The Minerals Council South Africa
Knowledge Transfer Framework pertaining to installation, repair and maintenance of collision prevention systems on trackless mobile machinery

Provided by The IDM Business Academy (Pty) Ltd
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Content

1. Executive summary

The project objectives

- The Mine Health and Safety Act (MHSA) 1996 has stipulated important standards to be achieved for the safe utilisation of Trackless Mobile Machinery (TMM), including the use of Collision Prevention of TMM for safe operations.
- As such, The Minerals Council is conducting a fact-finding and analysis project covering mining companies, original equipment manufacturers (OEMs) and technology suppliers with regards to Collision Prevention Systems (CPS) data analysis, installation, repair and maintenance landscape readiness that includes, but is not limited to, skills and capacity.
- The aim of the project is to support the mining industry in South Africa in getting ready for the upliftment of the suspended TMM regulations and more specifically to provide the mining industry with a comprehensive Knowledge Transfer Framework, to sufficiently guide them in the transfer of skills as it relates to the Installation, Repair and Maintenance (IRM) of CPS in TMM.

Key findings

- Original Technology Manufacturers (OTMs) differed in both their reliance on IRM services, the frequency of such services as well as the qualifications required.
- In general, the skills required to Install, Maintain and Repair CPS equipment on TMM requires the skills of an artisan electrician drawn from candidates with qualifications ranging from a Grade 12 (Matric) to Electrical Artisan level.
- In one instance, where a mining house has begun the process of recruiting their own technicians, they have insisted on an “Instrument Mechanician” because they understand the interface between the digital, electrical and mechanical components.
- The training required to equip such technicians, currently provided by the OTMs, varies from 1 week to 6 months.
- Some OTMs separate the level of seniority required to perform IRM at different levels:
    - Tier 1 – Basic inspection and parts replacement
    - Tier 2 – Fault finding
    - Tier 3 – Installation, Calibration & Analysis
- In terms of the mining houses, the recruitment and management of these resources require little change in terms of Job Descriptions, Salary Bands and Career Paths.
- Given the significant number of TMM currently unequipped with CPS, reasonable timelines will need to be provided, once legislation is enacted for this to be achieved.

- Based on the above, it would appear that the South African mining industry (SAMI) is not currently equipped to ensure that all TMM, new or legacy, is equipped with CPS devices within the 3 months stipulated by the amendments to the regulation.

Implications for the transfer of skills

- In terms of the mining houses, the recruitment and management of these resources require little change in terms of Job Descriptions, Salary Bands and Career Paths.
- The willingness of OTMs to transfer these skills and the training thereof is mixed, with many willing to cooperate, at least in part.
- Most OTMs (and mining houses) agree that the training, and in some cases supervision, will need to be retained by the OTMs due, predominantly, to their concerns around legal liability and potential reputational damage that may ensue as a result of their training potentially being implemented in a manner that does not meet their required standards.
- Given the significant number of TMMs currently unequipped with CPS, reasonable timelines will need to be provided, once legislation is enacted for this to be achieved. However, due to the 3-month window provided by the regulator until the law is enforceable, it is likely that most mines will need to apply for an exemption.
- The fulfilment of the IRM requirements, and the associated skills, are therefore likely to depend on a Technology based vs IRM based business model adopted by the OTMs and mining houses.
- Several important factors will need to be considered in the implementation of a skills transfer strategy by the mining houses. These are outlined in the report.

2. Background and context

Although a relatively small number of CPS suppliers dominate the supply side, the speed of innovation is accelerating and the rate at which new solutions are entering the market is rapid. The technical knowledge and skills associated with using and maintaining CPS are therefore changing rapidly and there is an urgent need to understand how to develop and maintain such skills and knowledge.

The MHSA 1996 (see *appendix D* for our understanding) has stipulated important standards to be achieved for the safe utilisation of TMM, including Collision Prevention.

As such, The Minerals Council is conducting a fact-finding and analysis project covering mining companies, original equipment manufacturers (OEMs) and technology suppliers with regards to CPS data analysis, installation, repair and maintenance landscape readiness that includes, but is not limited to, skills and capacity.

2.1 Intended outcomes for the work

The aim of the project is to support the mining industry in South Africa in getting ready for the upliftment of the suspended TMM regulations, and specifically in helping the SAMI in achieving an acceptable level of the requisite skills readiness, should the Regulator lift the suspension on the said regulations.

As such, the project seeks to investigate the skills development portion of a risk-informed, phased approach towards the introduction of the suspended TMM regulations in more detail. The risks to be mitigated in this regard include:

- High cost of data analysis, maintenance and repairs due to supplier-specific nature of work;
- Slow installation, repair, and maintenance of systems due to limited number of skilled personnel in the SAMI;
- Rising cost of skilled personnel when sought by different suppliers and mines simultaneously;
- Potential failure by mines to analyse data in-house, install timeously, repair correctly or maintain adequately should CPS be required at any mine where there is a significant risk of TMM collision;

The outcome of the project is to establish a framework of IRM and data analytics knowledge-transfer from suppliers to mines; and list resources required to develop skills to implement, operate and maintain collision prevention technology and develop holistic training for Supervisors and Managers on technology implications. The key outputs of this work include knowledge transfer related, but not limited to, data analytics, technology installation, repair, and maintenance from suppliers to mines.

2.2 Work Breakdown Structure

A Work Breakdown Structure (WBS) was created to provide a coordinated and managed approach to TMM in SAMI.

This WBS included the full set of disciplines required to coordinate the growth of TMM in SA, such as Traffic Management; Data Analysis; Change Management; Retiring Legacy Equipment; and Testing Capability and Capacity.

Within this WBS the Knowledge Transfer Landscape program is a cross-cutting sub-project and is housed under Work Packet 13. As such, the opportunity to deliberately manage the inter-connections between the Knowledge Transfer Landscape work and the wider WBS set of programs is in place, and this project has aimed to leverage these expertise and guidance during the course of the program.

