provides the best design for to press pedals at break oil inspection of vehicles. The design is made as per TKM standards of working condition and which also contributes in eliminating extra man movement at the process. The design is made as to operate the pedal pusher equipment by pneumatic force actuator and made easy to handle and operate.

After conducting number of trails and discussions the pedal pusher equipment is successfully implemented in the vehicle function inspection area at Toyota Kirloskar Motors industry.

5.1. Future Scope

1. Small change in design of Pedal Pusher equipment can make aesthetically look good.
2. Making Compact size can make an easy process for the members.
3. By introducing fully automated system for the equipment can make zero man movement.
4. Product can be Enhanced Ergonomically well than the existing as by making alteration in handling and operating of Equipment.

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