Operational Tabletop Drills to Improve Emergency Response Capabilities and Process Safety Culture

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Although it is mandatory to conduct emergency response drills at regular intervals as part of a legal requirement, Tupras aims to turn this obligation into gains and contribute to a safety culture within the organization. Tupras takes the emergency planning and response management one-step further and lays the foundations of its own operational tabletop drill, which is a cost-effective, scenario-based discussion designed to simulate an emergency without the expense of assembling the response team and staging a full-blown drill.

Keywords: process safety management system, emergency response, safety culture, operational discipline, employee participation, operational tabletop drill, preventive safeguard

INTRODUCTION

What people see, hear, feel, and say are influenced by their culture. In the organizations it is important to build the common culture to affect people's decisions and behaviours since the outcome of these behaviours and decisions have biggest impact on safety and performance. To prevent hazardous situations in refineries without delay and hesitation, an effective safety culture and operational discipline must be established.

One of the applications to develop safety culture in Tupras is operational tabletop drills. It provides different perspectives to the emergency management element under PSM elements [1].

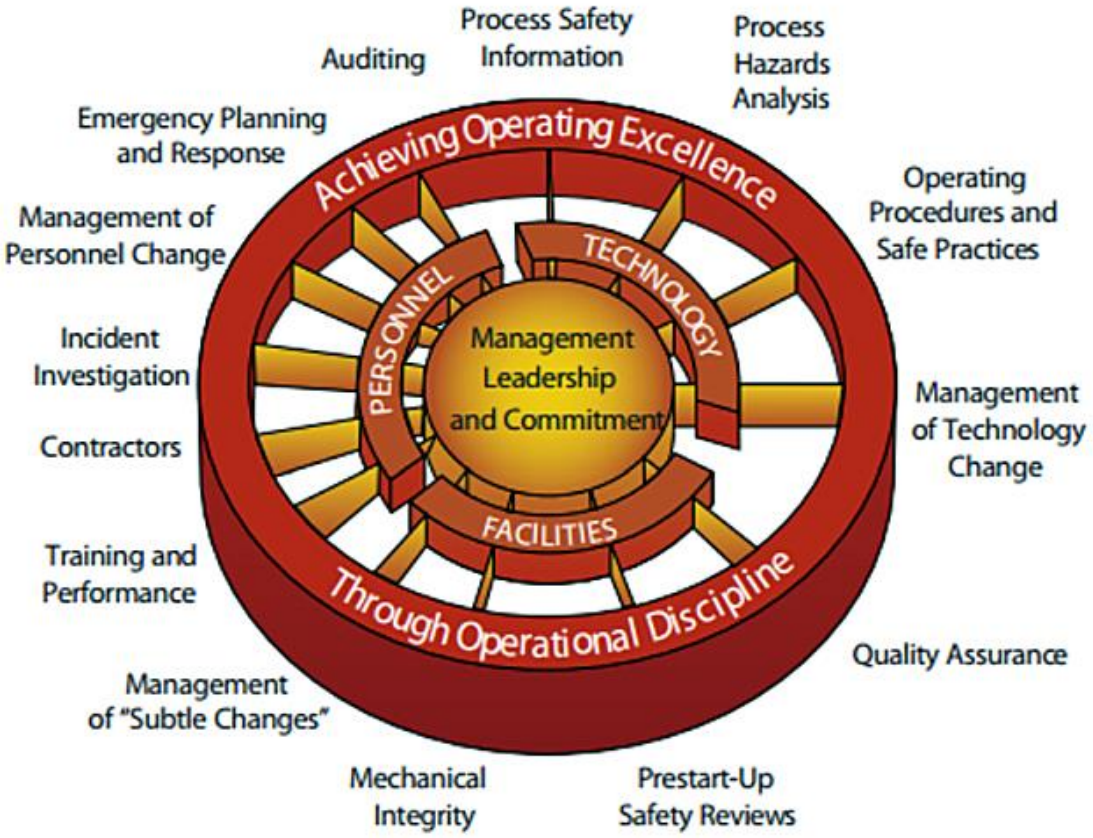

Figure 1: Elements of a Process Safety Management System [1]

According to Turkish legislation, it is obligatory to exercise critical equipment-based emergency response scenarios at intervals not exceeding 3 years, with at least one live drill per year to determine the accuracy, adequacy, and applicability of the emergency plan. Although it is mandatory to conduct emergency response drills at regular intervals as part of a legal

requirement, Tupras aims to turn this obligation into gains and contribute to a safety culture within the organization. Tupras takes the emergency planning and response management one-step further and lays the foundations of its own operational tabletop drill, which is a cost-effective, scenario-based discussion designed to simulate an emergency without the expense of assembling the response team and staging a full-blown drill.

