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Implementation of Vehicle Monitoring System in Oil and Gas Industries

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Abstract:

Motor vehicle crashes are the leading cause of work-related fatality as well as in the oil and gas extraction industry. Many factors contribute to this elevated risk, including driving on rural roads that may lack safety features, the movement of large trucks and equipment, and long work hours etc. In address this issue, many companies are turning to technology. Oil and gas extraction companies of all sizes and companies in other industries have found that monitoring their drivers' behaviors is an effective way to reduce risk. This project implement the new technology like In-vehicle monitoring systems (IVMS) used to reduce the fatality injuries in oil and gas industries. In-vehicle monitoring systems (IVMS), or driver behavior monitoring systems, refer to electronic devices that record data about a driver's behavior and vehicle use, such as date, time, speed, acceleration, deceleration, and safety belt use. IVMS measures driver performance against a predetermined set of parameters. The monitor records the information electronically so information can be downloaded to a computer. In-vehicle monitoring systems provide important information to support safe driving behaviors, but they should be only one component of a comprehensive motor vehicle safety program. So, this technology implement in India is very useful for the industry workers at the same time reduce the fatality accidents.

Key words: Industry, lack safety, Oil and gas industries, In-vehicle monitoring systems (IVMS), Motor vehicle safety.

1. INTRODUCTION

Motor vehicle crashes are the most common cause of fatality for the oil and gas extraction worker, accounting for almost one out of every three fatalities. Workers from companies with fewer than 100 employees have the highest rates of motor vehicle fatality in this industry. Driving is both a critical and frequent task for workers in the oil and gas extraction industry. All sizes of trucks, from pick-up trucks to semi-trucks are driven long distances between well sites to deliver equipment, supplies, and personnel. Deaths to workers can be prevented by implementing comprehensive motor vehicle safety programs. One component of such a program is in-vehicle monitoring systems (IVMS). Oil and gas companies tell researchers that these systems are helping to reduce the rate of crashes and injuries for their workers. This guidance is for oil and gas extraction safety and health professionals who are responsible for motor vehicle safety in their company. This publication was developed to assist these professionals in implementing in-vehicle monitoring system programs. The guidance highlights what is known about fatal motor vehicle crashes in this industry, the safety benefits of IVMS as reported by the oil and gas extraction industry and other literature, and things to consider when implementing an IVMS program.

Motor vehicle crashes kill more oil and gas extraction workers on the job than any other type of injury. Many factors contribute to this elevated risk, including driving on rural roads that may lack safety features, the movement of large trucks and equipment, and long work hours. To address this issue, many companies are turning to technology. Oil and gas extraction companies of all sizes and companies in other industries have found that monitoring their drivers' behaviors is an effective way to reduce risk.

In-vehicle monitoring systems (IVMS), or driver behavior monitoring systems, refer to electronic devices that record data about a driver's behavior and vehicle use, such as date, time, speed, acceleration, deceleration, and safety belt use. For the purposes of this guide, IVMS includes any device that can perform these functions (e.g., GPS, accelerometer-based, and video-based systems). Also, for the purposes of this guide, IVMS does not refer to in-vehicle technologies such as crash avoidance (e.g., lane-departure warning or other similar devices).

IVMS measures driver performance against a predetermined set of parameters. The monitor records the information electronically so information can be downloaded to a computer. Several types of monitors are available on the market, ranging from simple plug-and-go devices that record unsafe driving behaviors, to sophisticated systems that track the physical location of large fleets in real time. The time required to install the device varies widely as well, from less than one minute, to several hours. Although installing monitors is relatively simple, implementing an IVMS program is more complex and requires an investment of time and a commitment from all levels of the organization to be successful.

In-vehicle monitoring systems provide important information to support safe driving behaviors, but they should be only one component of a comprehensive motor vehicle safety program. In order for a company to have a sustained reduction in the risk of motor vehicle crashes, a comprehensive motor vehicle safety program needs to be in place.

1.1 USE OF IVMS IN OIL AND GAS INDUSTRY

For anyone involved in vehicle tracking, driver safety, or managing equipment costs, IVMS is an acronym you're likely

to become a lot more familiar with in the coming year—that is, if you haven't deployed an IVMS already.

In-Vehicle Monitoring Systems (IVMS) are already providing valuable driver performance information to keep workers safe in a variety of industries. Fleet managers and organizations employing IVMS are also benefitting from improved operational efficiency, reduced costs and enhanced regulatory compliance. The IVMS guidance was written by the International Association of Oil & Gas Producers (OGP) which includes member companies such as Schlumberger, Halliburton and Baker Hughes. While not an official standard, it serves as a reference guide when implementing workplace safety programs.

The primary goal of IVMS is the personal safety of the workers in the oil & gas, mining and other resource sectors. According to OGP, vehicle crashes are the primary cause of fatality for oil & gas workers in the field. Industry data has shown that vehicle accidents are commonly caused by excessive speeds or improper operation of vehicle for the conditions. Workers face many challenges in their driving duties given much of their time is spent on secondary roads or off-road where conditions are not necessarily optimal. In addition they may be deployed out-of-state or internationally in geographic areas not well known to them which may increase their risk of accidents.

In an IVMS implementation, companies develop programs where they

- ✓ Install advanced telematics devices on vehicles to identify drivers,
- ✓ Monitor time of operation, track position, and
- ✓ Capture incidences of speeding,
- ✓ Harsh breaking or hard acceleration.

