Dropsafe®

Drops Prevention Technology

EMPOWERING DROPS PREVENTION

A DROPSAFE HANDBOOK

CONTENTS

FOREWORD

Power generation is turning a corner. As the sector looks to bolster its approach to safety, operators of facilities such as coal, gas, hydro-electric and nuclear power plants are driving significant improvements in tackling Dropped Objects (Drops). The risks are better understood, and knowledge of Drops prevention best practice is taking root.

Drops prevention is not yet ingrained across the board, however. For example, contractors arriving on site during busy 'turnarounds' may have differing levels of Drops training. HSE and plant managers need to be able to apply common standards.

Each facility must be equipped with the knowledge – and the tools – to minimise Drops risks and deliver a safer working environment, while reducing long-term expenditure.

Empowering Drops Prevention: A Dropsafe Handbook is a guide on Drops prevention that provides a practical resource for power generation operators, ensuring that plant and turnaround managers are prepared to meet the Drops challenge. The handbook will offer guidance based on the real experience of Dropsafe and its partners in the power generation sector to effectively reduce Drops.

Mike Rice, CEO, Dropsafe

AN INTRODUCTION TO DROPS

In this section

CHAPTER 1

HOW DO DROPS AFFECT THE POWER GENERATION SECTOR?

This first chapter outlines the fundamental challenges of Drops prevention in power generation, focusing on three key questions:

- What are Drops in power generation?
- How common are Drops in the sector?
- What are the impacts of Drops on operators?

WHAT IS THE FREQUENCY OF DROPS INCIDENTS IN POWER GENERATION?

A lack of consistent reporting is a serious issue in power generation and represents a key stumbling block for effective sector-wide Drops prevention. Industries such as oil and gas have long established bodies such as DROPS to collect incident data and rates.

However, in power generation, incidents may not even be shared between facilities of the same company, let alone among the wider industry.

Despite a lack of hard data, Dropsafe has identified several key takeaways which give an indication of the challenges faced by plant owners and operators:

- Drops risks are significantly higher during 'turnarounds' due to an influx of additional personnel and unfamiliar work practices. This makes consistently recording incidents challenging, while increased activity raises the risks of human error and increases the consequences of potential Drops.

- The power generation sector frequently uses third-party contractors whose Drops training and competency levels may be unknown, reducing the control operators have over training.

WHAT ARE DROPS?

A Drops incident occurs when an item falls from height, causing equipment damage, personnel injury or fatality

Drops incidents fall into one of two categories: Static or Dynamic. Approximately 80% of Drops are Dynamic – the rest Static. Human error is a key factor leading to Dynamic Drops and an important consideration for plant operators in power generation designing Drops prevention programmes.

Dynamic Drops

Objects falling due to applied external force, including objects falling from conveyor belts, handheld items such as hammers dropped by personnel, moving equipment or materials being accidentally dropped when being lifted into place.

Static Drops

Fixed objects that fall from height with no external force applied, such as lights or speakers breaking free from their attachment points due to vibration, corrosion, poor maintenance or being incorrectly installed.

- The large size of an average power plant has presented a barrier to the widespread adoption of best practice Drops prevention solutions in power generation, as the initial investment can be significant when not considering the long-term savings.

- There is a generational divide in the sector, with experienced personnel providing a vital source of knowledge on Drops risks – but also being more reluctant to adopt new practices and technology.

WHAT ARE THE IMPACTS OF DROPS IN POWER GENERATION?

Drops incidents present a fourfold threat to the safety of personnel, the integrity of equipment, the reputation of businesses in power generation, and their financial performance. Safety is always the first priority for HSE and plant managers. However, as the diagram shows, the first three factors combine to create financial losses.

Personnel safety

The clearest and most commonly recognised impact of Drops for plant managers in power generation is the threat to personnel, who may be struck by an object and suffer anything from a minor injury to long-term disability or even death.

Behind every statistic is a person, with loved ones and family. Although equipment can be replaced, the duty of care to protect employees as much as possible is far more important.

Injuries to personnel also cost power generation facilities financially through working days lost. Furthermore, there are potential financial compensation implications, and, as HSE professionals will be well aware, the legal consequences that go hand-in-hand with injuries and fatalities.

As the DROPS Calculator shows, even relatively light objects can cause fatalities when dropped from height. For example, a 1.5kg wrench striking someone from 10m could present a high potential risk of death.

Equipment integrity

Drops can also strike equipment, leading to loss of tools and causing damage to structures.

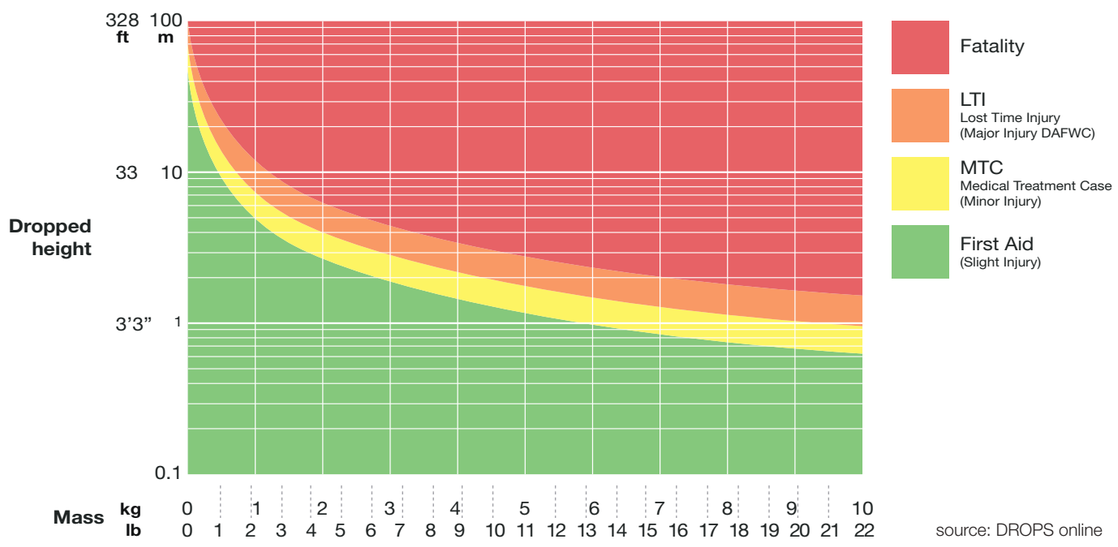
If a Drops incident causes damage to important generators, turbines or pressurised steam pipes, this incurs the cost of replacing damaged assets, but may also lead to a temporary suspension of operations, creating significant challenges for plant managers and causing further financial losses.

Preventing Drops is particularly critical for nuclear power facilities. Retrieving tools from foreign material exclusion zones means a hazardous, lengthy and expensive process. Damage to coolant or containment infrastructure could create a much more dangerous situation.

Corporate reputation

While plant managers are rightly focused on the day-to-day task of protecting personnel and equipment, Drops incidents can have more far-reaching impacts on companies, particularly when negative attention is drawn towards the operator.

Figure 1: DROPS calculator



source: DROPS online

Press coverage is sometimes the only way of uncovering the details of a significant Drops incident. Part of the reluctance to issue comprehensive statistics and provide potentially extremely useful case studies about incidents of falling objects relates to the reputational damage this could do to businesses.

If severe Drops incidents are reported by national media, it reduces trust in the company involved and can affect future business prospects. The experiences of the Californian wildfires and the Texas freeze have particularly hardened the industry's resolve to bolster its reputation for safety and reliability.

Financial risks

Again, financial impacts may be the least of a plant manager's concerns, but the above risks combine to impact the financial standing of a business in different ways – directly or indirectly.

It is difficult to accurately assess the cost to businesses of individual Drops incidents as operators are reticent to share this information. When the costs identified above in terms of compensation claims, lost time incidents (LTIs), damaged tools and equipment are combined, the result can significantly affect the profitability of a facility.

The disruption caused by an enforced inspection during a post-incident investigation can also be a drain on time and resources. The paperwork and reporting process undertaken by HSE managers and operations managers is time spent away from productive work. Should scrutiny of procedures by inspectors lead to a citation, this could mean further reputational damage.

The intangible costs to a business caused by this kind of reputational damage, can exceed all other financial costs.

Ultimately, establishing a holistic approach to Drops prevention will give plant managers more control over their Drops their incident rates, prevention costs, and the reputation of their company.

CHAPTER 2

THE FUNDAMENTALS OF DROPS PREVENTION BEST PRACTICE

This chapter scrutinises the risks posed by Drops in power generation, and provides a resource on current best practice in Drops prevention.

WHAT ARE THE KEY DROPS RISKS IN POWER GENERATION?

Managers of power generation facilities face a specific set of Drops risks due to the large size of their facilities and the irregular nature of maintenance operations. These risks may be influenced by the following factors:

- Large numbers of third-party and regular personnel enter facilities during shutdowns and turnarounds.
- Tasks undertaken during these periods may include non-familiar work that does not occur regularly, increasing the risk of Drops incidents.
- External third-party personnel may have no record of DROPS Awareness or competency, and can present an unknown factor in terms of safety.

Ultimately, these factors can increase the likelihood of Drops incidents occurring, particularly since the three main causes of Drops in power generation relate to human error:

- Inadequate securing of portable devices such as two-way radios, phones, tools and safety equipment used at height - leading to “dynamic” Drops.
- Poor housekeeping on stairways and raised working platforms, leading to tools such as wrenches and hammers being knocked through gaps in railings.
- Lack of inspection of equipment, maintenance and equipment corrosion leading to fixtures and fittings falling from height, or “static” Drops.

WHAT IS THE DIFFERENCE BETWEEN DROPS PREVENTION AND DROPS MITIGATION?

Before examining measures to tackle these issues, it is important to consider the difference between **mitigation** and **prevention**.

Mitigation:
Mitigation involves measures taken to minimise the impact of Drops incidents when they happen – without stopping them from occurring completely. Personal Protective Equipment (PPE), barrier systems and secondary securing solutions such as nets are examples of mitigation measures that power generation operators might use to protect personnel and equipment at their facilities. These physical controls may require initial expenditure.

Prevention:
Prevention means stopping Drops from occurring at all. This requires a holistic approach, considering the design of facilities, operational practices and protocols, and ensuring regular maintenance schedules are followed. Prevention measures can sometimes require no capital expense from an operator’s perspective, although investment in training and policy is a key element of effective Drops prevention programmes.

Both mitigation and prevention are vital – knowing when to apply each one effectively separates the best Drops prevention programmes from the rest.

WHAT ARE THE CORE INGREDIENTS OF A ROBUST DROPS PREVENTION PROGRAMME?

There are four crucial parts of a comprehensive Drops prevention strategy that plant and HSE managers in power generation need to bear in mind when seeking to make their facilities safe. These are:

1. Proactive prevention
2. Personnel training
3. Drops engineering
4. Holistic awareness

The section below will unpack these four components of Drops prevention and give practical advice on how to apply these principles to power generation facilities.