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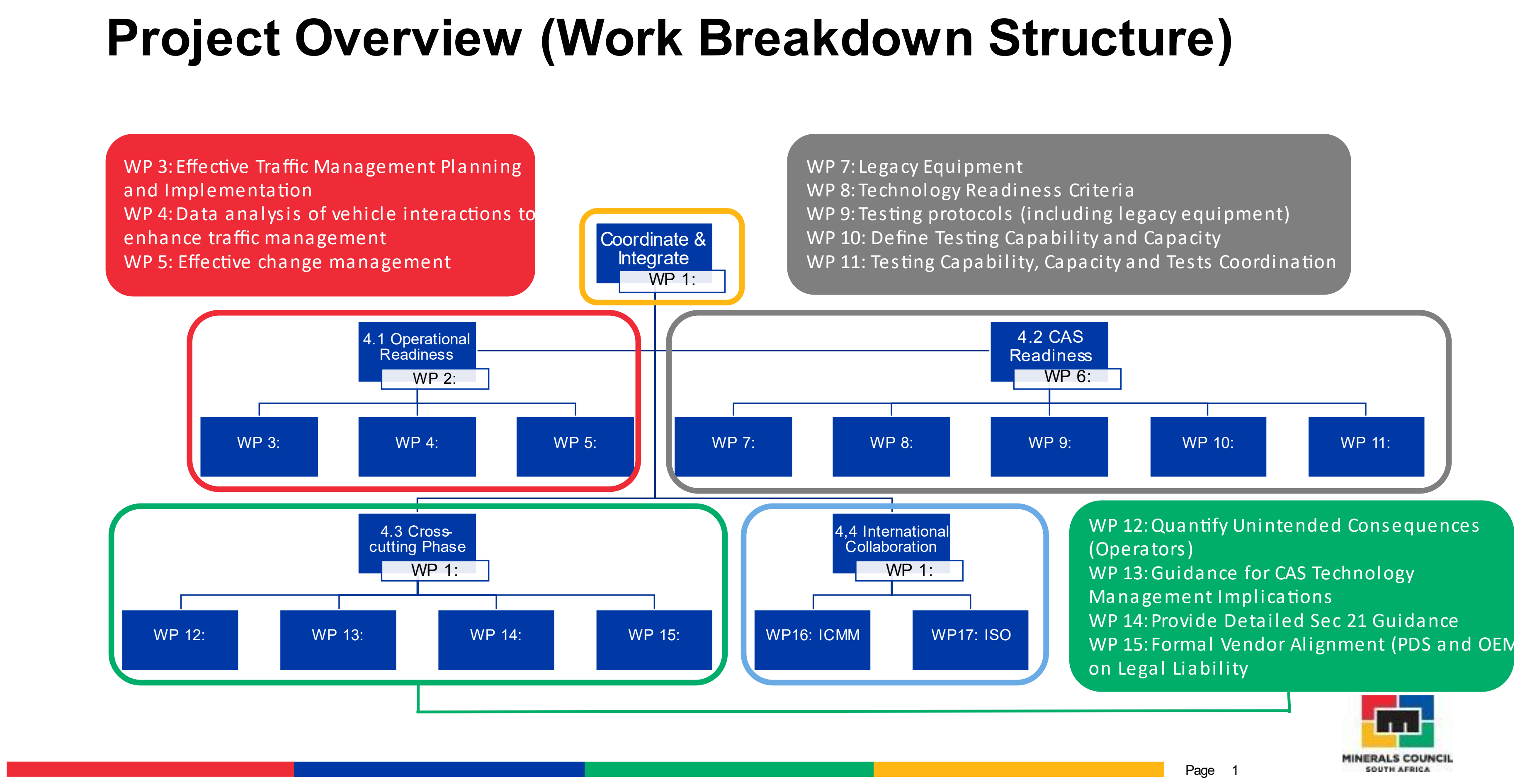

MINERALS COUNCIL SOUTH AFRICA

3. Approach and ground covered

This section provides a detailed overview of the methodical approach followed throughout the course of the project. It further illustrates the complete approach as to how the data was gathered.

3.1. Project approach and timelines

With a specific focus on the knowledge and skills to implement, operate and maintain CPS technology, including installation, repair and maintenance and collision prevention data analysis, the approach followed was detailed and methodical, whilst also allowing the flexibility to learn and adapt during the project.

Figure 1

October - December 2021 | **January 2022**

Diagnose & understand current skills transfer processes

Understand the current context and approach for skills transfer:

- Identify and engage the OEMs and technology suppliers
- Identify the current trades & occupations conducting IRM
- Identify and document the current training & programs
- Gather and assess the available data or results of the current training & programs, e.g., completion rates, skills & knowledge retention
- Meet and interview key Subject Matter Experts (SMEs) across stakeholders

Complete the skills gap analysis

Understand current and to-be best practice skills and knowledge:

- Document and define the current skillsets in the relevant trades and professions conducting IRM
- Document and define the best practice skills required by OEMs, suppliers and member firms conducting in-house IRM.
- Categorise skills sets - technical; cognitive; social; manual.
- Define the skills gap and clarify the learning need
- Derive key themes and insights
- Write up and present interim findings.

Assess & define best practice skills transfer

Define an initial knowledge transfer strategy:

- Conduct research into the methods OEMs, suppliers and mining companies use to successfully maintain the necessary skillsets
- Catalogue and evaluate the skills and knowledge benefits of the identified methods
- Evaluate the wider utility/practicality of the catalogued methods - e.g., scalability; CPD credits; costs; etc
- Identify and assess options for OEM and supplier involvement in skills transfer

Design the 'to-be' skills transfer process

Complete the framework and final report and recommendations:

- Develop holistic training approach
- Complete the Knowledge Transfer Framework
- Validate that all key risks are scoped and mitigated
- Develop final report, recommendations, outline implementation plan & next steps
- Deliver final Knowledge Transfer Report and present to the Minerals Council
- Discuss and agree next steps - e.g., pilot design.
- Close

Ongoing project management

- Weekly or bi-monthly project Steering Committee
- Regular interim progress reports
- Ongoing stakeholder management (OEMs, Suppliers, IRM providers)
- Ongoing risk management and issue resolution

3.2. Data gathering approach

Due to the significant number of Subject Matter Experts (SMEs) the project team needed to engage with, the variety of information that needed to be gathered and the challenge experienced by the project team to secure meetings and responses to requests for information, the following multipronged approach was used when collecting the required data:

1. **Interviews** - Semi-structured interviews were conducted via *MS Teams* or *Zoom* with various stakeholders from the relevant OTMs, OEMs and mining houses. The approach was to ensure the project team conducted interviews with SMEs from the major OTMs, OEMs and mining houses.

2. **Online questionnaires** - Online questionnaires were developed using *Google Forms* to assist with the gathering of the required information and were sent to a group of smaller OTMs, OEMs and Mining Houses. This approach was also used to secure information from SMEs that the project team were not able to secure an interview with.

3. **Desktop Research** - To gather and validate the required information to support the development of the Knowledge Transfer Framework desktop research was conducted by the project team using on-line resources as well as informal discussions with people within the industry.

The following table shows the number of OTMs, OEMs and Mining Houses that contributed to the findings detailed in this report, either through online interviews, the completion of an online questionnaire or the provision of required documentation.

		OTMs	OEMs	Mining Houses
Interviews	**No. of Interview requests**	**9**	**3**	**4**
	No. of interviews completed	**7**	**2**	**4**
Online questionnaires	**No. of requests**	**21**	**13**	**5**
	No. of responses	**4**	**4**	**0**

4. Findings

Using the approach explained above, this section details the key findings uncovered during the data gathering process.

While a plethora of information was gathered, the information presented in this section is the information that is most pertinent to informing the Knowledge Transfer Framework, as well as the implementation approach presented in Section 5.

Where possible, the information presented is aggregated and makes no reference to specific OTMs, OEMs or mining houses. Where distinction between companies is required, pseudonyms have been used. Finally, this section has been separated into three distinct parts showing the key findings and insights between OTMs, OEMs and the mining houses.

4.1. Findings – Original Technology Manufacturers (OTMs)

The data outlined in the graphs below shows that CPS devices fitted on TMM are provided by a range of OTMs (Companies A to I). However, only three of these OTMs (A, B and C) have more than 60% of TMMs currently fitted with devices (*figure 2*).