The data captured over time is very valuable as it allows organizations to develop key performance indicators (KPI) for comparison of driver to driver, same driver over time, or same vehicle over time to identify negative or positive trends in their fleet. From the data captured in the field, supervisors are able to identify higher risk behaviors and implement corrective action via driver mentoring programs. IVMS also helps to reduce maintenance and fuel costs.
When implementing an IVMS program, it is important to have partners that can deliver a system that provides reliable coverage and maximum flexibility. As an example, the IVMS must be able to respond to changes in road conditions, as the speeding alert threshold for highway driving should be different than that for a dirt road on a remote patch of farm land. Typically, oil exploration and extraction are done in remote areas with limited cellular connectivity, making a secondary satellite link necessary. Valuable add-ons to IVMS programs include two-way text messaging for dispatching needs or even for emergency communications.

2. PROBLEM IDENTIFICATION

The leading causes of worker fatalities in oil and gas industry accidents involves the transportation aspect of the job– highway crashes and trucking accidents, accounting for almost one out of every three fatalities. Driving is both a critical and frequent task for workers in the oil and gas extraction industry. All sizes of trucks, from pick-up trucks to semi-trucks are driven long distances between well sites to deliver equipment, supplies, and personnel. Deaths to workers can be prevented by implementing comprehensive motor vehicle safety programs. Those familiar with the industry note that the total accidents are only expected to rise, because of the steady expansion of the industry in recent years. More than 200,000 new oil and gas wells are expected over the next decade. Considering the seriousness of the problem, it is crucial to understand how these accidents arise. Many point to lax regulations on driver safety for the industry. Example, several exemptions exist regarding required rest times for industry drivers. Most commercial truck drivers are required to stop driving fourteen hours after the beginning of their workday. Not so for oil and gas drivers. That is because industry drivers are able to exclude time that they wait at wells while a crew is finishing work. Similarly, typical commercial drivers must take off 34 hours if working 60 hours in a single week. Oil and gas industry drivers are only required to take off 24 hours after the same amount of work. Together, these special rules make it more likely that oil and gas industry drivers may suffer fatigue while behind the wheel, causing serious accidents.

3. CAUSES OF OIL AND GAS INDUSTRIES ACCIDENTS

More than half a million of the population works in the oil and gas industries. These workers are exposed to hazardous working conditions most of the time. Though many of these companies are taking responsible steps to eradicate all possible dangers in the oil and gas rigs, there are many fatalities that have become a part of the industry now. The injuries caused by the oil and gas rigging activities are far more severe and take much more time to recover from as compared to the other sectors of the industry. Looking at the severity of such accidents, rigging companies are playing their part to mitigate risks by manufacturing quality rigging equipment that are much safer and easier to use. Most of the rigging injuries occur due to varied reasons such as, carelessness and recklessness of the workers, misuse of equipment, not using proper safety equipment, failure to provide proper training and delaying the repair or replacement of rigging equipment. Following some of the commonly occurring oil and gas hazards which need to be controlled:

3.1 VEHICLE COLLISION

One of the biggest dangers for oil workers is not at the rig but on the road. Over the past decade many oil workers have been killed in fatal road accidents. Working for 17 long hours at the oil rig and then climbing on to the truck for a 4 hour long journey to the oil service company outlet, is an activity that earns quite a few dollars for these workers. With the increase in drilling activities like fracking, millions of gallons of fresh water are required for this process. This requires a continuous supply of water, which is generally transported from various places.

All of the above activities have increased the number of trucks on roads, leading to frequent collisions. One of the main reasons for these reckless accidents has been carelessness and less alertness or exhausted drivers. Many a time's trucks were found to be in disrepair and in a bad condition. OSHA's Motor Vehicle Safety and NIOSH's, Work-Related Roadway Crashes: Prevention Strategies for Employers are documents that provide sufficient guidance and safety regulations to prevent vehicle collisions for oil rig workers.

Figure 3.1 oil and gas industry vehicle collision

3.2 MACHINE HAZARDS

Amongst all the industries that uses hazardous machines and equipment, the oil and gas industry arguably ranks first. Many of these machines operate in unguarded areas which further endangers the workers using them. This means operations such as traveling derrick, heavy lifts and hoists, spinning chain, loading and unloading materials, drilling should be conducted with care by competent operators.

Figure 3.2 oil and gas industry mechanical hazards

Machines used for drilling activities generally cause a lot of noise and vibration which can harm the operator. While using such equipment the operator should make it a point to wear protective gear like gloves and earplugs. Equipment like pumps, compressors, hoist blocks, belt wheels, and conveyors might cause injury if the operator gets struck by or caught between such machinery. Falling objects and equipment can cut or crush body parts of the workers in the process. It is important to follow OSHA regulations to guard machinery, update equipment and keep them in good working condition to ensure safe use.

3.3 CHEMICAL EXPOSURE

Chemical risks are common on oil rigs. Many of the drilling and oil processing plants diffuse extremely hazardous chemicals into the atmosphere most of the time. Prolonged exposure to toxic and volatile, chemicals and fumes can cause respiratory as well as major brain problems to the workers. Most of the oil rigs release high concentrations of H2S (Hydrogen sulfide). Pipeline operator and crude oil shippers face maximum risks caused by dangerous levels of H2S. It can cause paralysis, leukemia and other cancers or even death. Other side effects of toxic exposure that have been reported are headaches, nausea, dizziness, eye and skin irritation and chemical burns. This is the reason it is important that proper eye, face and respiratory protection masks are used on rigs.

Figure 3.3 oil and gas industry Chemical Exposure

3.4 FALL HAZARDS

Oil and gas rig workers have to work on elevated platforms. Lack of proper fall protection systems and safety wear can result in fatal falls. Most of the rig workers hurt their head, fracture their arms, and suffer brain and spinal cord injuries and even death. Some of the leading causes of such falls include harness failure or improper rigging methods, slipping over chemicals or tools and even being struck by tools and equipment.