In addition to the drill carried out by the emergency response teams, operational tabletop drills are organized to proactively deal with process safety in the refinery and take precautions against possible hazards, to become competent on the response side, to review the effectiveness/adequacy of our existing barriers, and to increase unit operators' experience/competency at the same time.

Focusing on the operational intervention and addressing the management of asset integrity before a loss of primary containment occurs or talking about the unit operator actions during emergency is a powerful weapon for emergency planning and response management. Thanks to the operational tabletop drills, discovering where and how plans fall short before anything more serious than the scenario happens can undoubtedly save lives and protect assets, the environment and reputation.

While the emergency response drills focus on reducing the consequences of an emergency, operational tabletop drills deal with preventing the events from happening, developing mechanism of instant and effective decision-make in a crisis.

SCOPE OF THE OPERATIONAL TABLETOP DRILLS

The resources of credible scenarios

As the scenarios of operational tabletop drills can be produced by being inspired by real events, it has been seen that it is more beneficial to deal with possible risks if they are predicted and applied before a more dangerous event occurs. The scenarios should be jointly developed by representatives of process safety and operations. To promote the drills throughout the refinery, process safety team create a scenario pool for supporting the operations team.

Seveso scenarios defined for critical equipment, critical scenarios from Hazop risk assessment studies, experiences from incident investigations and behaviour-oriented scenarios in the operator training program are addressed as auxiliary resources for drills. The abbreviations of scenario sources are used as follows; SEVESO, HAZOP, OSAR, RAYEP respectively. It is advised that the balance between low-frequency/high-consequence and high frequency/low consequence scenarios can be sought by unit chiefs.

Although catastrophic events are rare, it is important to explain that they are aspects of a dangerous workplace. SEVESO scenarios are very useful to prepare personnel as if they will happen, to tell what may happen at the end of the day, and to discuss what can be done to prevent it. Operational tabletop drills provide a platform to discuss these scenarios.

Mutual gain can be achieved by making HAZOP scenarios as main topic. As the unit operators gain knowledge about risk assessment, and develop, they can contribute to Hazop study with their experience and a risk-based perspective of operation team will increase and safety culture will ultimately develop.

Considering OSAR scenarios in operational tabletop drills helps to talk lessons learned from the events, to ensure operators participation and information. Besides, RAYEP scenarios contribute to testing reaction times in the field and refreshing operator knowledge in time.

When utilizing a ready-made scenario pool, the use of communication boards in unit control rooms for collecting scenario suggestions is also encouraged. It is thought that this not only contributes to the tabletop drills, but also supports the communication within the unit. By taking operator's opinion on scenario topic, it is aimed to make them own these tabletop drills and engage the activity. It is crucial that drills should be developed and conducted with significant worker involvement.

Participants

In general, field operators, control operators, head operators in shift, operations engineers and process safety engineers attend the operational tabletop drills. Since there is a shift system in Tupras, it is also important that the drill held during the day should reach to all shifts to ensure a conversation among themselves. Emergency response team can be sometimes invited as relevant discipline. Unit-based operational tabletop drills are aimed to be carried out in an interactive and open communication. To strengthen the effectiveness of these drills and support the team and to reinforce the visible leadership, the participation of the managers is also ensured.

The approach to unit operators during operational tabletop drills is very crucial element. It is advised that there should be an effective two-way communication where operators share their opinions openly and transparently, rather than a platform where the managers and engineers speak most, and operators listen to them. The operator should not hesitate to give the wrong answer in front of everyone, should not be afraid of saying something wrong. It is stated that these operational tabletop drills are not conducted for questioning purposes, and that mutual information sharing is aimed.

Planning

Calendars containing scenario information are set at the beginning of the year and shared with the relevant disciplines (Technical Safety, Process Safety teams) to provide the opportunity of planned participation. In Tupras standard, there is no defined frequency for these operational tabletop drills. It is recommended that the units determine their annual plans and scenarios upon their needs to make them own the drills.

In general, each unit makes its plan once a month. The shared sample calendar is given in the Table 1 below. According to the dates in the table, calendars are shared with the relevant participants via Outlook.