1. PROACTIVE PREVENTION – TACKLING DROPS FROM THE BEGINNING

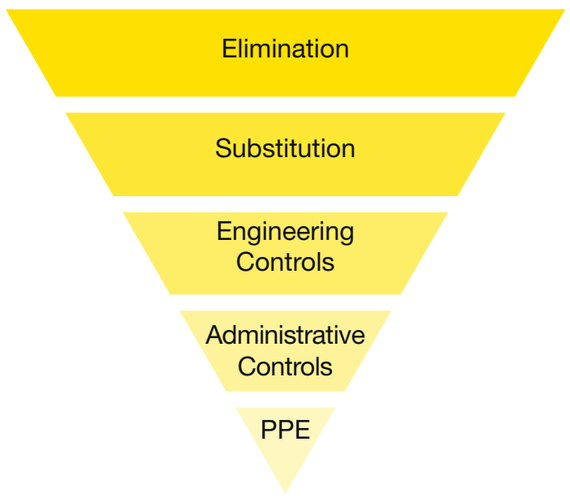
Drops prevention starts with planning. Plant and HSE managers will be familiar with managing complex operations. Drops prevention is no different – but it requires taking a step back to assess the wider picture. Setting out a holistic strategy guided by current best practice will provide a solid base for the individual measures taken.

The hierarchy of controls

The basic building block of health and safety across industries such as oil and gas, power generation and manufacturing is the hierarchy of controls. It should be the starting point for any HSE strategy – and this is particularly true for Drops prevention.

The hierarchy of controls, presented graphically below, shows the order of priority when tackling hazards such as Drops.

Elimination:
This means removing the risk. For example, when designing a facility, are there overhanging hazards such as lights and speakers? Are all of these fixtures required?



The same goes for operations. Lifting manoeuvres are a key source of Drops incidents. Plant managers should consider minimising lifting where possible.

Substitution:
Where it isn't possible to remove a risk altogether, it should be minimized. Operators should ask: can fixtures presenting overhanging hazards be positioned elsewhere? Could a different kind of lighting be used?

Engineering controls:
This includes nets, barrier systems, pouches and 'red zone mats', designed to place a physical barrier between Drops and personnel.

Administrative controls:
No-go zones, collision checklists and toolbox talks are examples of administrative controls to mitigate Drops, aiming to enforce procedures and reduce human error.

PPE:
The last line of defence against Drops, helping to minimise serious injuries and fatalities if personnel are struck by a falling object.

Policy and procedures

Well thought out procedures can play a significant role in minimising Drops incidents, as every other part of a Drops prevention programme stems from the overall policies laying out the direction and scope of Drops prevention at a facility.

Power Generation operators should follow the best practice laid out in the DROPS reliable securing handbook and DROPS online when designing their Drops prevention strategies to ensure that the scope for Drops incidents to occur is minimised. Dropsafe has been involved in supporting the development of DROPS policy and can advise on practical steps managers can take to meet established best practice.

2. PERSONNEL TRAINING – ENSURE FAMILIARITY WITH SAFETY MANAGEMENT SYSTEMS

To maximise the effectiveness of Drops prevention measures, a key preventative measure is ensuring all personnel working at the site have adequate Drops awareness and competency training. Outlined below is an explanation of concrete actions to implement the control measures, with links to further information.

Safety meetings

If they are not already doing so, plant managers should establish **pre-tower/pre-job meetings** before each shift. It is also common practice to have **toolbox talks** five minutes before each task proceeds. Building the latest guidance on Drops prevention into these meetings helps to prevent any potential incidents. You can read more about toolbox talks here.

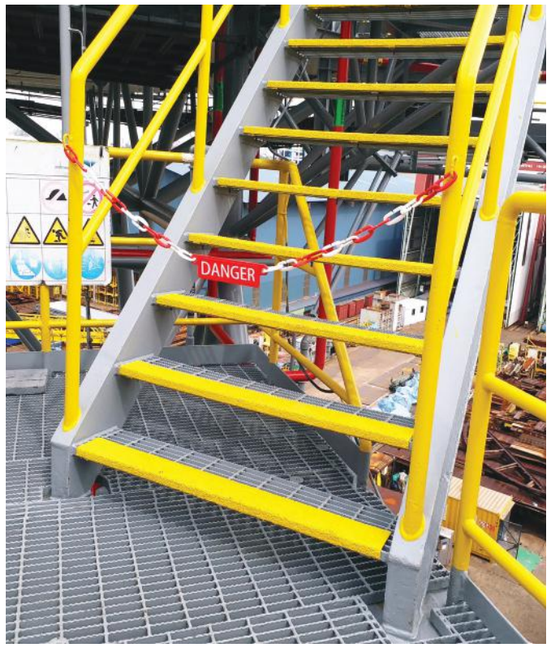
Time out for safety

Originally a campaign by oil and gas drilling contractors 15 years ago, **'time out for safety'**, or 'stop the job' is a way of empowering personnel to take responsibility for safety.

Operators should ensure that if a worker identifies a hazard, they can call for a temporary halt in operations until the issue is fixed. Sharing accountability for safety saves operators money, as it prevents Drops incidents from occurring. Read more about time out for safety here.

Red zones/no-go zones

Plant and HSE managers should aim to put physical barriers into place around high-risk areas to minimise the impact of Drops incidents on personnel. A **red zone** is a designated high-risk area, where personnel must secure permission to enter. For the most hazardous areas, operators should establish a **no-go zone** requiring a permit, granted following an inspection. Shell and DROPS released a guide on the topic with more information.



Housekeeping

Loose, unattended tools can easily become Drops when working at height, particular in a fast-moving work environment. Facility managers should therefore ensure that tools are tidied away safety after breaks, using posters to heighten awareness and building this guidance into toolbox talks.

Collision checklists

Plant managers should place **collision checklists** in the cabs of cranes and forklifts to highlight any obstructions that may become a dynamic Drops incident in the event of a collision during lifting operations. Below is an example of a collision checklist.

DROPS training

Operators in power generation should ensure personnel have Drops awareness certification, covering the factors outlined above, to foster a more comprehensive Drops culture at a facility. Dropsafe is able to advise on and recommend certified training providers, as well as deliver aspects of Drops training.

3. DROPS ENGINEERING – CHOOSING THE RIGHT HIGH-QUALITY SOLUTIONS FOR EACH RISK

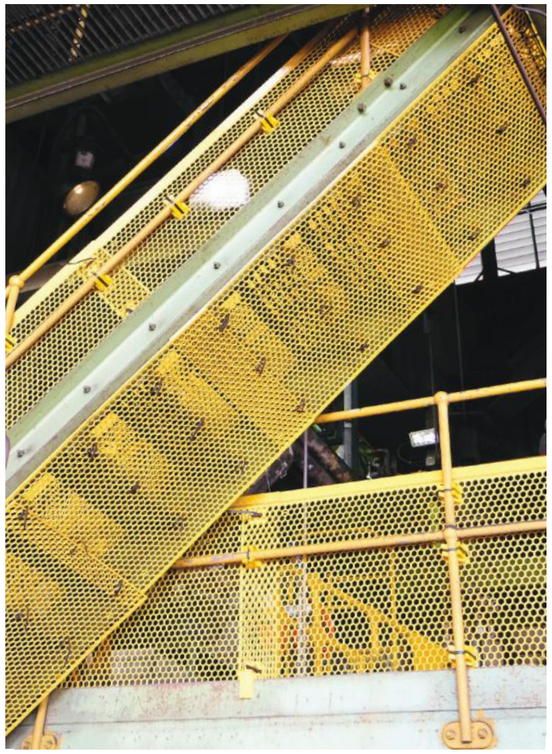
It is not always possible to eliminate Drops risks completely. To ensure a robust defence against Drops, power generation operators can install secondary securing solutions and other engineered controls at critical points in their facilities, containing any Drops incidents that occur. Drops mitigation technology can take the form of nets, barriers, and pouches, depending on the situation.

Tool Tethering

Tools are regularly required on facilities, especially during maintenance periods or turnarounds. It is important that all tools used at height are not only risk assessed and rated 'suitable', but can also be adequately secured while in use.

Tools need to be secured whilst being transported as well as when being used with tethers and lanyards. Tool tethers allow tools to be attached to personnel safely and securely whilst working at height. Heavier items should still be secured, but to a sturdy attachment point.

Tool tethers are one of the most simple ways to prevent dropped object risks, and dramatically increase the level of safety on a worksite.



Barriers

Barrier solutions are a key feature of Drops engineering and risk mitigation, and there are a large number of options available. Flexible mesh is commonly employed on power generation facilities, but does not offer the high level of safety that other systems do. Expanded metal is a stronger alternative, but is also heavier, harder to install, and requires ongoing maintenance.

Advanced polymer barriers, however, can be fixed to guardrailing on stairs and raised working platforms easily, while preventing tools from being knocked through gaps or ricocheting. For power generation operators, there are two main things to consider when procuring a barrier system:

1. Is the barrier designed for the operational conditions at your facility?

   The best barrier ranges will offer the flexibility for harsh, outdoor environments, while including a purpose designed barrier for temperate conditions such as a climate-controlled power generation facility.

2. Can the barrier be installed and re-installed with minimum hassle?

   Welding work will add significant labour costs and time to an installation and makes rapid redeployment difficult. A universal attachment system enables easy installation and removal.

   To find out more about best practice in Barrier system procurement, you can read the Dropsafe article on the 6 questions to ask your supplier.

Mats For Grating

It is not only tools that can be dropped from height. A significant number of dropped objects are a result of loose or discarded items, such as nuts and bolts, replaced parts or components. This is occurs most frequently during maintenance periods or fixture repair.

All items at height should be logged in an inventory, no matter their size or apparent importance. Grating mats are one of the best and most effective ways to stop small items or components from falling through grating or other gaps.

Pouches

Personnel can be equipped with steel wire mesh pouches to tether two-way radios and tools to their belts, mitigating any dynamic Drops that occur when working at height. All lanyards, pouches, bags and safety harnesses for carrying equipment and personnel at height should be visually inspected prior to use.

Find out more about the proper use of Pouches, click here.

Personal Protection Equipment

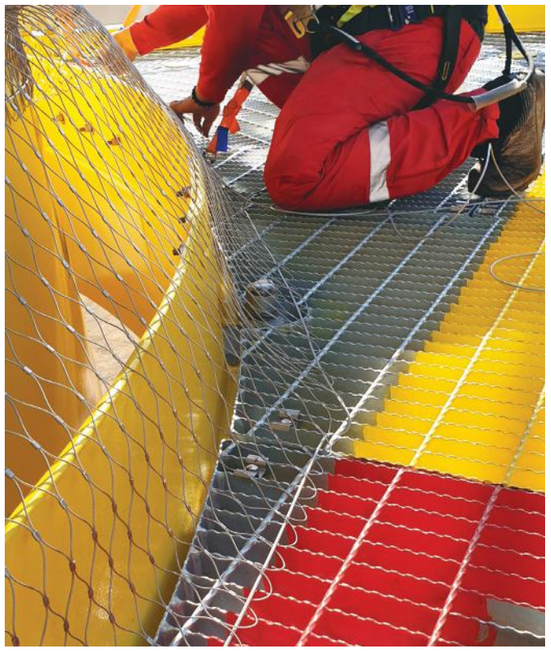
The goal of a comprehensive Drops prevention programme is to make PPE redundant. For example, hard hats are not infallible and may not prevent serious injury if a severe Drops incident occurs. PPE is still vital, however, and operators should ensure that high quality equipment is supplied to personnel.