A good housekeeping practice can reduce many of the trips and slips on the rig platforms. It is important that the floor is kept clear of unnecessary tools, ropes or cords. Also make it a point to clean oil or chemical spills immediately. Make use of slip resistant and waterproof boots to reduce slips and trips. Also ensure, you cover open cellars or potholes and use appropriate signage warning people of the same, wherever required. Make sure the ladders, guardrails are kept in good condition before every use. Use personal protective equipment like hard hats, gloves, goggles, masks and safety nets all the time.

Figure 3.4 oil and gas industry Fall Hazards

3.5 FIRE AND EXPLOSION

Oil and gas rigs house a lot of highly combustible chemicals and gas, which means there is always a chance of a fire breaking out or explosions. Most of the times these occur without the slightest warning and so are difficult to prevent. You need to be ready with all possible preventive measures to face such hazards.

Figure 3.5 oil and gas industry Fire and Explosion

Having a detailed fire-fighting plan is always recommended. You need to have equipment, extinguishers and suppression agents ready in case of an emergency. Most of the accident prone areas like gas chambers, oil tanks and electricity rooms are under continuous threat of fire and explosion; it is important that all the machinery and equipment susceptible to fire should be inspected on a regular basis. Place adequate amount of extinguishers and safety equipment in and around such places. Offer proper safety training to the employees working in such hazardous areas. Regular inspection and maintenance of such places and equipment can reduce the risks of such hazards. These are the commonly known hazards that occur frequently on oil and gas rigs. It is important that every company follows proper safety and health regulations to reduce such risks. Training your worker to perform their job with care and efficiency, and monitoring these risks will surely diminish the hazards.

4. VEHICLE ACCIDENTS IN OIL AND GAS INDUSTRIES

It likely comes as a surprise, but the leading causes of worker fatalities in oil and gas industry accidents involves the transportation aspect of the job–highway crashes and trucking accidents. This comes from the Centers for Disease Control and Prevention.

The CCD found that in a five year stretch (2012-2017) a total of 648 field workers were killed. Of that total, a little less than half (over 300) were killed in transportation accidents. This is unique to the oil and gas world, because when all workplace deaths are taken into account, highway accidents only account for about a fifth of the fatalities.

Those familiar with the industry note that the total accidents are only expected to rise, because of the steady expansion of the industry in recent years. More than 200,000 new oil and gas wells are expected over the next decade. On top of that, most of those new wells (90%) will utilize hydraulic fracturing (better known as "fracing"). Fracing requires uses of millions of gallons of water. That water reaches the well via trucks–necessitating many more oil and gas workers on area roadways. Accidents of one kind or another will undoubtedly follow.

4.1 OIL & GAS TRUCK DRIVERS SUBJECT TO FATIGUE

Driver fatigue is perhaps the leading cause of these oil and gas industry highway accidents. Considering the seriousness of the problem, it is crucial to understand how these accidents arise. Many point to lax regulations on driver safety for the industry. For example, several exemptions exist regarding required rest times for industry drivers. Most commercial truck drivers are required to stop driving fourteen hours after the beginning of their workday. Not so for oil and gas drivers. That is because industry drivers are able to exclude time that they wait at wells while a crew is finishing work. Similarly, typical commercial drivers must take off 34 hours if working 60 hours in a single week. Oil and gas industry drivers are only required to take off 24 hours after the same amount of work. Together, these special rules make it more likely that oil and gas industry drivers may suffer fatigue while behind the wheel, causing serious accidents.

Figure 4.1 Oil & Gas Truck Drivers Subject To Fatigue

4.2 REST TIMES INAPPLICABLE TO OIL & GAS TRUCK DRIVERS

There is no good reason for exempting oil and gas industry truck drivers from mandatory rest periods. The exemption puts those drivers along with everyone else sharing the highways at grave risk of injury or death. The rules related to regular commercial drivers were enacted for very specific reasons, with an understanding of the risks of fatigue and the potential for serious harm. It is not inherently clear why the exemptions exist for the oil and gas industry. There is not good reason for the exemptions. These exemptions put the workers and others that share the road at increased risk of harm. Lobbying efforts at the federal level have likely played a role. Unfortunately, the industry does not have the best record when it comes to being open and honest about the safety risks. Steps are often taken to circumvent the rules and keep the truckers on the road even after repeated highway violations.

4.3 SAFETY OF ALL DRIVERS PUT AT RISK ON HIGHWAYS

Innocent drivers and families are put at risk and are often among the victims of these accidents. The safety of all travelers–including that of oil and gas workers–is at risk when reasonable care is not maintained in industry transportation. It is crucial to ensure proper rules are followed at all times and accountability is had when those rules are violated. After all, these trucks are not on the road alone. Innocent drivers are often among the victims of these accidents. Due to the sheer physics of these accidents, wrongful death of one or several of the drivers or passengers is often the result.

4.4 IMPORTANT FACTORS FOR VEHICLE ACCIDENTS

More track equals more accidents. As the sheer number of trucks and 18 wheelers are let loose on the roads to service the increased production, more accidents will naturally occur.

- ✓ **Rural roads:** More and more the large rigs are travelling on rural roads. The problem here is two-fold. The roads themselves are not built for such heavy loads, and the rural residents are not used to sharing those roads with the big rigs.

- ✓ **Driver fatigue:** This is a big issue. It's not just the long hours on the road logged in by the big rig drivers, but many accidents are happening when workers get on their shifts and drive their personal vehicles back to their motel room or home. The drivers are simply exhausted, and exhausted drivers cause accidents.