Table 1: Example of Operational Tabletop Drills Calendar

	Production Units		
	Control Room 1-2 (Crude/Vacuum/ISO/LPG/NHT/HDS)	**Control Room 3-4 (HCU/HMU/SRU/SWS)**	**Control Room 5 (DHP/CCR/Amine/SRU/SWS)**
August	23.08.2022	17.08.2022	31.08.2022
September	27.09.2022	14.09.2022	28.09.2022
October	18.10.2022	19.10.2022	26.10.2022
November	22.11.2022	16.11.2022	30.11.2022
December	20.12.2022	7.12.2022	28.12.2022

	Utility Units				
	Oil Movement	**Wastewater Treatment**	**Loading/Unloading**	**Steam Generation Unit**	**Power Generation Unit**
August	11.08.2022	17.08.2022	18.08.2022	24.08.2022	16.08.2022
September	8.09.2022	21.09.2022	15.09.2022	20.09.2022	22.09.2022
October	13.10.2022	19.10.2022	13.10.2022	20.10.2022	18.10.2022
November	9.11.2022	16.11.2022	17.11.2022	23.11.2022	10.11.2022
December	8.12.2022	14.12.2022	15.12.2022	22.12.2022	15.12.2022

The topic of the scenario is also shared with calendar. The example of the scenario-based plan shared with calendar is given in Table 2 below according to the scenario categories.

Table 2: Example of Scenario-Based Plan of Operational Tabletop Drills

	Control Room 1-2	Control Room 3-4	Control Room 5	Oil Movement	Loading/Unloading
SEVESO	Leakage from outlet flange of the reactor C-1151	Loss of containment from inlet line of the high-pressure separator due to high pressure case	F-1877 furnace blow-out	Loss of containment from LPG sphere tank outlet line due to high pressure	Overfilling of LSRN tanker due to high level)
HAZOP	G-1202 C/D vacuum pumps trip	Closure of FV-017 by the reason of FIC-017 control loop failure	HC carryover to F-1876 furnace due to wrong level of D-1753	High level by the reason of level transmitter failure on the MTBE tank)	Accuload failure during LPG tanker loading operation
OSAR	Natural gas outage	No flow by the reason of seal blockage at the sulfur recovery unit	Boiler trip and steam outage in power plant unit	Leakage from the base T-4304	Leave open of the kerosene discharge valve at the rail car unloading unit
RAYEP	Release of hydrogen from valve packing on the make-up hydrogen pipeline	G-1826 pump trip	Out of operation of K-1452 A/B/C compressors	Entry of chlorinated HSRN to T-4201 tank	Overfilling of fuel oil unloading drum

The special evaluation of this plan, which covers the whole year, has to be made when the calendar day approaches. Since the plan of operational tabletop drills is created at the beginning of the year and the units are aimed to develop their own auto-control systematic for this activity, revisions on the plan should be made according to the need.

In addition, to allow the operator to brainstorm effectively, it is important to schedule operational drills for times that will not create extra intensity. Although each unit assigns the necessary operator depending on its field size during the operational tabletop drills, the drill should not take a long time for the operator. So, it is organized for an average of half an hour. It is ensured that drills do not coincide with the shift handover, the times when the field controls are conducted, and the times when the work permits are busy.

Application

Under the guidance of a unit operations chief/engineer, the scenario is identified for the unit operators, then brainstorming is carried out about proactive interventions before the event, reactive interventions after the event, and the recommendations.

Frankly, three fundamental risk questions are intuitively discussed during drill; “What can go wrong?”, “How bad could it be?”, and “How often might it happen?”.

To visualize the moment of the drill, a photo is shared below Photo 1.