For a quick guide on proper use of PPE in power generation, read OSHA's factsheet.

Catch Nets

When grating or flooring is altered or modified to accommodate piping, cables or fixtures requiring a 'feedthrough' point, it is important to become aware of potential Drops risks these can cause.
All piping and feedthroughs should have toe boards or adequate alternatives installed, although this is not always possible, depending upon location, size and shape of the feedthrough.

A more safety-aware and effective solution (even if toe boards can be installed), is ensuring any areas, especially potential high-risk Drops sites, are covered. Additional grating or tarpaulin covers can be effective prevention solutions. Similarly, steel mesh catch nets can be installed as an easy way to prevent objects from dropping from modified areas or gaps in grating.



4. HOLISTIC AWARENESS – INSPECTIONS, REPORTING, AND UNDERSTANDING

As outlined previously, the size of power generation facilities and the cyclical nature of maintenance in the sector has posed challenges for plant and HSE managers in the past. For personnel performing planned maintenance tasks, raising their awareness of potential Drops through visual inspection and reporting is particularly crucial.

Third-party inspections

Contracting a third-party Drops prevention specialist to perform an inspection of a facility can help to fine-tune a Drops prevention programme. To maximise the cost-effectiveness of these inspections, plant managers should aim to establish a comprehensive strategy and identify key risks throughout a facility.

Prior to the inspection, plant managers can contract an inspection firm to perform a **Drops Management Review and Drops Audit**, assessing the overall approach to Drops prevention taken by the business as a whole.

The third-party experts can then provide validation and offer final guidance. Dropsafe can advise on experienced and reputable inspection companies in power generation.

Planned Maintenance schedules

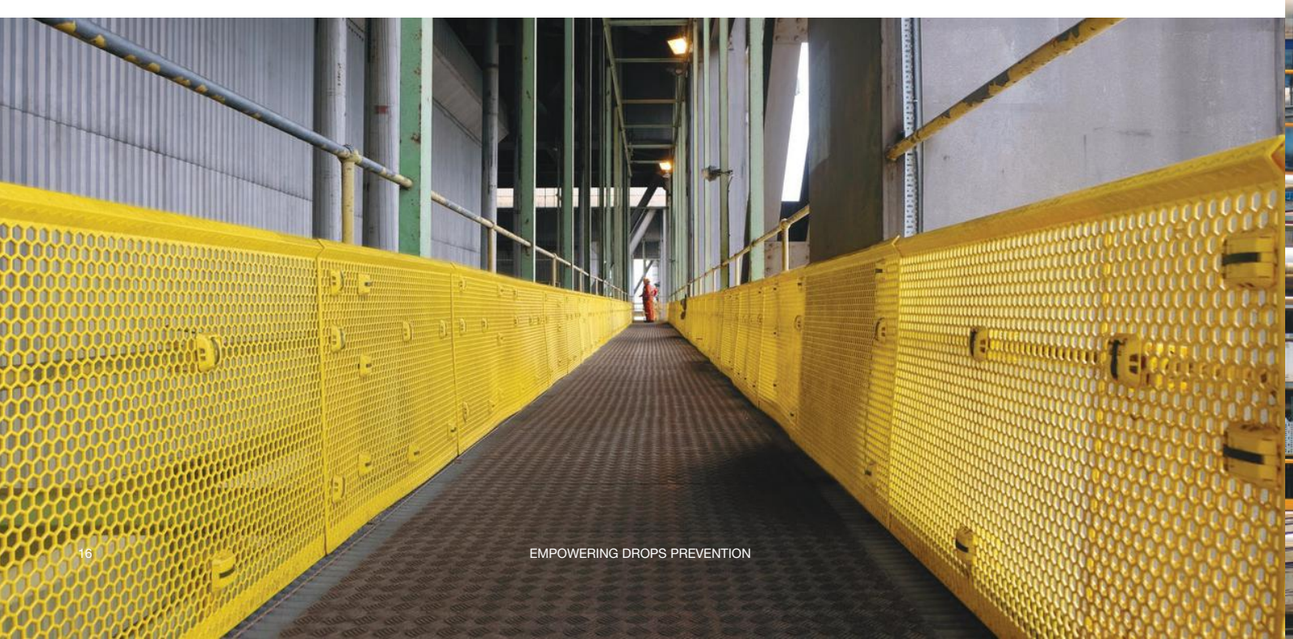
The 'shutdown' or 'turnaround' period is major event for a power generation facility. Within specific timeframes, certain sections of the plant will be maintained or replaced.

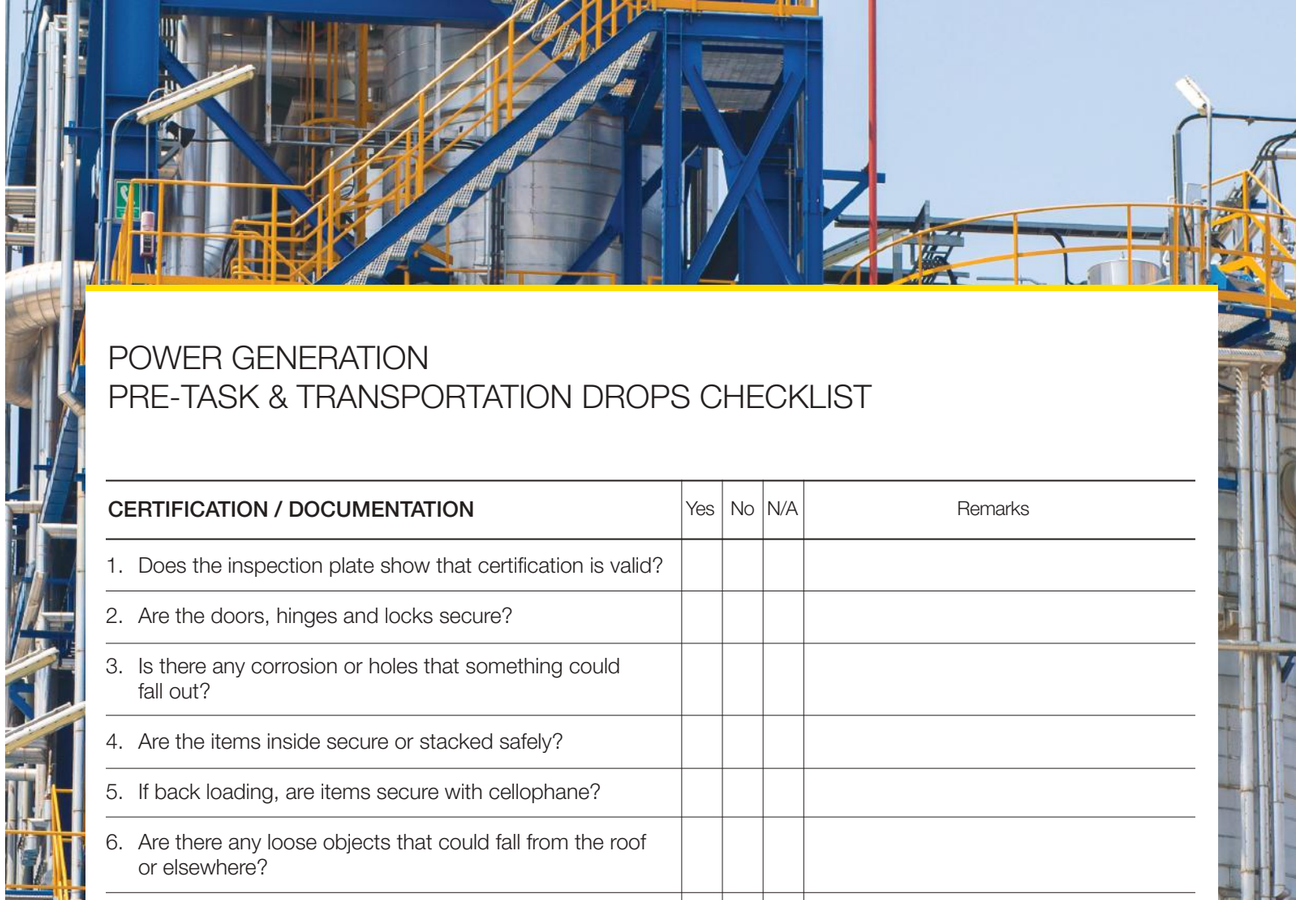
This presents an ideal opportunity to perform Drops inspections, so this should be factored into maintenance schedules. Keeping safety – including Drops prevention – front of mind at all times is free, and will save operators significant sums in the long-term due to reduced incident rates.

Sharing information

The drilling sector in oil and gas has led in reporting and wider information sharing. The experience of drillers has shown the value of an open approach to reporting, both within organisations and within the sector.

As discussed in chapter one of this handbook, the power generation sector should take the opportunity to ensure that information on Drops incidents is shared widely, to learn from mistakes and prevent them from occurring twice.





POWER GENERATION
PRE-TASK & TRANSPORTATION DROPS CHECKLIST

CERTIFICATION / DOCUMENTATION	Yes	No	N/A	Remarks
1. Does the inspection plate show that certification is valid?				
2. Are the doors, hinges and locks secure?				
3. Is there any corrosion or holes that something could fall out?				
4. Are the items inside secure or stacked safely?				
5. If back loading, are items secure with cellophane?				
6. Are there any loose objects that could fall from the roof or elsewhere?				
7. Check the fork lift recess holes for loose objects.				
8. Is the cargo net secure?				
9. Ensure there are no potential snagging hazards.				
10. Check the unit is not overloaded.				
11. Are the split pins fitted to the shackles?				
12. Have the slings and shackles been checked for damage and wear?				
13. Have you checked the gross weight against the safe working load?				
14. If tubular or loose items, are sling Bulldogs effective?				
15. Is the correct paperwork (including DROPS Check) in place?				

Name	Signature	Date

DROPS MITIGATION IN PRACTICE

In this section

CHAPTER 3

DROPS PREVENTION BARRIER SYSTEMS IN POWER GENERATION

This chapter examines one of the core engineered Drops prevention solutions available to plant managers as they look to mitigate Drops at their facilities – safety barrier systems. To date, there has not been a detailed guide on the best practice applications of this technology in power generation.

DROPS Reliable Securing, which was originally developed for O&G but has now formed the basis for best practice across other industries, states:

“Safety barricades and mesh systems may be applied to reduce potential for items to fall through guard rails. These should be of suitable materials, incorporate appropriate securing features and be installed and maintained in accordance with manufacturer’s recommendations.”

To expand on this guidance, this chapter of the handbook will help plant and facility managers in power generation to identify the best barricade systems and show how they can be used most effectively as part of a broader Drops prevention programme.