- ✓ **Distracted driving:** Cell phones are a great convenience – but mix talking on cell phones and texting while driving and you have a recipe for possible

5. OIL AND GAS INDUSTRIES ACCIDENT SURVEY

5.1 FACTORS CONTRIBUTING TO FATALITY

1. Driver's behavior
2. Vehicle use
3. Time
4. Speed
5. Acceleration and Deceleration
6. safety belt use
7. Small companies, contractors
    - ✓ Lack of resources and experience
    - ✓ Sense of urgency; 24/7 business
    - ✓ 'Get 'or done'

5.1.1 Driver's Behavior

To identify driving behaviors and mistakes that drivers make; based on a questionnaire, which may cause traffic accidents in India and highlight their effect on traffic safety. Also, to develop traffic accidents regression prediction models. Also, to propose effective countermeasures to reduce the frequency and severity of traffic accidents. The analysis is based on the questionnaire by using software to predict accident rates and compare the results with the model reports developed in India. The data for this study was collected from a survey questionnaire which was distributed to a sample of drivers in India. The data from the survey questionnaire were analyzed and used in forming the regression models. It was found that the

Drivers' behavior is considered aggressive, according to the first part which represents the participant's opinion weather they listed the behavior as aggressive or not, and the other part which represent weather the participants conducted this behavior or not. Also, there was a strong direct relationship between the driver behaviors and their exposure to accidents. In conclusion, the aggressive behavior increases the chance of exposure to accidents. From this study, it was concluded the main causes of traffic accidents, injuries, and fatalities that are related to driver behavior. Preventive countermeasures were recommended to enhance traffic safety.

5.1.2 Vehicle Use

In the oil and gas industry, driving poses the highest potential risk for accidents and is the leading cause of fatalities. Schlumberger is an acknowledged leader within the industry in managing driving safety risks. The company's Global Driving Safety Program helps manage these risks through quality training, technology, and proactive participation. Employees and contractors drive more than 150 million miles a year for work-related activities—in every type of terrain and in every imaginable condition. Schlumberger has standardized procedures and established a unified driving program across its operations worldwide. As such, the company's Global Driving Safety Program transcends corporate, national, and cultural variations in driving practices.

5.1.3 Time

Time of day plays an important role in evaluating fatal crashes, in no small part because other dangerous factors are compounded at night Speeding is a factor in 30% of all fatal crashes, according to the NHTSA.

5.1.4 Speed

In oil and gas industries drivers drive the vehicle Speed is one of the major factors contributing to accidents on Victoria's roads and research shows small changes in speed can result in a significant reduction in road trauma. In average conditions, a car travelling at 60km/hr will take 45m to stop in an emergency braking situation. A car breaking from 65km/hr will still be moving at close to 32km/hr after 45m travelled. Research from the Road Accident Research Unit of the University of Adelaide has shown:

- the risk of involvement in a casualty doubles with each 5km/hr increase in free travelling speed above 60km/hr and
- A 5km/hr reduction in speed can lead to at least 15% decrease in crashes.

Speed can be divided into three categories:

- Excessive - speeding is deliberate and substantially over the speed limit
  low level - the driver travels at a speed marginally over the posted speed limit, typically by 5km/h (research shows the majority of motorists engage in low level speeding) and
- Inappropriate - travelling at a speed that is inappropriate for the conditions such as travelling at the speed limit when the road is wet.
- All of these types of speeding are dangerous. Speeding reduces the time drivers have to avoid crashes, their ability to control the vehicle and lengthens stopping distances, increasing both the likelihood of crashing and the severity of the crash outcome.

5.1.5 Acceleration and Deceleration

Whether driver celeration (overall mean speed change) behavior can predict traffic accident involvement. Also, to test whether **acceleration, deceleration or the combined celeration measure** was the better predictor. Bus driver celeration behavior was measured repeatedly in real traffic, driving en route, and correlated with accidents for which the drivers were deemed at least partly responsible. Correlations around .20 were found in several samples between celeration behavior and culpable accidents for a 2-year period. The results show that although celeration behavior is only semi-stable over time, it predicts with some accuracy individual accident involvement over 2 years. The predictive power of acceleration and deceleration was slightly lower than the combined measure, in accordance with theory. The correlations found were strong enough to warrant the use of celeration behavior as a predictive variable for transportation companies in their safety work.

5.1.6 Safety Belt Use

Only one percent of people totally ejected from their cars had on a seat belt during the crash. Over 30% were not wearing seat belts. In 2006, 42,642 people were killed in car accidents. The NHTSA was able to gather seat belt data on 30,251 of the 42,642 car occupants that died in car crashes. Among drivers and front-seat passengers, seat belts reduce the risk of death by 45%, and cut the risk of serious injury by

50%. Seat belts prevent drivers and passengers from being ejected during a crash. Seat belts save thousands of lives each year, and increasing use would save thousands more. Seat belts save over 13,000 lives every year. The top 5 things you should know about buckling up. 1 Buckling up is the single most effective thing you can do to protect yourself in a crash. In 2008, seat belts saved more than 13,000 lives nationwide.