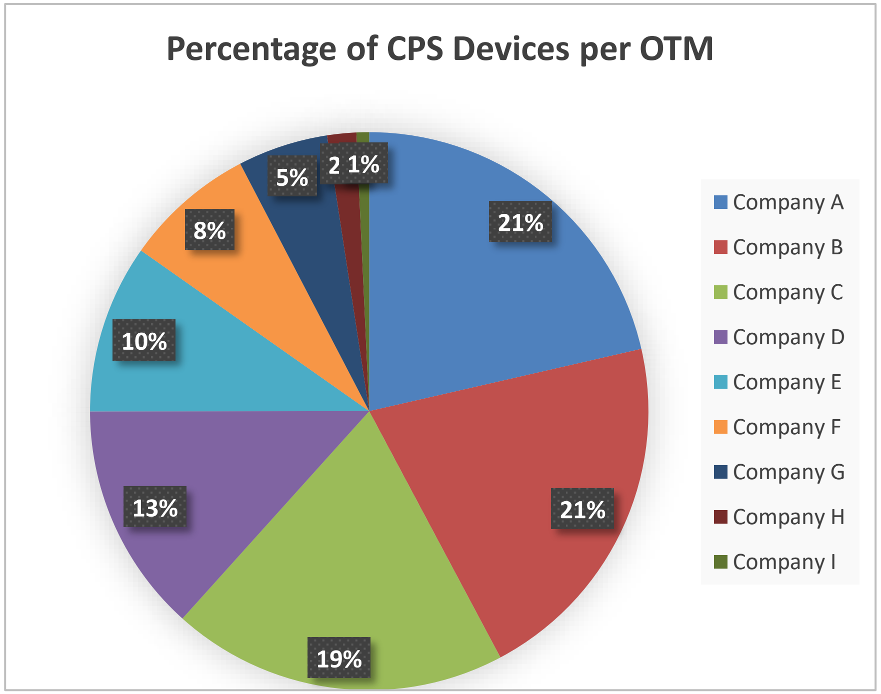

Figure 2

Moreover, *figure 3* indicates that only 11% of TMM are fitted with CPS devices. This suggests that when the required legislation comes into effect, for mines where there is a significant risk of TMM collisions, there will be a significant increase in the installation of CPS devices and therefore, in effect, a significant increase in the required provision for IRM resources.

Finally *figure 4* indicates that 92% of TMM are fitted with Proximity Detection Systems (PDS), a detection and warning intervention. Our research indicates that the complexity of the technology, to ensure an automatic slowdown and stop safety standard, lies largely in the interface between the CPS or PDS and the braking systems of the TMM itself. It would appear that to replace a PDS device with a CPS device, provided it is sourced from the same OTM, would be simpler than installing a new device.

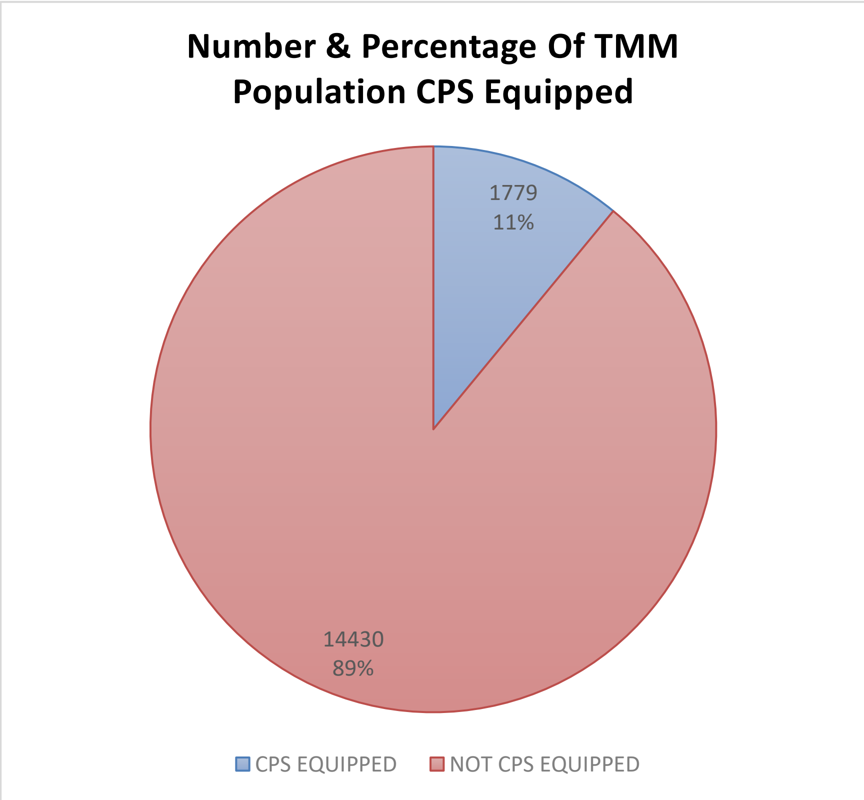

Figure 3

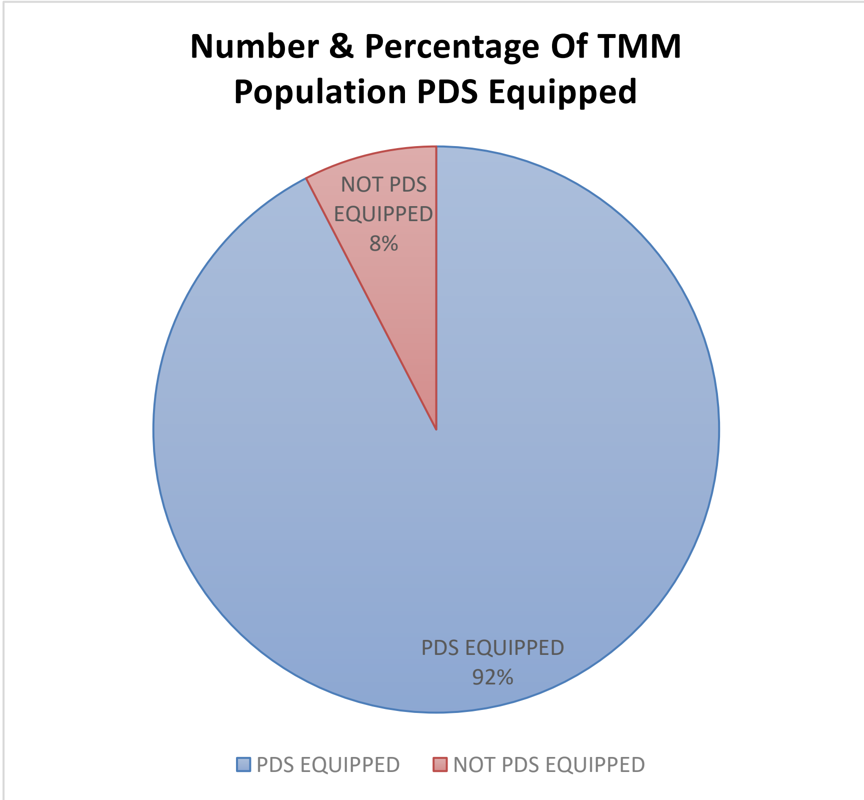

Figure 4

4.1.1. Key Insights - OTMs

From the data gathering process with the OTMs, the following key insights were established. These insights were critical data points in establishing the knowledge transfer approach and considerations.

These key insights can be categorised under three core themes: ***IRM Service, Training and Job Requirements***:

IRM Service

- In general, between 60% and 80% of IRM services are delivered under maintenance contract agreements, provided at the operations and delivered by the OTMs.
- The balance of the IRM services are delivered internally by the customers.
- OTMs in general prefer that the initial installation of CPS onto the TMM is done by the OTM or the OEM, and not outsourced to the mine, to ensure this is done correctly, due to legal liability issues and potential reputational damage.
- Most OTMs agree that basic IRM services (e.g., “low level maintenance,” “basic inspection and parts replacement,” “fault finding”) are easily in-sourced to the customer, provided that the maintenance standards are adhered to.
- Despite the transfer of legal liability, some OTMs are concerned about the loss of control over the IRM function and the reputational damage it could cause, particularly with the competitiveness of the market and the spotlight that the new legislation will bring to the CPS market.