WHAT IS A DROPS PREVENTION BARRICADE SYSTEM?

Drops prevention barrier systems attach along the inside of guardrailing on stairways, elevated walkways and raised working platforms, covering the gaps to prevent objects from falling through. These objects can include tools, handheld equipment, and loose fixtures or machinery components.

A robust barrier system will also prevent items that have dropped from potentially ricocheting further, by absorbing the force of a falling object. This is particularly important because items that drop can often ultimately strike a worker from unexpected directions.

DROPS INCIDENT CASE STUDY:

HAMMER IS KICKED FROM WORK BASKET

INCIDENT:

A 2.3kg (5 lb) hammer falls 3 metres (10 ft) from an elevated work basket, where it strikes an employee on the hard hat. The hammer creates a pinch point between the hard hat and safety glasses thus resulting in a laceration below his left eyebrow.

CIRCUMSTANCES:

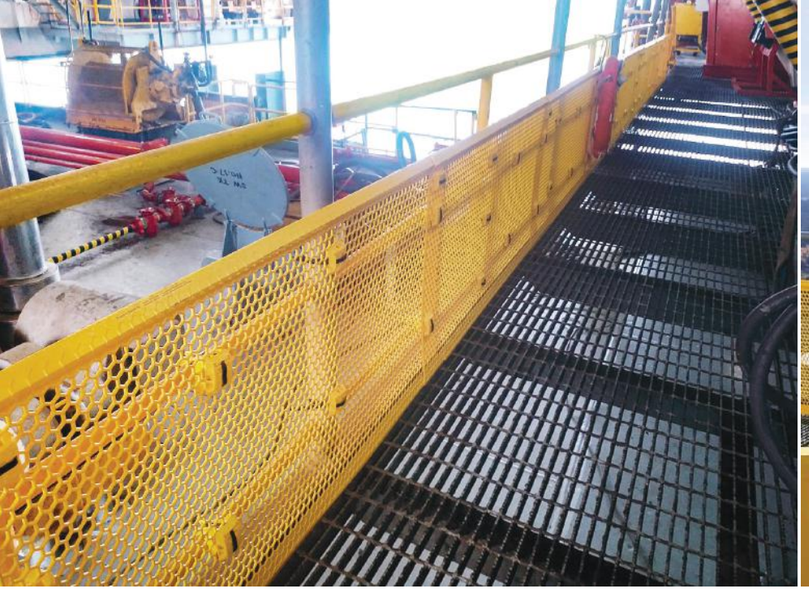
An employee operates a work basket while using a shop hammer. He drops the hammer to the bottom of the work platform and whilst moving about the area to arrange the chain hoist, accidentally kicks the hammer through the railings.

IMPACT:

Employees were reminded of the importance of tethering/securing any tools when working overhead, even when working in a work basket. Additionally, the work plan for operating in elevated work platforms must be reviewed to include the importance of keeping the lift basket orderly.

ANALYSIS:

This incident could have been prevented if a barrier system was installed on the work basket. In the case of the hammer being dropped to the floor, if kicked, it therefore wouldn’t fall from the platform.
The next section will demonstrate key risk areas in a power plant, guiding facility operators on how to install their barrier systems in accordance with current best practice.



WHERE SHOULD BARRIERS BE INSTALLED?

There are four main Drops risk areas at power generation facilities where installing a barrier system is most effective: walkways, stairways, turbine guards and storage tanks.

Walkways

Elevated walkways are high-risk Drops areas, due to large gaps between guardrailing, and a high likelihood of personnel walking below. Walkways also serve as arteries for maintenance teams, who often carry untethered tools and equipment throughout the facility, creating Drops risks. In power generation facilities, barrier systems are a crucial part of Drops prevention, as the walkways across power facilities are often extensive and will be placed over multiple levels.

Stairways

As a point of transition within a facility, a stairway presents a significant Drops risk. Additionally, when personnel are using stairways, they may carry tools or equipment in one hand while using one hand on the handrail, further increasing Drops risks.
Barrier systems should therefore be installed along the guardrailings at the sides of the stairs to prevent objects being dropped through. Where the gaps between steps are large, plant managers should also consider installing barrier panels on the underside of stairs.

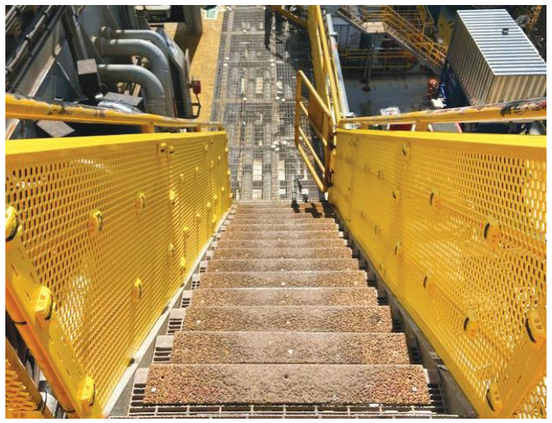
Turbine and furnace guards

In thermal power plants, the turbines and furnaces are often surrounded with guardrailings. If an object falls through these and damages vital components, it can have significant financial implications for the facility. Additionally, if a tool is dropped next to the turbine, it may be unsafe to retrieve, causing disruption to tight work schedules. A barrier system will help to mitigate these risks.

Storage tanks and chimney stacks

Although the layout differs depending on the facility type, power generation plants often store fuel in large storage tanks. Along with chimneys, the height of these structures makes even small objects potentially life-threatening if dropped or dislodged. Plant managers can mitigate this risk by installing a barrier system. For an illustration of how Drops risks increase with height, please see the first chapter of this handbook.
[Images of Pearlweave or Dropsafe Barrier installed around gas storage tank railings/chimney stack]

The correct installation of a barrier system is vital, but what characteristics need to be considered when choosing a barrier?



KEY ATTRIBUTES OF A BEST PRACTICE DROPS PREVENTION BARRIER SYSTEM

The following section will provide a breakdown of key benefits of leading barrier solutions available to power generation plant managers.

Commonly adopted solutions in power generation include:
- Flexible mesh netting
- Plywood
- Bolted metal fencing
- Modular polymer barricades

Each of these products can be used effectively in specific circumstances, but not all of them are appropriate for long-term use, depending on the conditions in which they are being deployed. Below are the key attributes of each solution that must be considered.

FLEXIBLE MESH NETTING

Flexible mesh netting is constructed out of connected strands of fibre or other flexible or ductile materials, and attached to rails on walkways at height.

Benefits

- Fast installation requiring limited tools
- Minimal number of attaching components
- Versatile, can be attached to any structure regardless of shape
- Readily available, with limited procurement time
- Low upfront cost

Flexible mesh netting is widely used due to its low cost, ease of installation and versatility. Although not ideally suited for use as a long-term solution when compared to more durable or hard-wearing alternatives, flexible mesh netting remains a popular choice at power generation facilities.

Sustainability

Flexible mesh PVC netting is an ideal solution for short-term, temporary installations in facilities. Its flexibility and speedy installation is somewhat overshadowed by its poor durability. Not able to withstand harsh weather conditions or high levels of impact makes PVC a weaker option for a drops prevention barrier when compared to alternatives. The short-term usage plays a big part in its low level of sustainability; it requires regular replacement due to damage, resulting in huge amounts of industrial waste. PVC netting can also not be recycled, due to the mixture of toxic chemicals used in its manufacturing. Of the four most popular barrier options, flexible mesh netting has the lowest level of sustainability.

Sustainability rating

Plywood is easy to procure, cost-effective and can be modified to cover most structures. The low upfront cost of the solution must be balanced with its higher installation costs and long-term replacement costs.

PLYWOOD

Plywood panels can be attached to guardrailing to prevent Drops. This solution is more commonly deployed within the offshore oil and gas sector.

Benefits

- Readily available, with limited procurement time
- Can be cut to exact sizes to fit non-standard guardrailing
- Low upfront cost, although not as low as flexible mesh netting

Sustainability

Plywood is commonly used for longer-term, temporary installs. It takes significantly longer to install, requiring the use of power tools such as drills to affix the plywood sheets to the guardrailing. While more hardwearing than flexible PVC, when removed plywood creates a significant amount of industrial waste. It does, however, remain installed for longer and is more durable, requiring little to no replacement during it's install period. While regular plywood can usually be recycled, plywood used on worksites is often treated with paint or chemicals to make it fire-retardant, non-slip, waterproof, or generally longer lasting. This rarely makes recycling a realistic option, therefore it is less sustainable than flexible mesh netting and results in high levels of industrial waste.

Sustainability rating

BOLTED METAL FENCING

Bolted metal barricades are attached to compatible bracket designs on guardrailing, stairways and raised working platforms. Typically, using this type of barrier involves the installation of a frame to it attach to. Bolted metal fencing is often used for security fencing but can be used as a barrier for walkways and platforms at height.

Benefits

- Long lifespan if maintained effectively
- High impact, heat, and fire resistance rating
- Wide operational temperature range
- Ability to cover and fit complex shapes and structures

Bolted metal fencing is one of the most robust solutions, with high impact and heat resistance. When maintained regularly, bolted metal fencing can be used successfully over longer timescales, but this maintenance may incur additional labour costs.

Sustainability

Bolted metal fencing requires a significant effort and specific skills to install. Some systems use mounting brackets, however, hot works is often required; therefore, the whole process takes longer than any other barrier option. It is, however, intended for a more permanent installation, lasting for a number of years. Metal fencing is hardwearing and very durable. It also requires maintenance to prevent rust or other corrosion, but on the whole is sturdy, withstanding impacts, extreme weather conditions and the test of time. Furthermore, when bolted metal barriers are uninstalled at the end of their life, they are recyclable. This lack of industrial waste makes this a very sustainable option.

Sustainability rating

MODULAR POLYMER BARRIERS

Modular polymer (plastic) fencing systems can be installed on various configurations of handrailing. Polymer barriers are available in a range of specifications, with different levels of resistance to environmental parameters.