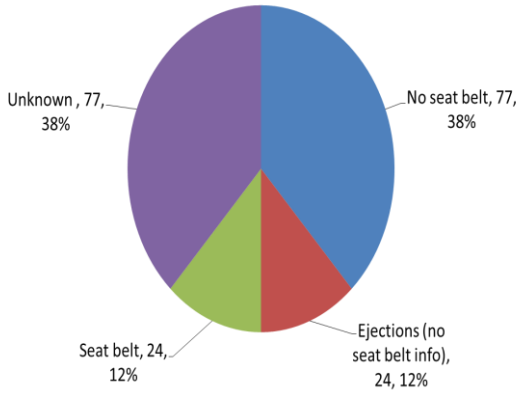

Figure 5.1 MV Fatalities by Seatbelt Status, Oil and Gas Extraction Industry, 2010-2017

6. IVMS TECHNOLOGY

In vehicle monitoring system is an advance technology used in abroad. This system very useful for record driving behaviors, time, speeding, crash ,seat belt use, acceleration and deacceleration, night driving, etc. Measures driver performance against a predetermined set of parameters. Has shown to be effective in realizing immediate and positive effect on driver behavior

6.1 COMPONENTS OF IVME SYSTEM

For designing this hardware many types of devices are used to make it perfectly working. All the devices are purchased from different manufacturers. These components are soldered on a soldering board. The following lists of hardware are required for IVMS system.

- GSM
- GPS
- SHOCK SENSOR
- MICRO CONTROLLER AT89S52
- MAX232
- RS232
- LCD DISPLAY
- POWER SUPPLY
- FIRE DETECTOR
- SWITCH
- CRYSTAL OSCILLATOR
- LM7805
- W10M BRIDGE RECTIFIER
- LED
- RESET BUTTON

7. IMPLEMENTING AN IN-VEHICLE MONITORING SYSTEM

The implementation of an IVMS program is a complex process that involves a lot of careful planning. The group of experts recommends a structured approach, such as the following steps, to implement an IVMS program:

1) **Select** an IVMS, and conduct a pilot project.
2) **Plan** who will be monitored, establish staff roles, and develop training and communications campaign for drivers.
3) **Deploy** the program.
4) **Review** monitor performance and adjust the IVMS where necessary.

There may be less need for formal planning in a smaller company; however the overall process will be the same.

7.1 SELECT THE IVMS SYSTEM

There are many IVMS systems. The right IVMS system will help a company to achieve their motor vehicle safety program goals and be consistent with company values. Once a monitoring system is selected, include agreed-upon terms and conditions in a contract.
Basic considerations for selecting an IVMS include:

• Durability of the hardware to meet the needs of the operating environment (ruggedness, tamper-proof, mounting, sensors, etc.).

• Scalability for expanding or shrinking needs, objectives, and area(s) of activity.

• How much time and expertise is required for installation.

• The amount of maintenance required.

• Availability and timeliness of technical and customer support for the monitor and reporting system.

• The communication capabilities of the monitor. For example, accessibility to wireless internet, satellite coverage, ability to operate in environments requiring 'radio silence' or the need to be intrinsically safe.

• The reporting and mapping capabilities of the system.

• The experience of the IVMS vendor. Make sure the vendor understands your business and that their IVMS will work for your operations. Always request references with current and past customers, and follow up with direct calls. Reach out to other companies in the industry that are using IVMS.

• What information will realistically be used, how often, and by whom.

7.1.1 Pilot Test

Pilot test the monitors with a small group first to ensure data is accurate and consistent before implementing companywide. Test all aspects of system functions to see that they are collecting accurate data.
• Pick a test group of drivers that will be willing to provide constructive feedback in an area with supportive local management.
• Establish procedures for ensuring monitors are working properly, with thresholds set to local driving conditions.
• It may be desirable to begin with more liberal settings to allow drivers to become accustomed to devices, adjusting them as the program matures. However, they should not be too liberal and thus ineffective. Ensure that settings are also not so sensitive that drivers are forced into bad habits as they try to avoid setting off the alerts.
Consider collecting baseline data for each driver for a short time before any performance improvement efforts occur in order to evaluate the effects of the program on driver performance.

7.1.2 Tracking Indicators

These are the most important primary tracking indicators:
• **Speeding** is one of the contributing factors to motor vehicle fatalities among oil and gas extraction workers.

With the reduction of speed, a crash may not always be prevented, but the severity of the resulting injuries frequently is.

• **Harsh braking** is an indicator of distracted or fatigued driving, the driver following too closely, or not looking far enough ahead.

• **Rapid acceleration** is an indicator of aggressive driving or being in a hurry.

• **Extended Hours of service** can lead to fatigue, which is a serious problem for the oil and gas industry. Drivers of light- and heavy-duty vehicles become fatigued when they have not received proper rest.

• **Night time driving** can increase exposure to night time hazards, such as impaired drivers, fatigue and limited visibility.

• **Safety belt use** significantly reduces the risk of injury in the event of a crash.

7.2 PLAN THE IVMS SYSTEM

After selecting your IVMS, the group of experts recommends that companies take the time to plan certain elements of the IVMS program before deploying it to drivers. These elements include:

• Determine which vehicles and drivers will be monitored.

• Establish goals for driver performance.

• Develop a communication campaign to inform drivers of the plan to use IVMS.

• Develop training about the IVMS and what driving behaviors will be monitored.

• Educate leadership about the system.

For this planning process, a workgroup made up of individuals from operations; health, safety, and environment (HSE); maintenance; administration, and other business units needs to be involved. A group of drivers should also be part of the workgroup. These drivers will likely serve as champions of the program if they are involved in the planning process. IVMS experts may also be needed at the outset. All groups who will be affected by the IVMS program should be involved in its planning and implementation. Once the system is in place, each business unit takes ownership of the program and their drivers. Depending on the size of a company, it may take several months to several years for in-vehicle monitoring to become an integrated part of the company's operations. A timeline for IVMS implementation should be developed in order to keep the process on track.

Whenever possible, those implementing an IVMS program should become familiar with the concepts of how to effectively manage change within a company, which includes communicating clearly why the change is needed, ensuring leadership commitment, and allowing for employee feedback.