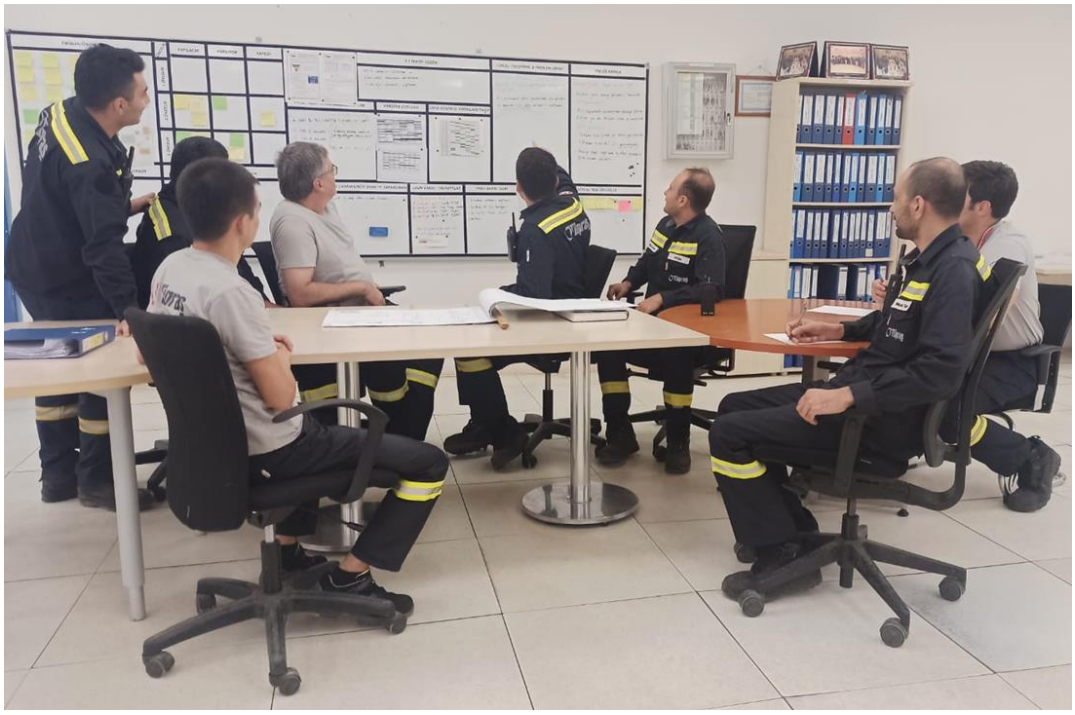

Photo 1: The snapshot of unit from the moment of operational tabletop drill

At the end of discussions, the unit chief sums up the drill and includes lessons learned and important information highlighted during the discussion on a registered form in the quality document management system (m-files) and has the form signed by the participants. Finally, necessary communication/distribution of the form is made to ensure its transfer to other shifts. The blank registration form is given in Figure 2 below.

Operational Emergency Scenario			
Unit Name:		**Date:**	
Unit Location:			
Initiating Event:			
Detail Description of Event:			
Scenario Source:			
Operational Interventions			
Actions Before Loss of Containment from Equipment/Line			
Actions After Loss of Containment from Equipment/Line			
Notes & Actions & Recommendations			
Attendees- Name&Signature			

Figure 2: Screenshot of blank registration form of operational tabletop drill

It is recommended that the units perform actual animations for 2 scenarios by means of in-unit radio channel without coordinating the emergency teams to monitor the reaction times for critical points in the field and to raise the awareness of the operator and to improve their reaction times.

Follow-up and control

After the operational tabletop drill is completed in the units and recorded in the registration form (Figure 2), the report is shared with the process safety team by the unit chief. For continuous improvement, operational drills are also followed through the relevant process safety key performance indicators. The compliance of the drills with the plan made at the beginning of the year is reported quarterly in process safety KPI's report. The monthly realization of operational tabletop drills in 2022 is shared below Table 3 as unit based.

Table 3: Unit-based drill realization by month in 2022

Month	Production Units			Utility Units					
	Control Room 1-2 (Crude/Vacuum/LPG/NHT)	Control Room 3-4 (HCU/HMU/SRU/SWS)	Control Room 5 (DHP/CCR/Amine/SRU/SWS)	Oil Movement	Wastewater Treatment	Car Loading/Unloading	Railway Loading/Unloading	Steam Generation Unit	Power Generation Unit
January	live	x	x	x	✓	x	x	x	✓
February	x	x	x	x	✓	x		x	✓
March	✓	✓	✓	✓	✓	✓	✓	x	✓
April	✓	✓	✓	✓	✓	✓	✓		✓
May	✓	x	x	✓	✓	✓	✓	x	✓
June	✓	✓	✓	✓	✓	x	✓	✓	✓
July	✓	✓	✓	✓	✓	✓	x	✓	✓
August									
September									
October									
November									
December									
% Compliance	86	57	57	71	100	57	57	43	100

In addition, at the end of the year, further analysis about the operational tabletop drills is carried out according to items shared below for each control room:

- Scenario selection and balance
- Planning
- Invitations
- Drill records
- Transfer to shifts
- Compliance with plan & Drills Realization
- Tracking actions management
- Drill management

Successful and open to development issues are reported to all parties. The number of drills held in units and the distribution of stability in this regard by units from 2018 to today are shared to show that drills are owned by the units. The goal is to turn this process in a culture and to strengthen operational discipline in units.