Benefits

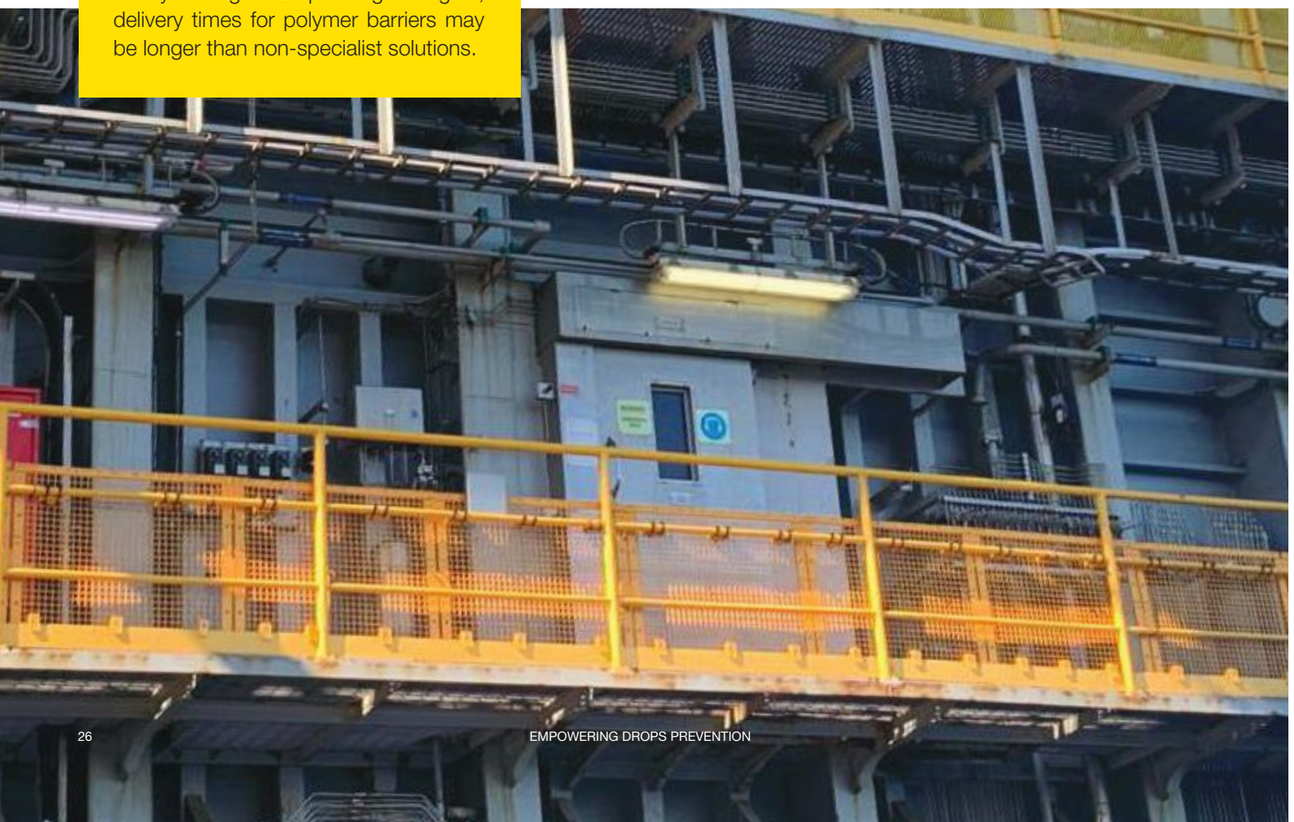
- Minimal tools required for installation, with no ‘hot works’
- Minimal Drops risks during installation due to limited components
- Easy reinstallation
- High resistance to impacts, heat, wind, and chemicals

Polymer barrier systems are easy to install, maintain and redeploy. With high resistance to impacts and adverse environmental conditions, the solution is a common choice for power generation facility managers. Depending on region, delivery times for polymer barriers may be longer than non-specialist solutions.

Sustainability

Modular polymer barriers are intended as a long-term solution, but due to the ease and speed of installation (which requires neither tools nor hot works) can often be uninstalled and redeployed. The quality of polymer systems does need to be considered; weaker options are often not tested, while stronger, more robust options are designed for long periods of use (often 10+ years). Those that are designed to be permanent are strong enough to withstand harsh conditions and impacts, requiring little (if any) maintenance or replacement. Modular polymer barrier solutions are usually fully recyclable, eliminating industrial waste, offering another sustainable barrier solution.

Sustainability rating



CASE STUDY: POWER GENERATION

What does a successful barrier roll-out look like in power generation? The following case study outlines how one facility owner was able to mitigate Drops risks across their facility with a barrier system.

Challenge

At one of Asia’s largest coal-fired power stations, there are eight separate generating units, each of which has its own furnace and boiler. These units are on a rolling maintenance programme, which sees no more than two shut down at any one time to maintain consistent production.

Conducting essential routine maintenance at this plant is resource intensive and involves the deployment of specialist technicians, many of whom work at height in the vicinity of critical infrastructure. During maintenance periods, mitigating the dual risk to personnel and equipment posed by Dropped Objects (Drops) from walkways and stairwells was a core concern for the plant’s operators.

Solution

A polymer barrier system was installed to mitigate Drops risks during essential maintenance operations - with technicians working at height to conduct vital inspections and repairs on furnaces and boilers.

Initially, enough barrier was installed to safeguard two out of a total of eight furnaces on site. Following the success of this initial installation, the system has now been rolled out across the whole facility.

Drivers

Universal attachment system

Easily attached and removed using a universal mechanism, the barrier was installed quickly, reducing installation time. When conducting such a large-scale rollout, ease of installation was a crucial factor for the facilities maintenance teams, requiring minimal training and saving time.

Installation cost

This versatility ensured that installation costs were minimized, as the plant’s engineering and maintenance provider installed the barrier in a timely and cost-effective manner.

Manufacturing quality

The certified manufacturing quality of the barrier system gave the facility owners confidence they had invested in a long-term, effective safety solution. The barrier was engineered from high-grade polymer, which is robust, but lightweight.

Outcome

The barrier system was easily installed, reducing both the overall time and resources required, whilst ensuring technician safety.

The facility’s owner is well-placed to comprehensively mitigate the risk of dropped objects during maintenance, and in doing so, will set a benchmark amongst power generation businesses with its robust approach to tackling one of the major safety risks to the industry.

CHAPTER 4

TOOL TETHERING – THE FIRST LINE OF DEFENCE

DEVELOPED IN PARTNERSHIP WITH STOPDROP TOOLING

Tool tethering is a crucial element of preventing dropped objects when working at height in the power generation sector. From thermal plants to nuclear power facilities, dropped tools pose a serious risk to personnel and equipment.

This section of the handbook shows how plant and HSE managers in the sector can prevent the risk of dropped tools by adopting a systematic approach to working with tools at height.

THE RISKS POSED BY DROPPED TOOLS IN POWER GENERATION

Power plant maintenance routinely involves personnel working at height across multiple levels. During plant turnarounds and shutdowns, the number of personnel on-site increases – and so do the risks posed by dropped tools. Hand tools such as hammers, wrenches and screwdrivers, or their components, may slip from a technician's grasp and fall through gaps in railings leading to a Drops incident.

You can read more about the potential consequences of a Drops incident in chapter one of this handbook.

By taking a proactive approach to preventing dropped tools, plant and facility managers in power generation have an opportunity to effectively manage the risk of potential harm to their people, assets and businesses' reputation.

A THREE-PRONGED APPROACH TO TACKLING DROPPED TOOLS

Following the principles of the 'Hierarchy of Controls', there are three key elements to ensuring safe, cost-effective mitigation of dropped tool risks in power generation. These are:

1. Tool design
2. Tethering
3. Training and application

1. Tool design

Implementing a Drops strategy aligned with best practice guidance requires tools on site that are specifically designed for working at height.

Where possible, plant managers should ensure the use of tools with the following characteristics:

- Engineered single piece design to remove failure points
- Designed with a specialised, integrated attachment point
- Colour coded and laser engraved to add traceability

Single-part tools

When tools are comprised of multiple components, years of wear and degradation can lead to failures. Plastic handles on hammers or files, for instance, may come loose from the heavier metal part, causing a Drops incident. Where possible, using tools that consist of a single part represents a safer option.

Purpose made attachment points

The DROPS 'Recommended Guidelines for the Safe Use of Tools & Equipment at Height' states that: 'tooling should be manufactured and supplied with tested and certified lanyard attachment points.'

The use of tape wrapped around tool handles to attach tethers is common in industries such as power generation. The risk of applying adhesive tape to general tools is that it degrades over time, weakening its effectiveness and raising the risk of failure regardless of the number of times it is applied to the tool. This approach, where personnel adapt their general tools for working at height, also leaves increased room for human error.

Colour coding and laser engraving

Colour coding and engraving each tool with a unique identifier for each department means that a tool can be easily identified as part of a specific set. Should the tool be misplaced, or be involved in an incident, plant managers can trace the tool when carrying out a route cause analysis.

DROPPED TOOL INCIDENT:

HEAD DETACHES FROM LUMP HAMMER

An incident highlighted by IMCA's 'Safety Flash' shows the importance of using the correct tools when working at height.

Two personnel were working with a spanner wrench and 2kg lump hammer at the upper level of a tower. The hammer was used to strike the spanner wrench, and upon impact, the hammer head detached from the handle and fell 25 metres.

There were no injuries as the area below had been barriered off, but according to the DROPS calculator, the hammer head would have likely caused a fatality if it struck a worker.

Crucially, the subsequent investigation found that:

- The hammer shaft was attached to a lanyard
- The hammer showed no defects when inspected prior to use
- The wooden shaft attaching the handle to the head failed

Pipelay tower showing where hammer fell

The incident would not be possible with a tool specifically designed for working at height, where the handle and head cannot be separated.

'Near miss' incidents such as this occur frequently in many industries, including power generation. Many go unreported, underlining the need for more consistent incident sharing between power generation facilities.

Broken lump hammer

2. Tethering

All tooling used at height should be attached via a lanyard to a tool bag, to a harness equipment loop or to the worksite. Lanyards can be constructed from plastic coil, fabric or stainless-steel wire, and should be fitted with rated screwgate carabiners.

'Universal' lanyards may present challenges for power generation workers when working in a confined space or where an extended reach may be required to carry out a task. Choosing the correct lanyard in advance is crucial, saving unnecessary trips to swap out items, and thus reducing risk.

Heavier tools used in power generation should be secured to the worksite with wire lanyards. The DROPS Guidelines recommend that 'for tools and equipment ≥ 5kg, a minimum 4mm certified wire is recommended.' Best practice tethering solutions will ensure that coil lanyards can only be fitted to tools which are under this weight.

3. Training and application

Training personnel in the latest tool tethering best practice is crucial. There are no accredited tooling programmes in power generation, so plant and facility managers should ensure that robust training is available for their staff.

Applying tool tethering best practice effectively involves:

- Correct use of tool bags and belts
- Control measures
- Managing third-party contractors

Tool bags and belts

When working at height, best practice is to store tools within a bag, tucked securely inside and tethered separately to attachment points inside it. This ensures that tools cannot swing on their tethers when climbing or working at height, which could cause injury, damage to equipment or a Drops incident.

The DROPS Recommended Guidelines stipulate that:

- "Tools shall be taken aloft in some form of kit bag."
- "The kit bag shall be attached to the user, and leave both hands free."
- "Tools are to be attached to the kit bag (not merely put in it)."

Control measures

Using a static toolkit where tools need to be signed out manually from a central depot is an additional safety barrier enabling better housekeeping and tracking tool usage.

The Guidelines state: "Tools used at height should be logged in and out using a simple Tools Register to ensure that no tools have been left behind."

Furthermore: "Tools should be stored in such a manner that a simple visual inspection can highlight any discrepancies or omissions in the toolbox inventory, such as 2-colour laser cut foam inserts."

Contractors

Third-party contractors are an invaluable part of the turnaround process in power generation facilities, both bringing expertise and boosting capacity. Contractors will often supply their own tools, however, these may not be suitable for working at height.