7.2.1 Determine Which Vehicles and Drivers

Determine which vehicles, drivers, and locations will be monitored. The group of experts recommends installing monitoring systems in *all* vehicles and tracking *all* drivers in *all* locations. Some companies are also encouraging or incentivizing their contractors and sub-contractors to install monitors. When it is not possible to install monitors in all vehicles due to cost or other constraints, target the types of vehicles that have the highest crash rates based on established company-level or business unit-level metrics such as crashes per million miles (CPMM) or annual crashes per 100 vehicles. If these data are not yet available, consider initial implementation on the following vehicles:

Program at the highest levels within the company.

• Passenger vans or other vehicles that frequently carry a large number of people.

• Vehicles with the highest number of annual miles driven, or with greatest exposure to hazardous road conditions.

• Vehicles with particular risks, such as transporting hazardous materials.

• Vehicle types with a high center of gravity, such as water trucks.

• Single drivers who drive long distances and work long hours.

7.2.2 Obtain Staff Support

The group of experts report that IVMS systems increase administrative workload. During the planning process, staff should be identified to:

• **Coordinate** the IVMS program. This person reviews driver reports daily or weekly, works closely with the IVMS vendor as well as drivers whose behavior is identified by the system as being at-risk

• **Oversee** the installation of monitors if needed.

• **Train** drivers on how the monitors work and why they are being used.

• **Manage** drivers' information in a database.

• **Coach** drivers using the IVMS data.

• **Train** administrative staff in their support functions.

• **Be present** and available to address issues in a timely manner.

7.2.3 Establish Goals for Driving Performance

Take the time to determine the goals and expectations for driving performance to be measured with the new IVMS. Identify the tracking indicators that will be used to determine if goals have been met. Make sure that your goals are specific, measurable, achievable, realistic and time-based. Goals for driving performance may vary between individuals or groups of individuals based on varying driving environments.

7.2.4 Develop a Communication Campaign

The group of experts report that it is important to develop a communication campaign to prepare workers for the change. Inform drivers about the role of IVMS as it relates to the company's overall motor vehicle safety program and goals. Emphasize the positive safety and environmental impacts of IVMS. Provide industry crash statistics and compare with company data (if available) to show how your company performs. Explain to drivers that the monitors will serve as a tool to help identify and reduce risky driving behaviors, thus reducing crashes. There may be apprehension or resistance to installing the monitors. It will be necessary to communicate with workers and review the system with employees to help alleviate this. The campaign should emphasize that the IVMS program is a safety initiative rather than a punitive program.

7.2.5 Develop Training for Drivers

Training on IVMS should explain how the technology works and what the monitor records. Explain to drivers what data will be collected and why, when it will be reviewed and what will be done with the information. Share this information in pre-implementation meetings. For example, explain that supervisors or fleet managers will review over-speed incidents on a weekly basis, and those drivers with a high number of over-speed incidents will be coached on their driving. Explain to drivers that they may encounter circumstances that trigger monitors from time to

time and that is expected. Rather, it is consistently poor scores coming from monitors from multiple incidents that would be a cause for coaching. The objective is safe driving behavior.

7.2.6 Educate Leadership

An IVMS program must have strong leadership and management support throughout all levels of the organization. In order for senior management to be able to effectively support IVMS, they need to have an understanding of the system's features, limitations, and reports. It may be detrimental to the program if a manager overreacts to data due to lack of understanding, fails to recognize or respond to a hazardous trend, or fails to recognize which resources are required for successful deployment. In addition, engage the unofficial leaders ("opinion leaders") within the company to be on board with IVMS, to score well, and to advertise the benefits of it.

7.2.7 Frequently Asked Questions by Workers

The group of experts noted that there will almost always be some resistance to IVMS by a handful of workers. Some of the concerns will be valid. For example, workers have a right to know the accuracy of the data and how the data will be used. In some cases, however, drivers will oppose the system because it will require them to change their driving habits and, quite possibly, how they do their jobs. The amount of effort placed on communicating the goal of reduced motor vehicle incidents at the outset will help to ease this transition. Be prepared for these common questions and respond with consistent and rationale explanations.

- **In order to get my job done, I feel pressure to drive fast. What can I do about that?** IVMS may help to identify trends in unsafe driving that are a result of managerial and/or operational pressures. IVMS reports should be reviewed from this perspective. Opportunities to implement company policies and practices that eliminate the need to drive unsafely should be identified.
- **Does the monitor affect my vehicle's operability?** In-vehicle monitors are read-only devices; they do not impact the way a vehicle drives in any way.
- **Will I be constantly monitored when driving, including where I am driving?** The main purpose is not to track where the driver is going other than for possible logistical needs; it is to monitor driving behavior and therefore keep all drivers safer, saving money and liability. If the driver is concerned about being monitored because he knows there are areas for improvement, he can ask for support. He doesn't have to wait for a crash or a poor driver performance report.
- **Sometimes I have to brake hard on the highway because people drive crazy, will I be penalized?** A driver's pattern of behavior is more important than isolated incidents. A frequent number of hard braking incidents would be an indicator that a driver is distracted, fatigued, follows too closely, fails to look far enough ahead, etc. A conversation with that driver, for example, may reveal that he is being distracted by having to eat while driving, a distraction that can be removed. Ask drivers to note isolated incidences for further explanation during reviews, if significant.
- **The monitor is faulty and is providing inaccurate data. Will I be penalized in some way?** IVMS managers should be careful to ensure monitors are reporting accurately. If possible, review data from other drivers in the same vehicle to check if the pattern is similar. Once the monitor is inspected, report the results back to the driver.
- **Everyone goes at least 5 miles over the speed limit on the highway I drive on; will I be penalized for going with the flow of traffic?** It is recommended that the monitor's threshold include a reasonable buffer for slight variations in speed due to grades, traffic conditions, etc., and for the driver to respond in a reasonable time to variation in speed. It is also recommended that drivers select the appropriate lane in order to avoid congestion or acts of aggressive driving. IVMS managers should provide drivers with safe-driving tools and be careful not to unwittingly condone illegal or unsafe speed.
- **I drive on icy/snowy/muddy roads and sometimes have to spin my tires to get my vehicle unstuck. Will these events be recorded and show up for my supervisor to see?** Supervisors should be aware that this is a possibility and take it into consideration. It is clearly not an indicator of aggressive driving like rapid acceleration on dry roadways may be. Again, what is important to track is a driver's pattern of behavior. If a driver is repeatedly and aggressively spinning tires due to being stuck, coaching may be appropriate.