At the same time, it is tried to benefit from other process safety elements which is audits. During the process safety site visits/audits, the folders kept for the operational tabletop drills are also audited and the improvements are determined, and feedback is given. It is emphasized that unit's communication board can be used for effectively sharing, disseminating, and following up the operational tabletop drills.

To provide value, the observations which are documented on the drill report as findings or recommendations should be turn into actions. Of course, there should be a consensus on actions before recording into a well-established action tracking system

(m-files). Review of actions such as delay time, what and how the actions are taken, is carried out and is reported to unit supervisor and manager.

CHALLENGES DURING OPERATIONAL TABLETOP DRILLS

We must also acknowledge that difficulties are encountered in the operational tabletop drills.

For example, the consistent compliance to annual drill plan is one of the challenges. While the units prepare their drill plan with their own business plans and needs, the workload can affect the stability of operational tabletop drills. Even if the drill schedule is determined, it is difficult to find a suitable time for all participants. It is also observed that the participation of managers in tabletop drills for the phenomenon of "leader walks, safety talks" is less. Leading and owning the process with the participation of the unit chief engineer and chief in the tabletop drills where the operation manager cannot attend softens this situation a bit. Even if there is no attendance of manager on the day of the drills, the communication of the drill reports in the unit can be made through visual boards, allowing the manager to be involved later. By the way, a brainstorming environment has been created again and the issues in which manager is desired to be involved can be clarified in the presence of the unit operators.

Another challenge is that operational tabletop drills is not just an activity of process safety but must be carried out under the responsibility of and owned by the unit personnel. This can cause disruption of review the drill, reading the registered drill report and signing the form by all shifts. For this reason, the drill cannot be spread equally to all unit shifts.

It is another problem that some employees who think that the operational tabletop drills remain theoretical, say that this process appears as a formality and workload.

During the discussions in tabletop drills, it may be encountered that an operator who complains about a different issue disperses the drill. If the operator's questioning style prevails during the drills, the operator may hesitate to share his/her comments interactively.

Another important issue to be mentioned is, to manage the "this has always been here, we always do it like this" perception that operators take for granted. It turns into a problem that seriously affects the efficiency of the exercise and the ownership of the outputs. We can also see this as an opportunity due to expression in a conscious environment thanks to tabletop drills, without being demotivated by negative, destructive comments. Operational tabletop drills can provide an opportunity for us to listen to the comments of operators who have this point of view, to improve and even correct this perception without spreading poisonous seeds. In this way, a contribution to the company culture will be provided.

Since operators expect the recommendations, which they gave in previous drills to be implemented immediately, complaints can occur when they do not see the realizations of their recommendation.

BENEFITS AND DIFFERENCES OF OPERATIONAL TABLETOP DRILLS

The benefits aimed through the operational tabletop drills organized by the units are summarized below.

- ✓ The importance, effectiveness, reliability and adequacy of existing preventive and mitigating barriers are evaluated. The potential safety vulnerabilities in the units can be found during operational tabletop drills. Corrective actions can be assigned in response to the "not working since the commissioning" comments. Operational discipline is tried to be strengthened again with safety messages.
- ✓ It provides to detect that the original design of preventive barriers is changed without management of change for years ago. For example, in the operational tabletop drill in LPG tanks area, the operator reaction time was tested by sending him to the field to close the drain valves. However, it was determined that the drain lines with double valve configuration were cancelled during a maintenance or any operation on one of the valves, and a spool was installed on its place. So, the double block valve barrier was removed. Thus, we regained the control for preventative safeguards which is alarm and operator

intervention to prevent incident. By re-functioning the barrier, a Tier 1 or 2 process safety events [2] may be prevented and the safety perception about the barriers in the unit is thus gained.

✓ Importantly, actions that will reveal the effect of these operational tabletop drills on the preventive barrier side are determined. They are given in Table 3 below, specific to the unit and scenario. So, it helps to identify the corrective and remedial actions from critiques of tabletop drill and to track them from m-files system. Moreover, the actions can be shared with other units as a good practice. This allows information exchange and dissemination between units.