Power generation facility managers should either supply safe tools for working at height, or ensure all contractors bring tools and accessories that are suitable – and safe – for working at height.

Stopdrop Tooling offers a full range of hand tools and tethering systems specifically designed to prevent drops while working at height. For more information, please visit: https://stopdroptooling.com/

CHAPTER 5

SECURING MOBILE ELEVATED WORK PLATFORMS

DEVELOPED IN PARTNERSHIP WITH TUTUS

Mobile elevated work platforms (MEWPS) are an essential piece of equipment in power generation, but they also increase Drops risks for personnel and equipment.

This chapter examines how facility managers and contractors in power generation can mitigate these risks through robust processes and best practice engineered solutions.

MOBILE ELEVATED WORK PLATFORMS AND DROPS IN THE POWER GENERATION SECTOR

Mobile elevated work platforms allow personnel to work at height temporarily in situations where scaffolding is not possible or practical. For example, this could be to install or maintain a camera or light, inspect pipes or electrical wiring, or install secondary securing solutions on fixtures in a raised position.

A mobile elevated work platform can include work baskets, man baskets, scissor lifts and cherry pickers, and is intended to support personnel to carry out work from the work platform rather than transporting personnel to an exit position at height.

During the construction of power generation facilities and related grid infrastructure, large rough-terrain 4X4 – wheeled or tracked – platforms may be used. Risks are increased due to unstable terrain and exposure to wind, which can cause instability of platforms and dislodge loose equipment.

Drops risks from mobile elevated work platforms include:

- Knocking untethered tools, water bottles or radios through gaps in the basket railing or off the control panel
- Colliding with structures and dislodging fixtures
- Dropping equipment or tools during fixture installation or maintenance activities

THE ‘ACCIDENT FORGIVENESS’ APPROACH TO DROPS PREVENTION

A Drops incident does not need to cause injury to personnel to create serious consequences for power generation organizations. One approach to Drops prevention which illustrates this is ‘Accident Forgiveness’.

Not all Drops cause serious injury or fatalities, but they can still result in disruption. One reason is that assets being installed may be valuable in themselves, with some specialised cameras costing more than $80,000.

Another reason is that there will inevitably be serious disciplinary consequences for a mobile elevated work platform operator who causes a Drops incident. A common cause of Drops from mobile elevated work platforms is when personnel turn around in the basket and strike water bottles or other loose items, knocking them loose.

This could result in a highly skilled employee being terminated, leading to lost knowledge and an expensive hiring process to replace a scarce resource.

With mitigation installed, an accidental Drops incident is contained safely, the power generation facility retains its talent, and the organisation can learn from Drops incidents in a constructive way to strengthen their Drops programme.

MOBILE ELEVATED WORK PLATFORM DROPS INCIDENT CASE STUDY

An EPC contractor was involved in the construction of a plant in Louisiana, using mobile elevated work platforms to perform key tasks at height.

During an operation at height, a fire extinguisher was dislodged from the platform, falling only 15 feet to the ground below. Although nobody was injured, the incident led to a full shutdown of the 6,000 staff and craft, impacting a team of 30 main construction contractors. The overall financial cost of this shut down to the project was $1.2 million dollars.

Orange debris mesh was installed around the basket of the platform, but this was insufficient due to the weight of the fire extinguisher. A more robust solution would have prevented the incident, saving millions for the facility owners.

Choosing the DIY solution means that the reputation of the overall Drops safety program on site was affected, as it implemented a site requirement that failed to keep an essential safety device (fire extinguisher) within the basket of the access equipment.

BEST PRACTICE DROPS PREVENTION FOR MOBILE ELEVATED WORK PLATFORMS

To mitigate and prevent Drops incidents when using mobile elevated work platforms on power generation sites, facility managers can use engineering controls and administrative controls.

ADMINISTRATIVE CONTROLS

The key administrative control to protect personnel and equipment when working inside mobile elevated work platforms in a power generation facility is implementing '**red zones**'. This means demarcating an area underneath the platform which personnel are forbidden from entering while the work takes place.

Other administrative tools include placing **collision checklists** in the control section of the platform to remind the operator of best practice, and conducting toolbox talks to ensure all personnel are aware that a platform will be used.

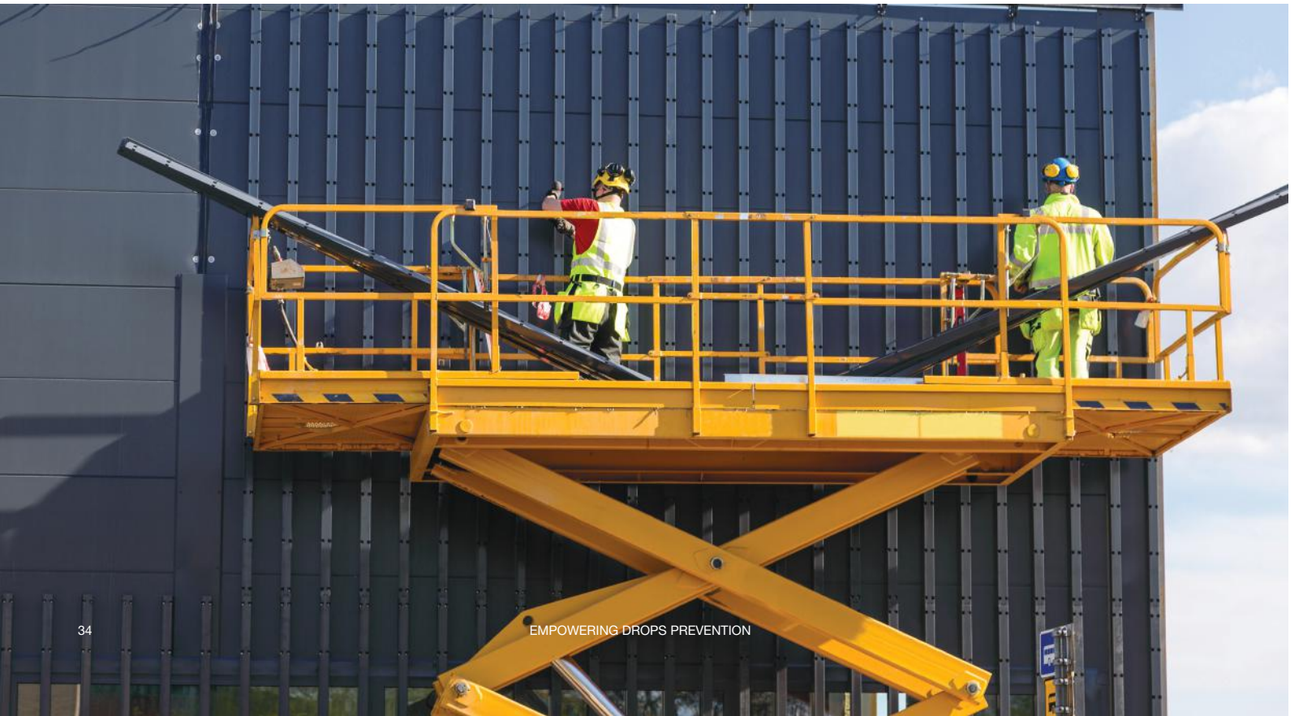
More information about red zones, collision checklists and **toolbox talks** can be found in Chapter Two.

ENGINEERING CONTROLS

There are three main engineered solutions available to power generation facility managers when tackling Drops from mobile elevated work platforms. These are tool tethering, mesh netting, and floor mats.

1. Tool tethering

Ensuring that appropriate tools designed for working at height are used – correctly – by personnel at power generation facilities ensures that wrenches, hammers and other tools do not become Drops. To learn more about tool tethering, please refer to Chapter Four.



2. Mesh netting

In other industries, operators have been known to use homemade debris mesh to secure mobile elevated work platforms. However, retrofitting this DIY solution takes longer than using customised solutions, and the netting will need to be replaced regularly due to its less robust construction and materials.

Purpose-engineered mesh netting solutions, in contrast, provide reliable protection over longer periods. Best practice mesh netting solutions designed for use on mobile elevated work platforms will:

- Cover the access doors, control panel, and bottom of the lift – completely encapsulating the work platform.
- Be wind tunnel tested and designed for the rigors of industrial work.
- Ensure that personnel can easily exit platform through the entryway.
- Provide an unobstructed view through platform base.
- Require minimal care and handling and be cleaned with petroleum distillates.
- Safely absorb and contain impact from heavy objects.
- Be resistant to sunlight UV degradation.
- Be resistant to airborne contaminants.
- Be rip resistant.

3. Floor mats

A floor mat should be affixed to the bottom of the mobile elevated work platform to prevent small loose objects such as screws from falling through holes in the grating. When procuring a floor mat for mobile elevated work platforms, facility managers should ensure that their chosen solution is lightweight, durable and small enough to be man-portable.

The floor mat must be securely attached to mitigate the risk of snagging and avoid creating a potential trip hazard. Best practice solutions will use magnets, which require no installation time and increase the versatility of the solution.

For more information on floor mats, please revisit Chapter Two.

Drops risks arising from mobile elevated work platforms have long been overlooked in power generation. Growing awareness of Drops prevention best practice has driven demand for robust and reliable solutions. By increasing the uptake of these solutions throughout the power generation sector, operators will benefit from reduced Lost Time Injuries, protected equipment, and a workforce with the tools and knowledge to prevent Drops.

GoTutus supplies versatile netting solutions to help operators tackle Drops on mobile elevated working platforms – from man baskets to scissor lifts. To find out more, please visit: https://www.gotutus.com/

BUILDING A DROPS PREVENTION CULTURE

In this section

CHAPTER 6

OVERCOMING BARRIERS TO THE ADOPTION OF DROPS PREVENTION BEST PRACTICE

This chapter directly addresses the ten most common obstacles to the wider roll out of a systematic approach to tackling Drops, dispelling common myths. The obstacles are grouped under four key categories:

1. **Practical barriers**
2. **Financial barriers**
3. **Organisational barriers**
4. **Cultural barriers**

PRACTICAL BARRIERS TO DROPS PREVENTION BEST PRACTICE

1. Time constraints

> “We want a safer workplace but we don’t have time to install Drops prevention solutions”

Recommendations:

- Identify ways to reduce the installation time of Drops prevention solutions, ensuring that:
  - No ‘hot works’ are required – these can necessitate temporary shutdowns.
  - No additional tools or power tools are required.

2. Labour constraints

> “We can’t dedicate the manpower to install Drops prevention solutions”

Recommendations:

- Choose a solution that can be installed efficiently by a small team.
- Ease of use is essential to minimise training required – regular maintenance teams without welding or other specialist skills should be capable of the installation, eliminating the need for external contractors.

3. Unfamiliarity with solutions

> “It is hard to select the best Drops prevention product”

Recommendations:

- Refer to the DROPS Reliable Securing Handbook to learn more about key product types and their uses.
- Arrange an appointment with a Drops inspector to identify risk areas and recommend solutions.