7.3 DEPLOY THE IVMS SYSTEM

Once the planning process is complete, the IVMS program should be ready to deploy. Deployment includes the installation of the monitors, training of drivers, and implementing a recognition and accountability program. The group of experts recommends that the deployment start from the "top-down," with a commitment from senior leadership. Starting the program with leadership and supervisors will set an example. After leadership, continue with the company's drivers engaged in the highest risk activities, such as transport of passengers, movement of hazardous materials, or those with the greatest number of miles driven.

7.3.1 Installation and Training

Create the least amount of disruption for drivers in order to get monitors installed, such as doing installations on drivers' off duty hours. Ensure data is accurate so drivers have a positive experience with the IVMS.

All employees should receive IVMS training as soon as possible after being hired and preferably before driving unsupervised. This training should be done in conjunction with basic driver safety training. In the training, include information about your company's unique operating environments (such as wildlife hazards, weather hazards, remote locations).

Consider having drivers sign a "driver commitment" form, which is an acknowledgement that the driver understands the purpose of the IVMS and other driver safety policies and procedures. This could be an effective tool for communicating both expectations of performance and accountability for non-compliance. An example of a driver commitment form is provided in Appendix B.

7.3.2 Recognition and Accountability

The group of experts strongly recommends an IVMS program include a policy addressing recognition (rewards) and accountability (penalties). This policy should provide an explanation to drivers of how the data collected from the monitors will be used, if at all, for rewards or penalties. It should be consistent with previously established goals and expectations for driver performance. A clear, well written

policy will help to put at ease drivers whose driving skills are being monitored for the first time.

Recognition

Some companies offer rewards to drivers for either high scores or improved scores. Many companies have found that some type of recognition of top drivers for their respective units or for the company as a whole is very useful and motivating.

Rewards that may be appropriate include:

- Letters or certificates of appreciation, or recognition in company newsletters. Group and peer recognition can be very powerful—it often pays higher dividends than a financial or other type of reward.
- Gift certificates, personalized engraved plaques or awards, personalized embroidered jackets, vests, or coats, hardhat stickers and/or key chains.
- A driver of the month award.
- Newest vehicles in fleet- awarded to higher scoring drivers.

It may be more effective to target rewards to teams of drivers or business units, rather than individual drivers. This type of reward may provide some additional peer pressure to certain drivers who are consistently receiving lower scores. Companies report that if too many parameters are included, and especially those that aren't closely connected to driving safety, the rewards system loses value. The goal is to keep things simple.

In addition to using scores from monitors for rewards, other measures should be taken into consideration, such as the employee's overall driving record, that is the absence of motor vehicle incidents where the employee was deemed at fault, moving violations, or violations of company policy.

The group of experts suggest being thorough and careful in the development of a driver recognition program. Recognition through monitors can be completely objective, based on drivers' scores rather than subjectivity of the supervisor. However, be sure of the quality of the data. Rewarding an undeserving driver will undermine the IVMS program. For example, if you monitor speeding but don't compare speed driven and location, a driver may end up being rewarded for never exceeding 65 mph in a school zone!

Accountability

Periodic coaching is recommended for all drivers in order to provide positive as well as constructive feedback. It is also the first action taken with a driver who has poor scores reported from the IVMS system. To be most effective in providing quality feedback on driver behavior, it is recommended that the coach participates in a commentary drive (ride-along) with the driver and then review together the related IVMS report. When providing constructive feedback, the best approach is to have the driver identify any problems and develop a plan (with the coach) for future performance. This approach encourages ownership by the driver of what behaviors need improvement. A sample IVMS driver coaching form is provided in Appendix C.

The coach must be able to effectively:

- **Interpret** the IVMS report.
- **Recognize** the at-risk behavior.
- **Understand** the tendency for drivers to sometimes deny/rationalize risky behaviors.
- **Identify** the underlying opportunity for improvement.
- **Articulate** the possible outcomes.
- **Communicate** the expected future behavior.
- **Formulate** an action plan for improvement where required.
- **Determine** whether management or operational policies have contributed to the at-risk driving behaviors, and if so, formulate recommendations for policy change.

It is important when building a safe driving culture to ensure drivers and coaches know that IVMS is to be used primarily for ongoing improvement. However, the group of experts reports the need for consistent accountability for blatant disregard of expected future behavior.

Coaches should give special consideration for a particular employee's driving environment. Those employees who are required to drive in congested city traffic *may* exhibit more frequent harsh braking than those who drive in a rural environment. In some rural areas, wildlife crossing roadways *may* be cause for some harsh braking events being reported for a particular week. Individual events certainly can warrant discussion and can be valuable for identifying specific examples, but it is essential to evaluate *patterns of driving behavior* rather than isolated incidents.