Training

- Most training is done locally and in-house by the OTM.
- In cases where the technology is sourced offshore, the product specific training is done in the country of origin.
- CPS training programmes are generally not registered with the SETA’s. One OTM indicated their training used to be accredited with the MerSETA but due to the administration involved they no longer accredit their training.
- CPS is in some cases TMM agnostic and in some cases the training will differ depending on the type of TMM. This is dependent on the OTM.
- CPS system training courses range from 1 week to 6 months.
- Short refresher courses are usually provided every 18 months or when there are significant system changes/upgrades.
- Training is usually a mix between theory and practical.

Job Requirements

- The general term of “Electrical Technician” or “Electrical Artisan” is used to describe the role that delivers IRM services, with no general distinction between roles.
- In some cases, there is a distinction between levels of responsibility with Tier 1 artisans being responsible for basic maintenance, Tier 2 artisans for fault finding and diagnostics, and Tier 3 artisans for installation, calibration, and analysis.

- Basic qualification varies from Matric/School leaver up to N4 level Artisan Electrician depending on the OTM and technology provided.

4.1.2. OTM Business Models vary from reliance on proven technology to reliance on IRM

As an observation, it appeared that the business model of the OTMs varied on what might be termed, a loose continuum, with OTMs investing in reliable, and possibly more expensive, technology, while others provided perhaps simpler devices that were cheaper, but required more IRM skills as well as a higher frequency of inspection, and probably maintenance.

To demonstrate this relationship the *IDM Business Academy* has created a 2x2 matrix (*figure 5*), as a guide for the criteria that can be considered when opting for a technology vs IRM weighted investment.

Figure 5

IRM INVESTMENT ↑

LARGER RELIANCE ON IRM

- Reliance on Admin Controls
- Mine may opt for cheaper technology and place more reliance on IRM
- People dependent
- Safety incidents dependent on sophistication of safety culture
- Initial investment costs lower, but maintenance costs higher (people & parts)
- Suited to operations in close proximity with shared resources or dedicated CPS technicians per site

RELIANCE ON SOPHISTICATED TECHNOLOGICAL CAPABILITY, SUPPORTED BY COMPREHENSIVE IRM PROTOCOLS

- Investment in sophisticated technology but with the support of basic IRM services
- Investment in new TMM's vs legacy equipment fitted with CPS
- Tend to opt for more qualified technicians
- Environments with a high reliance on TMM equipment and high traffic patterns

MINIMAL INVESTMENT IN TECHNOLOGY AND IRM

- Minimum technology investment
- Basic IRM controls but with high supervision
- May be suited to Life of Mine < 2 years
- May be suited to lower-risk sites

RELIANCE ON SOPHISTICATED TECHNOLOGICAL CAPABILITY, LESS IRM PERSONNEL REQUIRED

- Reliance on Technology Controls
- Mine may opt for sophisticated technology over admin controls
- Reduces reliance on human error
- Reduces reliance on people costs (increased headcount, turnover etc)
- Initial investment costs high, but maintenance costs lower
- May be suited to geographically dispersed operations

TECHNOLOGY INVESTMENT →

4.1.2. Comparison of OTMs in their approach to IRM training

When comparing OTMs and their approach to IRM, *figure 6* illustrates the similarities and differences under five key areas. These are Inspection Frequencies per TMM; Training Channels; Curricula; Entry Criteria; and Skills Transfer Considerations.

	Company 1	Company 2	Company 3	Company 4	Company 5
Inspection Frequencies per TMM	Inspection frequencies range broadly from weekly, monthly, fortnightly and bi-annually. This is dependent on the requirements stipulated by the OTM as well as the mining house.				
Channels - Face-to-Face vs Virtual	Face to Face	Basics – E-Learning Face to Face - On the Job	Face to Face	Face to Face, theoretical and supervised practical	Face to Face, Local and at Country of Origin
Curricula	Provided	To Be Provided		Provided	Can View Under Supervision
Entry criteria (Matric, etc)	Matric to N4	A person with electronics (hardware and software) and IT (hardware, networks and software) background	N4 Auto Electrical (In house clients employing Instrument Mechanician)	Completion of theoretical and practical pre-evaluations N4 Auto Electrical Mining experience preferable	Underground Electrician
Skills Transfer Considerations	Few Considerations. In favour	Legal and Skills Implications. Not supportive.	CPS tech is low maintenance. Skills focus is on calibration. B-Degree required	Supportive but not preferred due to rate of mining staff turnover, workforce planning – mines have different entry requirements Reskilling	Source of skills. Skills complement would need to be insourced from 3rd Party

Figure 6

4.2. Findings – Original Equipment Manufacturers (OEMs)

The data outlined in the graph below (*figure 7*) shows that 44% of CPS is fitted on TMM from only 2 OEMs and all CPS covers 10 OEMs.

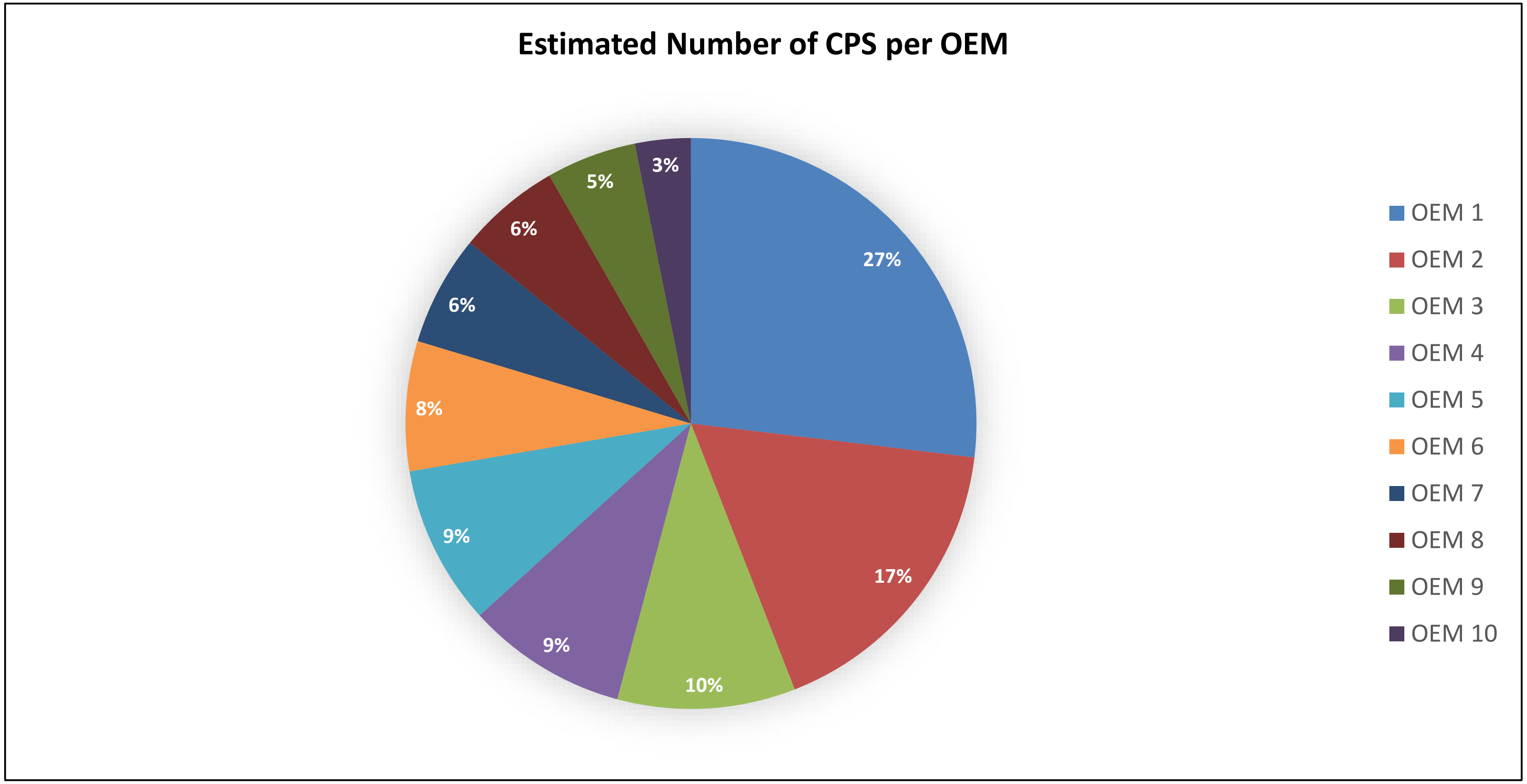

Figure 7

4.2.1. Key Insights - OEMs

From the data gathering process with the OEMs, the following key insights were established. These insights were critical data points in establishing the knowledge transfer approach and considerations:

- OEMs provide the technology to the internal TMM providing automated interventions such as "speed control" and "slow down and stop".
- The CPS system does not provide the parameters upon which the braking systems react, but simply the proximity data, upon which the braking systems react, based in turn on the parameters set by the type of mining (Surface vs Underground, Hard vs Soft Rock, Traffic Management systems etc).

- The OEM "smart" technology is, in most cases, well protected. However, the interfacing protocols can be hampered by these high levels of protection.
- Despite this, the OEMs are generally in favour of working directly with the mining houses or including the CPS technicians in their maintenance team.

4.3. Findings - Mining Houses (Customers)

4.3.1. Key Insights for Insourcing - Mining Houses (Customers)

In determining the feasibility of in-sourcing the IRM of CPS for TMM, the data suggests that there are numerous advantages as well as challenges that each mining house needs to consider. These potential advantages and challenges are highlighted in the table below and have a considerable impact on the knowledge transfer approach.

Advantages of in-sourcing the IRM of CPS

- The IRM function can be reasonably seamlessly integrated into the Engineering teams within the mining houses.
- Training and Senior Supervision may remain with the OTMs.
- The HR infrastructure required to manage these roles is well entrenched within the mining houses.
- In certain cases, the maintenance routines required for CPS IRM can be integrated into the routines of existing artisans.
- Operations can manage the costs of this function (incl. spares) a lot more closely.

Challenges and caution

- Spares replacements and software upgrades can be compromised if operational budgets and margins are under pressure.
- Loss of trained staff.
- Legal liabilities need to be clearly understood.
- Potential skills shortages at this level could compromise maintenance routines.
- Parameters set by the OEMs/Mining Houses need to be monitored closely to ensure that production targets are not unnecessarily affected.

5. Knowledge Transfer Framework and Implementation Approach

The research conducted and the subsequent findings suggest that an effective Knowledge Transfer Framework should accommodate 6 key dimensions, namely: ***knowledge & skills, organisational design, legal & regulatory, work practices and processes, upskilling, training &***

development, and operations. This is a robust and scalable framework that can be adjusted to local skills transfer requirements on a case-by-case basis, and therefore provide a holistic guide to effective knowledge transfer.

5.1. Knowledge Transfer Framework

- ***Installation outcomes***
- ***Base equipment repair***
- ***Spares and replacements***
- ***Equipment testing***
- ***TMM availability & reliability***

- ***Experience***
- ***Qualifications***
- ***Capability and Competence***

- ***Make or buy***
- ***Training Plans and Matrices***
- ***Accreditations***
- ***Cross/Multi-skilling***

- ***Job Architecture***
- ***Levels and Bands***
- ***Workforce Planning***
- ***Career Pathing***
- ***Reward and Remuneration***
- ***Management and Supervision***

- ***Planned, Unplanned and Ad-hoc Work***
- ***Maintenance and installation practices***
- ***Location of skills in the value chain***
- ***Ways of working, working culture***

- ***Legal Liability***
- ***Employment Contracts***

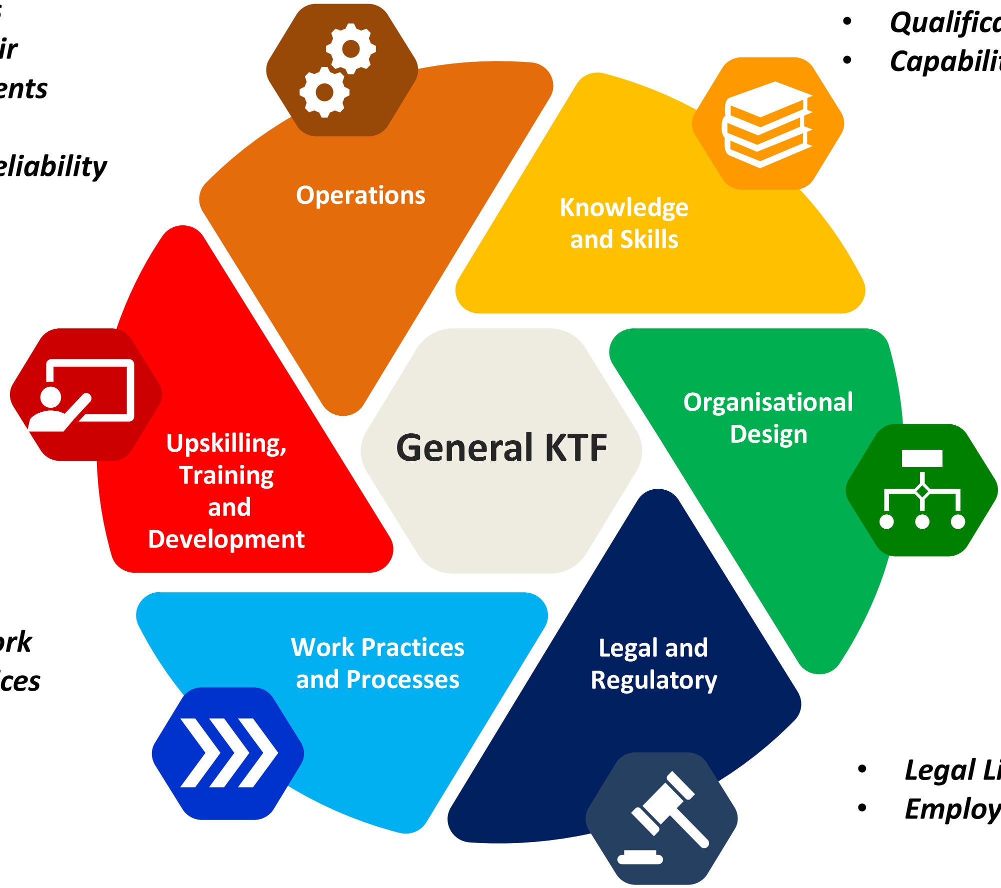

Figure 8

5.2. Implementation Considerations and Guide

To best enable mining houses to use the Knowledge Transfer Framework, the following tables detail what each dimension encompasses, how it relates to the findings of this study and finally provides a list of key questions that should support the thinking of mining house personnel when considering the insourcing of the IRM of CPS for TMM within their unique context.

Knowledge and Skills	
Elements	• Experience • Qualifications • Capability and Competence

Key considerations based on study findings	• The complexity of skills ranges from a single technician able to perform the entire array of IRM services to a split function as follows:
	  • Tier 1 – Basic inspection and parts replacement
	  • Tier 2 – Fault finding
	  • Tier 3 – Install, Calibrate & Analyse
	• As a guide, see *appendix A* for a generic job description which includes minimum qualifications, required experience, technical skills and behavioural competencies to perform IRM of CPS for TMM.