Table 3: Recommendations of Operational Tabletop Drills as Unit-based

Plant	**Scenario**	**Recommendations**
Control Room 3-4 (HCU)	Leakage from EC-1354 A/D bundles	Evaluate placing a steam station for the location of EC-1354 A/D.
Control Room 1-2 (ISO)	Loss of containment from outlet of C-1180 Reactor due to high pressure	Evaluate relocation of snuffing steam valves
		Convert that C-1151 reactor manuel emergency quench valve to DCS controlled valve (HCV) and revise the nitrogen lines to the inlet of C-1180 and C-1151 reactors
Control Room 1-2 (NHT)	Trip of K-1401 Recycle compressor and the operation mode changes to "Once Through Operation"	Prepare "Once Through Operation"'s instructions
Steam Generation Unit	Opening of PV-014 B, MP pressure breaker valve by control loop failure	Transfer the motorized vale position to DCS
Control Room 1-2 (Crude)	Failure of DCS	Evaluate that the valve of HCV-368 is to be FO (fail open). Its current position is FC (fail close).
	Abnormal amper and voltage of desalter and going to IOP	Evaluate placing a shut off valve at the inlet and outlet of the desalter
Wastewater Treatment Unit	Overflow of Balance slope oil pit	Evaluate auto-start of G-1154 A pump when LT-010 reaches 4.9 m.
Oil Movement Unit	Random leakage from HC slop lines	Develop and recommend a systematic that will ensure the periodic control of the HC slop lines between units

✓ Thanks to the emergency tabletop drills, the resources needed for emergency response can be discussed and checked that they will function when they are needed. The emergency management organization, whether the decision-making mechanisms work correctly, whether the decisions taken are compatible and correct with the emergency response procedures, and the adequacy and applicability of the emergency response plans are discussed by the unit operators rather than emergency response team in HSE department. Unit personnel do not participate in desktop drills of emergency response teams. Since they are organized by HSE department, it looks like HSE department is in charge. However, unit is in charge in operational desktop drills. Moreover, unit personnel can focus on their operational interventions in operational desktop drills, since there is not much verbal participation of operators in other drills.

- ✓ It has been experienced in a few cases that our reactions in real events have also improved thanks to these drills. The importance of operational tabletop drills has come to the fore, especially in cases of boiler trip, compressor trip, loss of natural gas etc. The incident subject to the exercise has been evaluated before, so that possible accidents/losses can be prevented by reacting safely and quickly.
- ✓ Compared to emergency tabletop drills, the operational tabletop drills held by unit personnel help to be prepared and conscious for operational intervention against all possible process safety events that have been experienced or not by brainstorming the scenario which is selected from diverse scenario pool. This builds operational discipline to ensure a quick response in the event of an incident.
- ✓ Operational tabletop drill contributes to the increase of the competence of the unit personnel. It also shows the level of competence and determines the need for development. When the operational tabletop drills are held as they are planned, the number of exercises during the year will be much more, so operators' emergency capabilities increase.
- ✓ During the operational tabletop drills, the operator can be sent to intervene in the field or to show the location of equipment/valve etc. This provides the opportunity to improve operator reaction times and ultimately lives can be saved.
- ✓ It is cost effective because there is no need to assemble the response team, use fire-fighting utilities and stage a full-blown drill.
- ✓ Since there is no need for processes such as manager approval and announcement preparation, the workload is relatively less.
- ✓ There is more flexibility in program or scenario changes due to small group of participants. Unit personnel can also perform the drill alone. This is very important to make operators own the drills in terms of safety culture.
- ✓ It can be regarded as a training tool for process safety since it improves knowledge and skill level of the operators about the PSM. It turns into a platform where oral and written experience and knowledge transfer takes place. Thanks to these drills, they can learn how their activities affect process safety. They make them realize that the smallest contribution they make to process safety can save lives. Motivation also increases as operators see that they are listened to and their ideas are valued. In this way, employee participation is ensured, and they can focus on their work better, develop themselves and be successful. As a result, this reinforces the safety culture in Tupras.

These learnings are tried to be shared throughout Tupras refineries by the coordination meetings held between the 4 refineries or by the platform where good practice examples are shared. In the process safety symposiums held in Turkey, it is aimed to share as an example of the best practice within Tupras with wider industry.

CONCLUSION

Predicting potential process safety incidents by turning operational emergency drills into a culture in the units, uncovering the systemic vulnerabilities before they occur by scenarizing these incidents, and identifying critical operational interventions for the unit to help manage the crisis in coordination with the emergency teams in case of an incident, are considered as a huge gain for Tupras. Especially, operational tabletop drills do not only contribute to the safety culture, but also serve the emergency planning and response, which is one of the elements of the process safety management system. Thus, this can undoubtedly save lives and protect assets, the environment and reputation.

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