The group of experts report that penalties may be appropriate if a driver continues to receive poor driving scores after coaching. The use of penalties for drivers with poor driving scores varies widely among companies. In general, most companies focus on recognition for high-performing drivers and coaching for drivers with low scores (rather than penalties). Many companies, however, have a zero-tolerance policy for certain behaviors, such as tampering with the device, or lack of safety belt use. Each company will want to determine what is best for their business and clients while considering how it impacts the employees and company values.

Where penalties based on IVMS data are used, a number of things are suggested to be in place:

- The consequences for certain driver behaviors are clearly stated in company policy. For example, consider removing driving privileges if score is below a certain threshold for more than 2 months.
- The monitor's data is assured to be accurate risky driving behavior.
- The driver is given due process in any situation where a penalty is imposed, giving the driver an opportunity to explain his actions.

Be careful of unintended consequences that could arise, such as drivers swerving unsafely to avoid triggering a harsh braking event. When penalties for poor driving scores are a possibility, the risk of these unintended consequences may rise. In general, the group of experts suggests not using the IVMS system as a policing tool.

7.4 REVIEW THE IVMS SYSTEM

Reviewing the performance of the IVMS program is a crucial step and occurs on multiple levels. The four levels of review addressed here include individual driver performance, motor vehicle crash rates, the performance of management in implementing the program, and the performance of the IVMS system itself.

7.4.1 Driver Performance Report

The most effective monitoring systems create a driver performance report, which reports the calculated scores of drivers against the predetermined settings of the indicators being tracked. The report aids in identifying at-risk behavior, or conversely, expected behavior. The speed score is almost always the most heavily weighted measure, followed by harsh braking, and then by rapid acceleration. A "cutoff" is usually

set to identify which drivers need attention— be it further coaching or recognition for good performance.
In companies where IVMS has been implemented, the fleet manager or IVMS coordinator usually monitors the data from the IVMS system daily. The system is sometimes set up to report driver scores to the drivers themselves (e.g., weekly). Drivers can use this feedback to make improvements where necessary. Behavioral changes are the key to success and lasting results.
The IVMS coordinators often send driver scores and trends to supervisors. Supervisors frequently review drivers' performance monthly—sooner if there is a negative trend developing or high-risk events occurring. In some companies, senior management is also copied on these reports or at least receives a quarterly status and performance review.
At least one company surveyed attaches driving performance to overall performance evaluations and holds supervisors accountable for their drivers' scores all the way up to the most senior executives.
Where possible, it is suggested to compare drivers' scores to other drivers with similar numbers of miles and/or terrain in order to compare similar driving environments. It can also indicate at-risk behaviors by groups.
The group of experts report printing overall company or unit specific results monthly and posting on a bulletin board to publicly communicate progress, trends and opportunities for improvement.

7.4.2 Tracking Changes in Motor Vehicle Crash Rates

In order to determine if the IVMS is having a long-term impact on motor vehicle safety for a company, the company should maintain a database tracking motor vehicle crashes, the amount of damage, severity (see following table), injuries, root causes, and costs associated with lost productivity. All incidents involving a vehicle in motion with any amount of property damage should be recorded.
Communicate to drivers, supervisors, and leadership the successes and value of the IVMS program. Share with them any improvements in driving behavior, reduced motor vehicle crash rates, reduced costs, increased efficiency, etc.

7.4.3 Motor Vehicle Crash Rate (MVCR) Calculation

A common form of measurement should be used to determine the motor vehicle crash rate. Internationally, the oil and gas extraction industry has adopted metrics developed by OGP.
MVCR = CMS (Catastrophic, Major, Serious) crashes / million kilometers driven.

7.4.4 Management Performance

As mentioned previously, to ensure the success of the program and to realize the greatest return on investment, management leadership and commitment is required. Consideration should be given for measuring the performance of management in implementing the IVMS and in ongoing support for and engagement in the program. Some metrics to consider would be: percentage of vehicles with working monitors installed; software and hardware revision dates; coaching records and records of the application of accountability for at-risk drivers; visibility of the program and related reports; installation of devices in management vehicles. For larger operations, consider such things as comparing operating locations, regions, business units.

7.4.5 System Performance

Metrics that measure IVMS performance and user satisfaction are recommended to be used. Meetings should be arranged with the IVMS vendor on a regular basis (e.g., every 3–6 months) to review these metrics to identify well-functioning components of the IVMS and those components that require attention. Some metrics that can be included are:

- Outstanding items, availability of parts.
- Hardware reliability.
- Warranty—response, turn-around time.
- Communication—time successfully connected (up-time), costs.
- Internet interface and application up-time.
- System updates.
- Response to requests for system enhancements and/or improvement.

7.4.6 Making IVMS program changes

After reviewing the IVMS program on these levels, there will likely be some modifications that need to be made in order to make the program more effective. It is recommended that you identify these changes, return to the planning step to make the changes, and then deploy and review them. This cycle will continue as needed.

8. CONCLUSION

Motor vehicle fatality rates are high for the oil and gas extraction industry, and it is the leading cause of on-the-job death. Workers from small- and medium-sized companies are at the highest risk for fatality.
In-vehicle monitoring systems, along with a comprehensive motor vehicle safety program, have been shown to be a promising tool for improving driving behaviors and reducing motor vehicle crashes in this industry. We hope that companies will use this guide to implement successful in-vehicle monitoring system programs.
The authors acknowledge that more research to evaluate the impact of IVMS on reducing crash rates and improving driving behaviors in the workplace is still needed. Nonetheless, results thus far suggest that the implementation of IVMS programs will likely produce safer drivers and fewer injuries in the future for this industry.

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