Questions to guide the implementation approach	• What is the minimum experience, qualifications, capabilities, and competencies required to perform the role or roles? • Does the required knowledge and skills exist internally within the organisation/operations?

Organisational Design	
Elements	• Job Architecture • Levels and Bands • Workforce Planning • Career Pathing • Reward and Remuneration • Management and Supervision
Key considerations based on study findings	• In some mines the IRM responsibilities are completed by one role/job whereas others have three different roles that are tiered based on the complexity of responsibility. • There is widespread agreement that supervision of the technicians will remain the domain of the OTM.

	• These jobs would likely fall within the structure of the engineering team. • As a guide, see *appendix A* for a generic job description which indicates likely Patterson Band and job titles.
Questions to guide the implementation approach	• Would the roles and responsibilities for end-to-end IRM be performed by one role or tiered based on complexity of duties? • Where would these roles fit within the organisation and who would they report to? • What are the potential career paths to or from these jobs? • How would these jobs be graded and how does that inform their reward and remuneration?

Legal and Regulatory	
Elements	• Legal Liability • Employment Contracts
Key considerations based on study findings	• Based on the contractual relationships the mining houses have with OTMs there is a mix of insourced IRM services vs outsourced IRM services, which will inform the ease of transitioning to a fully insourced model. • In general, OTMs are concerned with the legal liability and reputational impact that comes with the transfer of skills. • The interface between CPS equipment and OEM braking systems is key. Certain OEMs are protective of their Intellectual Property and ensuring who takes responsibility for what is key to the installation process. • CPS equipment ranges from devices that simply pass on proximity data to the TMM technology on the one hand, to those that are calibrated to provide the "Slow Down" and "Stop" instructions on the other. This informs the degree to which the liability for successful safety compliance vests in the CPS equipment.
Questions to guide the implementation approach	• Who is liable for what in a fully insourced model? How is this impacting the successful transfer of skills? • Does the mine have employment contracts in place for these roles?

Work Practices and Processes	
Elements	• Planned, Unplanned and Ad-hoc Work • Maintenance and installation practices • Location of skills in the value chain • Ways of working, working culture

Key considerations based on study findings	• Service providers vary in their recommended inspection frequencies. This determines the number of internal technicians that will be required.
Questions to guide the implementation approach	• What is the required frequency of inspection of CPS? • Have the processes and procedures been mapped? • Do these processes include a RACI (responsible, accountable, consulted, informed) matrix?

Upskilling, Training and Development	
Elements	• Make or buy • Training Plans and Matrices • Accreditations • Cross/Multi-skilling
Key considerations based on study findings	• OTMs are not willing to insource their product specific training due to concerns around intellectual property, quality, and standards. • Of the OTMs interviewed none of their training Is SETA accredited. • See appendix B for an overview of typical training that is provided by the OTMs.
Questions to guide the implementation approach	• What training is required for technicians to be suitably equipped to perform IRM on the CPS used on TMM within the mine? • Who provides the training? • What elements of the training can be insourced? • How long is the training and refresher courses? How does this inform our workforce planning?

Operations	
Elements	• Installation outcomes • Base equipment repair • Spares and replacements • Equipment testing • TMM availability & reliability
Key considerations based on study findings	• Some mining houses have multiple OTM devices installed on their equipment. The number of suppliers increases the complexity of the transfer of skills. • The complexity and type of equipment differs in some cases across underground vs surface, hard rock vs soft rock. This may subtly alter the basic skills required to perform IRM tasks.

	• Implementation of new CPS equipment on legacy machines is costlier and riskier than on new machines, but replacement of old equipment has cost implications in and of itself.
	• Mining Houses need to evaluate the lifecycle costs of CPS. The component costs that need to be evaluated are:
	  • Equipment (Capital)
	  • Spares
	  • IRM Resources (Total Cost to Company)
	  • Training, whether insourced or outsourced
	  • Structural and procedural oversight
	• This will be assessed by a combination between OTM claims and customer's confidence factors and is generally a function of the OTM investment in quality and reliability. This will also determine the cost of insource vs outsource.
	• Mining Houses whose operations are closely geographically clustered will be able to optimise IRM resources across several operations.

Questions to guide the implementation approach	• Is there a list of all TMM on the mine site and which have been fitted with CPS and which haven't? • Is there a list of which CPS were fitted and calibrated by which OTM? • Is there inventory list of spares and other equipment or hardware that needs to be available on-site? • Have the lifecycle costs been evaluated for IRM of CPS for TMM? • Has the reliability of current CPS been evaluated? • How can resources from other operations be leveraged to optimise the availability of this skill?

5.3. Maturity Model

The great diversity of situations across the SAMI in regard to the current levels of CPS installation, means that there is a wide diversity in the kind of approach to knowledge transfer that different mining companies may adopt.

This project has developed a Maturity Model that allows mining companies to review their current situation, and therefore develop the best approach for knowledge and skill transfer for their specific context.

This Maturity Model is based on the extensive input from across the SAMI that was gained as part of this research.

The Maturity Model has been designed to allow the user to assess those organisational capabilities to be addressed, to facilitate the transfer of skills and knowledge pertaining to IRM of CPS in TMM.

The steps to using the model include:

- reviewing your current situation;
- diagnosing the root cause of outstanding issues or problems;
- defining the intended change;
- spotting any barriers or bottlenecks; and
- executing a plan.

	EMERGING	REACTIVE	PROGRESSING	INTEGRATED	ADAPTIVE
LEVELS OF CPS ADOPTION	Little or no CPS technology and devices deployed in TMM.	Some CPS technology and devices deployed in some TMM.	CPS technology and device deployment progressed in half / or a growing percentage of TMM.	CPS technology and devices deployed in most TMM and integrated across the operation.	Latest CPS technology and devices deployed and regularly renewed across all TMM.
KNOWLEDGE & SKILLS	Poor understanding of the knowledge & skills required to conduct IRM in CPS for TMM. Little or no access to a supply of IRM skills.	Current skill requirements partially understood and documented. Poor or inconsistent internal supply of IRM skills. Heavy reliance on external providers.	Current IRM skill requirements well understood and documented. Internal supply of IRM skills meets most of internal demand. Some reliance on external providers.	Current IRM skill requirements fully understood and documented. Internal supply of IRM skills consistently meets demand. Well balanced internal & external skills sourcing.	Current & future skill requirements fully understood and documented. Supply of IRM skills adapts for current and future demand. Well balanced internal & external skills sourcing.