4. Availability of appropriate Drops prevention equipment for a specific facility

> “We can create our own DIY solutions for specific equipment”

Recommendations:

- Consider investing in bespoke solutions to meet specific challenges in order to mitigate Drops risk more effectively.
- Work with an accredited Drops inspector, who can advise on appropriate custom mitigation measures.

ORGANISATIONAL BARRIERS TO DROPS PREVENTION BEST PRACTICE

1. Turnarounds - third party maintenance teams bringing different standards

> “It is hard to enforce consistent approaches to Drops prevention with so many contractors”

Recommendations:

- Mandate Drops prevention awareness courses for any third-party contractors on site.
- Build Drops prevention into Toolbox Talks, ensuring awareness of facility risks for all personnel.
- Ensure that on-site signage includes Drops hazards in high-risk areas.

2. Siloed decision making from one facility to the next

> “We can install solutions at our facility, but other facilities may have different policies”

Recommendations:

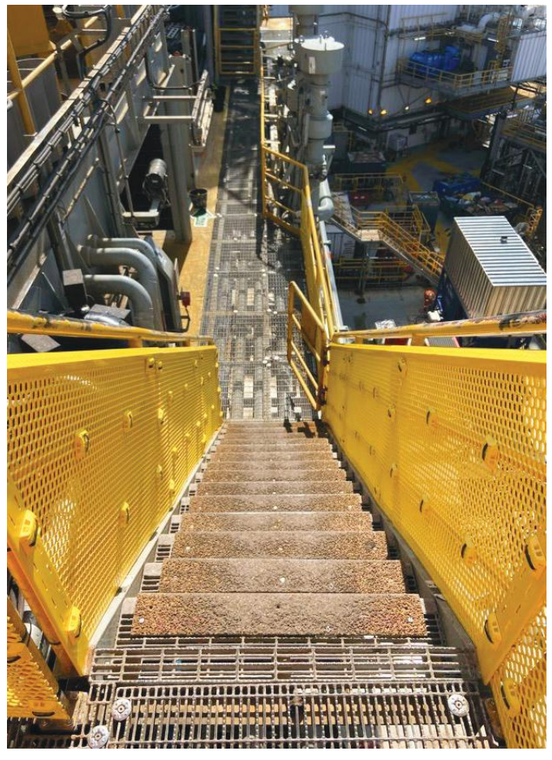
- Arrange regional safety meet ups to facilitate communication on key safety issues with your peers and align on safety policy within the organisation.

3. Siloed decision making within power generation organisations

> “We understand the value of Drops prevention, but procurement decisions are made at HQ”

Recommendations:

- Communicate the financial benefits of Drops prevention to procurement departments.
- Consider the important role each business function plays in creating a safe working environment – from HSE managers and facility managers, to operations, procurement and corporate.



4. Large global organisations = slow moving decisions

> “We are keen to improve Drops prevention but there are too many hoops to jump through”

Recommendations:

- Raise awareness of Drops prevention at every level of an organisation, from the facility floor to the boardroom, by including Drops on the agenda in safety meetings and providing information about Drops in common/rest areas.
- Take a ‘corporate’ approach to Drops prevention, similar to other areas of safety such as chemical exposure or fire control.

FINANCIAL BARRIERS TO DROPS PREVENTION BEST PRACTICE

1. No existing budget for Drops prevention

> “We don’t have the money to spend on Drops prevention right now”

Recommendations:

- Balance the cost of Drops prevention with the potential cost of an incident.
- Target the highest risk areas first following a ‘hazard hunt’ to maximise the impact of your Drops prevention investment.
- Take a systemic approach to Drops prevention – many of the most effective actions are process-driven, preventative and involve no extra expenditure.

2. Short-term cost savings leading to adoption of low-quality solutions

> “The cost of Drops prevention solutions is too high”

Recommendations:

- Incorporate long-term replacement and maintenance costs into safety budgets.
- Short-lived consumable products are most suited for temporary installations.

CULTURAL BARRIERS TO DROPS PREVENTION BEST PRACTICE

1. Lack of Drops specific training

> “Drops are a challenge but it’s unclear how to solve this cost-effectively”

Recommendations:

- Use free resources to increase awareness of Drops risks and identify prevention and mitigation measures that meet your facility’s needs, including:
  - This handbook
  - The DROPS Reliable Securing Handbook
- Provide third-party Drops and other safety training from a certified organisation to bolster existing programmes.
  - The Energy Institute offers comprehensive training programmes to help energy sector professionals improve their safety processes[2].

2. Reactive approach instead of preventative approach

> “We will wait until a Drops incident occurs, then pay for Drops prevention equipment”

Recommendations:

- Take a proactive approach to Drops prevention to minimise costs, hassle and injury – severe Drops incidents can lead to facility shutdowns and fines from regulators, with additional administrative costs due to increased paperwork.

3. Limited knowledge transfer from other industries

> “It doesn’t matter what O&G do – we are a different sector”

Recommendations:

- Take the opportunity to learn from the experiences of other high-risk industries, to avoid having the same challenges.

4. Individual awareness

> “I don’t think Drops are a problem”

Recommendations:

- Include Drops prevention as part of Toolbox Talks and Pre-Job Meetings
- Share incident reports in internal bulletins and mailers.
- For more information, see Chapter 2 of this handbook.

5. Industry awareness

> “We haven’t heard of any incidents occurring”

Recommendations:

- Adopt industry-wide anonymised incident sharing to build awareness at a broader level and stops the same incidents being repeated across different facilities.
- For a good case study of effective industry-wide incident sharing, refer to the International Marine Contractors Association (IMCA) Safety Flashes here: https://www.imca-int.com/safety-events/

CHAPTER 7

A SYSTEMATIC APPROACH TO TACKLING HUMAN FACTORS IN DROPS PREVENTION

The best Drops prevention programmes take a systematic approach. Power generation facility managers can prevent or mitigate Drops risks using a variety of approaches. One key cause of Drops incidents worth analysing in greater depth is human factors.

In future, automating hazardous or repetitive tasks in power generation will start to eliminate the human element of the safety equation. For now, facility design, best practice equipment and robust procedures all play a part in reducing the impact of human factors.

The following chapter, with reference to Dropped Object Prevention Scheme (DROPS) best practice and guidance, explores the importance of considering human factors in Drops prevention, and places these within a wider context of power generation safety.

WHAT ARE HUMAN FACTORS IN DROPS PREVENTION?

Anyone can make a mistake. When working at height, however, a mistake can lead to a Drops incident, with severe consequences for individuals and organisations. Rather than accepting mistakes as an unavoidable part of industrial operations, Drops prevention aims to reduce the scope for human factors and shift the emphasis away from individuals, and onto organisations.

Within the wider energy sector, the Human Performance Oil & Gas (HPOG) initiative brings together key stakeholders to identify and manage the way tasks are carried out in daily operations, and examine how this interacts with human factors.

HPOG defines human factors as “The range of physical, psychological, social or organisational influences which affect human performance and how people carry out their activities. It is a scientific discipline concerned with understanding interactions among humans and other elements of a system.”

According to HPOG, human factors are also referred to as performance shaping factors, performance influencing factors, error traps and error producing conditions.

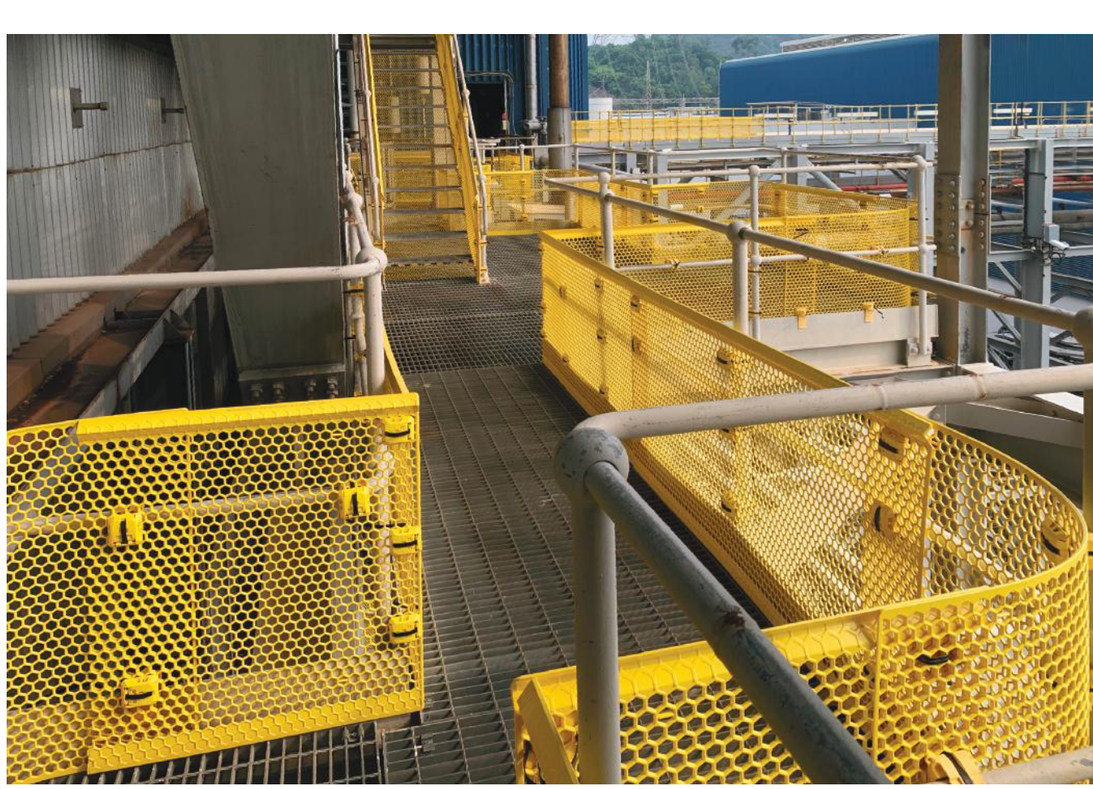
Crucially, HPOG recognises that tackling human factors involves “designing equipment, work environments and activities so that people find tasks easy to perform, safe and matched to their strengths and limitations. It is an approach which is integrated into risk management, engineering, procedure writing, job planning and training.”

To tackle this challenge, power generation HSE and facility managers can adopt this approach, and the tools it uses, into their own Drops prevention programmes.

HOW CAN HUMAN FACTORS INCREASE THE RISK OF DROPS INCIDENTS IN POWER GENERATION?

Inappropriate procedures, inadequate design, and inadequate maintenance are all major causes of Drops which ultimately aggravate human factors. Accordingly, a holistic approach to Drops prevention is needed to ensure that all the root causes of Drops are tackled together.

That said, human factors remain a key cause of Drops incidents. According to a forthcoming DROPS survey interim report, over a third of reported Drops incidents can be attributed to poor behaviour, operator error, planning or operational miscalculations, and not following procedures.



Below are some common examples of human factors which can contribute to increased Drops risk at a power generation facility – although this list is by no means exhaustive.