ORGANISATIONAL DESIGN	The IRM skills included in formal structures or job architecture is ad hoc or absent. Little internal parity related to job grades, career paths and remuneration. Poorly articulated or ad hoc accountabilities and responsibilities.	IRM skills partially incorporated into structures and job descriptions. Some alignment of job grades, career paths and remuneration. Siloed, poorly aligned accountabilities, slow decision-making that cause inefficiency.	IRM related structures and job descriptions are in place. Job architecture defined and with clear responsibilities defined. Internal parity to be improved.	Efficient and fit-for-purpose structures in place with clear role clarity and minimal supervisory input. Strong internal parity across roles within the mine.	Sophisticated multidisciplinary teams embedded operating effectively with minimal supervisory input. Quick to respond to unexpected needs.
LEGAL & REGULATORY	Little or no ability to respond to regulatory change. Compliance & reporting of CPS regulations seen as checkbox; little or no data management; limited or no management involvement. Compliance team is siloed. Full reliance on CPS provider(s).	Poor ability to respond to regulatory change. Compliance & reporting seen as an obligation; some automated CPS data management; management involved, but limited business involvement. Compliance team leads the process. Heavy reliance on CPS provider(s).	Some ability to respond to regulatory change. Compliance & reporting seen as a necessity; well automated CPS data management; management and business involvement. Business work with compliance team. CPS provider(s) support compliance.	Strong ability to respond to regulatory change. Compliance & reporting seen as an enabler; regulatory system integrated into business processes; business users lead regulatory adherence. Business accountabilities well defined. Business works with provider(s) to enable compliance.	Organisation is agile & adaptive in responding to regulatory change. Compliance & reporting seen as a differentiator; regulatory system part of continuously improving workflows; leaders proactively track the process. Dedicated business user's bandwidth. Deep business and vendor partnership.
WORK PRACTICES & PROCESSES	Informal and ad hoc CPS related inspection and maintenance working practices and processes. Little or poor control of CPS related risk. IRM of CPS poorly integrated into an effective working culture. Few or ad hoc IRM related KPIs and metrics	IRM related work practices and processes are developed but inconsistently embedded. Moderate control of CPS related safety risk. IRM of CPS somewhat integrated into an effective working culture. KPIs and targets defined but inconsistently achieved.	Work practices and processes defined and mapped but require active monitoring and enforcement. Good control of CPS related risk. IRM of CPS is deliberately managed as part of the working culture of the operation. KPIs and targets clearly defined and usually achieved.	IRM considerations fully integrated across operational working practices and processes. Minimal safety related risk, few or zero accidents or safety events. IRM fully supported by an effective safety conscious working culture. IRM related KPIs and targets clearly defined and always achieved.	Highly effective and efficient work practices and processes entrenched in day-to-day activities leading to consistent achievement of performance benefits and safety goals.

UPSKILLING, TRAINING AND DEVELOPMENT	No established skills plan Ad hoc training practices, unpredictable and inconsistent learning outcomes Fully reliant on OTM and other external suppliers for training.	Basic skills development plan Repeatable training practices, effective scheduling and control, generally consistent outcomes Heavily reliant on OTM and other external suppliers for training.	Learning and development plan & process standardised. Competency and key-skills based training practices, consistent process and quality control.	Learning and development delivery measured & optimised Measured training practices track and control quality and ROI. Delivery refined against training evaluations.	Leading edge skills-on-demand. Learning is aligned to strategic workforce planning models and drives market advantage.
OPERATIONS	Installation timings and re-work at unacceptably high levels. Base equipment inspection and repair frequency and reliability at unacceptably low levels. IRM operating and lifecycle costs are unknown. Reliability of CPS is unknown and availability to TMM regularly impaired. Frequent stoppages and unacceptable levels of safety events due to TMM collision.	Installation timings and re-work are inconsistent and difficult to control. Base equipment inspection and repair frequency and reliability is erratic. IRM operating and lifecycle costs are uncertain and hard to control. Reliability of CPS is uncertain and availability to TMM regularly impaired. Regular stoppages and unacceptable levels of safety events due to TMM collision.	Installation timings and re-work at acceptable levels. Base equipment inspection and repair frequency and reliability at acceptable levels. IRM operating and lifecycle costs are understood and controlled to budget. Reliability of CPS is well managed and availability to TMM is within target parameters. Stoppages and levels of CPS related safety events are within target parameters.	Installation timings and re-work are at or under target levels. Base equipment inspection and repair is far higher than industry standards. IRM operating and lifecycle costs consistently deliver a strong ROI. Reliability of CPS is assured and availability to TMM exceeds the target parameters. Stoppages and CPS related safety events are well below target parameters.	Installation timings and re-work consistently deliver ahead of plan. Base equipment inspection and repair is far higher than industry standards. IRM operating and lifecycle costs consistently deliver a strong ROI. Reliability of CPS is leading edge and availability of TMM is unaffected by CPS related issues. Stoppages and CPS related safety events due are at industry leading low levels.

Figure 9

5.3.1. Using the Maturity Model

The Maturity Model can be utilised by following the steps below:

Review your situation against the Maturity Model

Step through the model above and discuss the types of problems that your line managers may be encountering with TMM availability and reliability and with the proximity and safety related issues pertaining to TMM.

Diagnose root cause

Choose some easy to adapt strategies to deepen your understanding of any root cause to the operational problems that you identify.

Note: not all strategies may be practical or feasible in the specific context of the operation. Examples of different approaches include:

- observing employee behaviour during IRM activities.
- talking to employees and understanding their perspectives of IRM related activities.
- and using data to explore different patterns of CPS performance and reliability.

Clarify the change you want to see

Clearly define the skills based or operational performance related changes that you want to achieve on the operation.

Set these out clearly in a document or an email, so that they can be shared with all stakeholders and tracked as you progress.

Identify potential blockers

Clearly define any constraints that may limit HOW employees adopt the new skills.

There may be “behavioural bottlenecks” or cognitive biases (these can be visible in the predictable ways in which employees seem to make errors in choices or reasoning) that may be contributing to the problem. It may be useful to describe how the behavioural blockers themselves may contribute to the identified problem.

As examples, these blockers may include:

- Hierarchy structures: Hierarchies at work and at home may inhibit shifts in behaviour.

- Belief and attitudes: Beliefs and attitudes held by different employee groups may inhibit a shift in behaviour.

- Employee choices: Specific choices may amplify or inhibit a shift in behaviour. For example, the choices an individual makes around the effective execution and detail of a CPS inspection.

- Limited attention: The available bandwidth of attention employees experience during a busy working day may inhibit a shift in skill and behaviour. It may detract from their attention levels or their ability to absorb new skills or adhere to a quality standard.

- Optimism bias: The optimism bias may influence or inhibit a shift in behaviour, especially where the relative perception of risk may vary, potentially influenced by underlying beliefs or attitudes.

Set out the steps to move forward

Define your approach.

Having specified the desired skills based and behavioural change, the next step is to set out a plan for the training and skills and knowledge transfer required.

- Capabilities: Have you clearly set out the knowledge, skills and capabilities that employees need to have in order to be able to execute the defined IRM related work and will your planned approach support employees in gaining the identified new skills and knowledge?

- Opportunity: Are you able to specify the changes in the operating and enabling environment, both in terms of the shift, job description or operational changes, as well as in terms of the cultural and managerial changes needed to provide employees with the right opportunities to deploy their new skills and knowledge?

- Motivations: Have you clearly identified the key drivers that motivate employee behaviour, their job description and job opportunities; remuneration levels; and core attitudes and beliefs, and can you check and validate that your designed training approach will influence employee skills and motivation in an appropriate way to achieve a change in their skills and knowledge?

Create the skills and knowledge plan

Use the Knowledge Transfer Framework to guide the development of an appropriate knowledge transfer implementation approach (see 5.1 and 5.2).

Elements may include:

Coordination and control: Describe any kick-off meetings, steering groups etc, ensuring that these are appropriately interfaced against any previously identified dependencies and are scheduled as necessary.

Understanding key trade-offs: Describe the process for clarifying and confirming trade-offs that may emerge in the plan, for example, between diligence in healthy and safe ways of working versus operational efficiency and production targets.

Leaders and supervisors: Describe how the user defines and specifies what leaders and supervisors do, how and when.

Training and capability building: Describe the plan, resources, channels and schedule to roll out and assess the impact of the training or capability building interventions that are necessary.

Communications: Describe the plan, resources, channels and schedule to roll out and assess the impact of the necessary communications.