- Distractions in the working environment
- Overly complex procedures incentivising shortcuts
- Repetitive tasks leading to fatigue
- Not enough personnel assigned to a task
- Completing a task under time pressure
- Incorrect tools for the task
- Inadequate training
- Novel situations requiring improvisation
- Difficulties communicating

The examples above can be caused or exacerbated by long-term, or '**latent**' conditions, or short-term, '**active**' conditions.

Latent conditions include poorly written procedures, repetitive manual handling and unclear roles & responsibilities.

Active conditions, in contrast, include poor shift planning, unreasonable deadlines, restrictive PPE, and an uncomfortable working environment.

The key to tackling both latent and active conditions is systematic planning with Drops prevention in mind, which minimises the space for misinterpretation, fatigue and improvisation.

'WORK AS IMAGINED' VERSUS 'WORK AS DONE'

A key tool for understanding why tasks and procedures may sometimes create the conditions for Drops incidents to occur is the distinction between 'work as imagined' and 'work as done'.

HPOG defines work as imagined as "how engineers, planners, advisers, managers or anyone else involved in design believe the work should be done, under ideal circumstances."

'Work as done' is defined as "what people actually do to get the job done, taking into account the realities of the situation such as the equipment configuration, and ease of use of the procedure, and the time and resources they have."

When there is a significant gap between the two, personnel may have to adapt their behaviour. The overall goal for decision-makers is to ensure that 'work as imagined' is as close to 'work as done' as possible. Therefore, clear lines of communication within power generation organisations – especially where decisions are taken off-site or centrally – are crucial to mitigate conditions that raise the risk of Drops incidents.

HUMAN FACTORS DROPPED OBJECT CASE STUDY: FALLING PIECE OF ANGLE BAR

The International Marine Contractors Association (IMCA) reported on a high potential near-miss Drops incident where a piece of angle bar fell 11m (feet and inches too for USA) Personnel and contractors were removing a platform, and assumed that contractors had cut the platform as the barricade tape had been removed.

A previously unnoticed piece of angle bar was cut off and placed on the scaffold floor. The person who had cut the bar subsequently kicked it off the scaffold accidently. Four personnel were below – the angle bar landed 1.5m away from them. If the object had struck one of them, it could have caused a fatality.

The operator found that the worker who performed the cutting task was not qualified for the procedure, and failed to remove the angle bar from the scaffold.

According to IMCA, to prevent future incidents from occurring, the operator took the following preventative measures:

- All loose materials should be removed from all high-level working platforms or relocated away from the edge of platform and properly secured.
- All areas underneath where work is taking place at height should be barriered off with hazard tape until overhead work is completed.
- A guard worker should be posted outside the hazardous dropped object zone prevent access.
- Only properly trained and competent workers can carry out the work.
- Before work at height starts, appropriate inspection of the worksite should take place by qualified personnel.

HOW CAN THE IMPACT OF HUMAN FACTORS IN POWER GENERATION BE REDUCED?

Power generation facility managers and other key stakeholders can reduce the scope for human factors as a cause of Drops incidents by following the four steps below. These are:

1. **Build a Drops prevention culture**
2. **Design facilities to remove Drops hazards**
3. **Use engineered controls to mitigate risk**
4. **Use administrative controls**

1. Build a Drops prevention culture

Changing fixed attitudes and building a Drops prevention culture through all levels of an organisation is key to tackling human factors in power generation. It means that procedures can be designed and implemented more effectively, as decision-makers are more aware of how Drops risks affect daily operations.

To learn more about how to build a Drops prevention culture in power generation, please refer back to Chapter 2.

2. Design facilities to remove Drops hazards

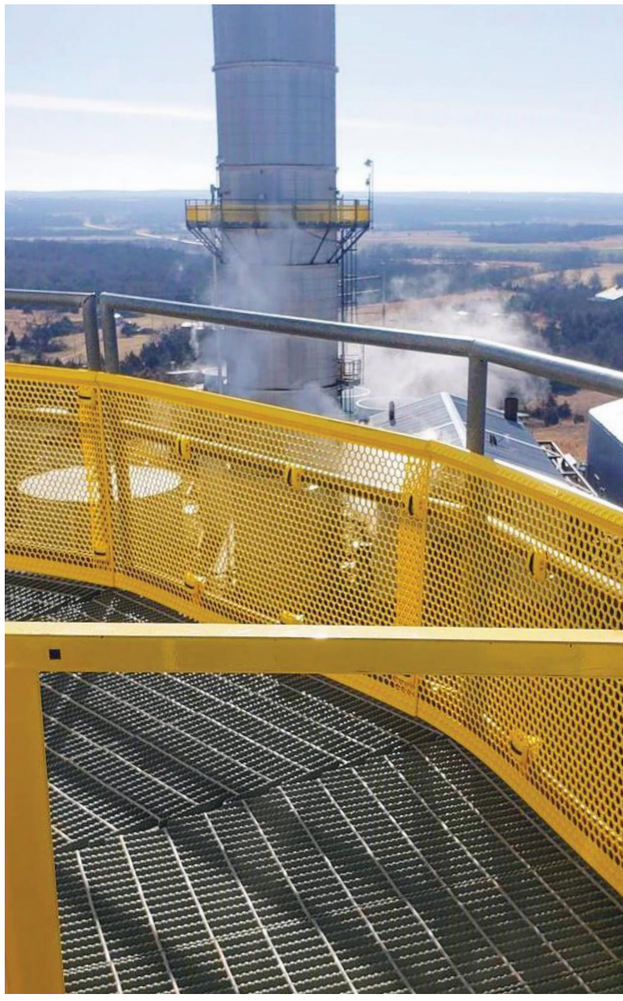
The first priority of the hierarchy of controls is designing out Drops risks from facilities, ensuring that human factors do not come into play. For more information about using the hierarchy of controls in power generation facilities, please refer to chapter two of the handbook at the previous link.

3. Use engineered controls to mitigate risk

Alongside other control mechanisms to mitigate Drops, there are engineered solutions available which aim to reduce the impact of Drops that occur due to human factors. This includes tool tethering solutions, safety securing solutions, and barrier systems.

For more information on best practice use of tool tethering solutions in power generation, please see Chapter Four of this handbook.

For more information on how barrier systems can help to mitigate Drops in power generation as part of a systematic approach to Drops prevention, please read Chapter Three.



Power generation facility managers should ensure that the primary fixings are correctly installed and maintained. Appropriate secondary retention, such as washers, pins, locking nuts, are used to secure the primary fixing. Safety securing products act as a mitigation measure to respond to the remaining risk. For a detailed analysis of all engineering control measures, please refer to the DROPS Reliable Securing Handbook.

4. Use administrative controls to tackle human factors

Taking a step back from daily operations to consider what safety benefits long-established working practices deliver can help facility managers understand where potential areas for improvement may exist.

QUESTIONS FACILITY MANAGERS CAN ASK MAY INCLUDE:

- Are adequate breaks given beyond basic regulatory requirements?
- Are suitable employee health programmes in place?
- Is the facility signage up-to-date and supportive of Drops prevention best practice?

A useful tool developed by HPOG for understanding specific tasks is the Walk Through, Talk Through procedure. This aims to break down a task at a granular level to identify potential human factors and risks, helping decision makers to put appropriate administrative controls in place to mitigate Drops.

A free-to-use Walk Through, Talk Through template can be found in the appendix. Please refer to HPOG's guide for more information on how to use the template.

As technology progresses and the ability to automate hazardous or repetitive tasks increases, human factors will steadily decrease as a cause of Drops in power generation. In the meantime, robust procedures, widespread Drops awareness and best practice Drops prevention solutions can help tackle the challenge.

Drops prevention guidance and additional resources are available free of charge at the DROPS website. For more information on human factors, please visit the HPOG resources centre.

DROPS are also able to provide bespoke Drops Awareness and Training programmes – sessions can be schedules through training@dropsonline.org

Sources:

Free industry resource from HPOG, DROPS and IMCA has supported the development of this chapter. Please see a list of references below.

HPOG Glossary:
https://www.hpog.org/resource-centre/glossary/

IMCA Safety Flash:
https://www.imca-int.com/safety-events/high-potential-near-miss-dropped-object/

DROPS Reliable Securing Handbook Revision 4:
https://www.dropsonline.org/resources-and-guidance/drops-reliable-securing-booklet-rev-04/

Walk Through, Talk Through Guidance:
https://www.hpog.org/assets/documents/WTTT-Guide-Leaflet-Rev01.pdf

Free DROPS resources:
https://www.dropsonline.org/resources-and-guidance/

Free HPOG resources:
https://www.hpog.org/resource-centre

FINAL THOUGHTS

Where next for Drops prevention in power generation?

Power generation facility managers are faced with a Drops challenge, and thus far, industry-wide Drops prevention initiatives have been limited. This handbook brings together resources and insights which the sector can draw upon to tackle the challenge, using best practice from adjacent sectors such as energy.

This handbook outlines that a holistic approach to Drops prevention will give plant managers more control over their safety expenditure. It shows that widely sharing information is key for a coordinating industry response. It dispels common myths to remove perceived obstacles to Drops prevention best practice, and draws on the expertise of industry partners such as Stopdrop Tooling and Tutus to highlight effective tool and work basket Drops mitigation.

Drops should never be a fact of life in power generation. They can be reduced, and the most effective measures are often free. If you are interested in finding out more about how you can put a best practice Drops prevention programme in place throughout your facility, please do get in touch at info@dropsafe.com. Alternatively, reach out to DROPS admin@dropsonline.org.

FREE WALK THROUGH, TALK THROUGH TEMPLATE FROM HPOG

WHAT YOU NEED TO DO AS PART OF YOUR WTTT

- **Conduct a Walk-Through / Talk-Through in the field / on the shop floor (where the task is done) with the Person who will be doing the job.**
  You will aim to identify the key steps in a task, discuss what can go wrong with each step, and under what conditions mistakes are more likely. If possible, take photos of the task activities, tools, equipment, working environment etc.
- **Document your WTTT in the template below.**
- **Embed the photographs in the template below or append these as a picture book if possible.**

Task Name:	Task Description:

Photos of Task Activities:

1. HAVE A CONVERSATION WITH THE PERSON DOING THE JOB TO PRIME YOUR WTTT

Have the individual talk about a time in the past when it was really challenging to complete this task. What made it difficult? What did they do to adapt? How did they know what to do?

What was the situation?	What made it difficult?	What did you do to adapt? How did you know what to do?	What are the most important learnings and corrective actions that we should adopt from that situation?

2. CONDUCT THE WTTT WITH THE PERSON DOING THE JOB

Walk through the activity and write down the steps (Literally walk through the task guided by person doing the job in the field (or wherever the task is conducted) OR if unable, paste the task steps from the procedure)	Jointly with the person doing the job, select 3 steps that may lead to most severe problems/ consequence? (e.g. injury, defect, time, cost, impact on production). Write down what the potential problem / consequence may be.	When walking through the steps, what makes a mistake more likely? What factors make the step more difficult to perform? What is it about this step that a new person could find confusing? (according to the person doing the job)	What can be done to remove / address error traps (according to a person doing the job)? Has the operator found better ways of completing the step?

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