Enabling environment: Describe the plan, resources and schedule to roll out and monitor the impact of the changes necessary in the enabling environment of the employees.

6. Skills Readiness Plan

There is a significant in-house gap between the current skills supply and the likely future skills demand. This gap can be readily bridged using the KTF and the guidance outlined in this report.

However, the longer any given Mining House takes to operationalise this approach, the more potential risk will accrue when the new regulations do finally come into force.

To help mitigate this risk and given the time pressures that the mining houses are likely to experience once the proposed regulations have been enforced, an expedited Skills Readiness Plan has been proposed as an outcome of this project.

This plan is intended to guide the mining houses in establishing the right number of technicians, with the required level of skills, qualifications, and experience to perform the required frequency of IRM services to ensure maximum reliability of CPS within their operation.

Recommended Skills Readiness Plan

Phase One: **Review CPS Inventory and IRM Schedules:**

1. ***List CPS equipment currently installed:***
    - Per Operation
    - Per OEM
    - Per Geographic Region
2. ***Assess total number of CPS to be installed per operation to ensure compliance***: The research conducted as part of this project found that only 11% of TMM are fitted with CPS devices. This suggests that when the required legislation comes into effect, for mines where there is a significant risk of TMM collisions, there will be a significant increase in the installation of CPS devices and therefore, in effect, a significant increase in the required provision for IRM resources. Therefore, identifying the total CPS requirement per operation is a key first step in ensuring the right skills are in place to the IRM of CPS.
3. ***Identify timelines to ensure compliance:*** The timelines to install and calibrate the CPS for an operation's TMM fleet will depend on the size of the fleet and the CPS supplier. This is a critical step as it allows for the mining house to negotiate with the Regulator an extension to meet the regulations requirement. These timelines will also inform the mining house the best approach to ensure the required skills are available on time. For example, should an operation not have the required technicians available when the TMM fleet is operational they may need to find temporary solutions such as outsourcing the IRM services until such time that the required technicians are available in-house
4. ***Determine IRM maintenance schedules as per supplier requirements and standards:*** An understanding of the required maintenance approach set out by the OTMs will provide mining houses with a better sense of how these can be incorporated into their current operations.
5. ***Review current maintenance agreements:*** Review the Servicel Level Agreements currently in place with existing service providers in order to establish how these can be incorporated in the current operations of the mining houses.

Phase Two: **Determine future IRM Knowledge & Skills demand**

1. ***Using the job descriptions provided identify the minimum qualification, experience, skills, capability and competencies required for future operations***: see appendix 8.1 for a detailed job description, which outlines the generic core requirements of a CPS technician. This information serves as a foundation that could be expanded on given the potential unique requirements of a mining house.
2. ***Determine the total number of technicians required per operation to perform required IRM:*** Understanding the total number of CPS within the operation and the preferred maintenance approach will help guide the required compliment of technicians needed. This report explains that some OTMs have up to three levels of technicians at increasing levels of responsibility based on their experience within the field. This

approach allows for the availability of skills to perform more complex IRM issues as well as to provide a level of managerial or supervisory support.

3. ***Review current training requirements/matrices as per OTM standards:*** Appendix 8.2 provides a generic training matrix based on input from various OTMs and review of their current training approaches.

4. **Review current in-house training vs OTM required training:** An understanding of the training requirements as highlighted in section 8.2 will provide mining houses with an idea of which skills can be developed in-house and which skills need to be developed by the product specific OTM training.

Phase Three: **Determine current internal Skills supply and Availability**

1. ***Develop current inventory of existing in-house skills per operation and geographic region:*** take stock of the current skills available across the mining house, given the requirements detailed in the section 8.1, as well as where these skills are located. This will inform the best approach for further development, the sourcing of further skills and their deployment.

2. ***Create slate of internal candidates and assess against the required skills, competencies, availability and location.***

3. ***Discuss potential S197 possibilities with OTMs.*** Discuss the possibility of transferring existing, and currently skilled staff from the OTM's payroll to that of the mining houses, thus minimizing the impact of potential S189 retrenchment procedures on the OTM.

4. ***Assess and document skills gap in relation to total number of technicians required and complete the Training Needs Analysis***

Phase Four: **Develop the Training Plan**

1. ***Identify internal training resources:*** take stock of the current training skills available across the mining house, given the requirements detailed in the section 8.1, as well as where these training skills are located. This will inform the best approach for further development, the sourcing of further training skills and their deployment.

2. ***Create slate of internal training candidates and assess against the required skills, competencies, availability and location.***

3. ***Discuss potential S197 possibilities with OTMs.*** Discuss the possibility of transferring existing, and currently skilled staff from the OTM's payroll to that of the mining houses, thus minimizing the impact of potential S189 retrenchment procedures on the OTM.

4. ***Assess and document skills gap in relation to total number of trainers required***

5. ***Negotiate "Train the Trainer" programs and timelines with OTM's:*** Discuss the transfer of training skills with OTMs, including refresher training, version updates and new product training frequencies.

6. ***Schedule "Train the Trainer" programs:*** Schedule "Train the Trainer" programs timeously to ensure legislation timelines are met.

7. ***Evaluate and resource training syllabi:*** Determine internal technical requirements to deliver training, develop the syllabi as per OTM's requirements, and ensure that content and training aids are in place prior to first batch of training.

8. ***Develop training schedules and communicate:*** Develop and communicate training dates, delegates and locations in accordance with OTM specific and legislated timelines

Phase Five: **Onboard and evaluate**

1. ***Onboard technicians into the required systems, processes and structures:*** Once the required skills are available to perform IRM within the context of the mine's operations it is important to onboard and embed these resources into the systems, processes and structures of the mine. The Knowledge Transfer Framework proposed in section 5.1 and the key Knowledge Transfer considerations in section 5.2 should be used when considering the onboarding approach, specifically, as it relates to issues of organisational design, legal and regulatory, and work practices and processes.

2. ***Evaluate technicians in line with agreed and recommended KPIs:*** Appendix 8.1 provides suggestions of key KPIs for CPS technicians, these serve as a base and should be expanded or amended to fit the mine's operational context. These KPIs should then be introduced into each technician's performance contracts where their performance should be reviewed to enable continual growth.

3. ***Evaluate IRM processes and activities in line with the proposed maturity model and refine to ensure continued growth and maturity of the function***: As with any technology CPS will continue to evolve and therefore so should the supporting IRM services. Section 5.3 provides a model that can be used to measure maturity across each dimension of the Knowledge Transfer Framework. A mining house should use this to continuously evaluate their current IRM operations to ensure they remain relevant and move towards being best in class. This approach is critical to overall safety of the mine's operations.

Phase Six: **Deliver the Training Plan**

1. ***Deliver training according to agreed schedules***

2. ***Monitor and evaluate*****:** Ensure that training is delivered according to OTM standards and modify accordingly. Provide required on-site mentoring and observation for technicians.

3. ***Update HR Documentation*****:** Update Individual Development Plans and Performance Agreements according to completion of training, pass marks, and on-site supervisor evaluation.

7. Summary and Conclusions

Current Landscape

Of all the TMM in use on South African mines, approximately 92% are fitted with Proximity Detection Systems (PDS), but only 11% are fitted with Collision Prevention Systems (CPS). This means that should legislation be tabled that requires that all TMM be fitted with the latter, where there is a significant risk of collisions, a large number of TMM would need to be equipped with CPS.

This would result in an exponential increase in skills required to not only install, but to repair and maintain the CPS equipment on an ongoing basis.

OTMs of CPS provide between 60% and 80% of the Installation, Repair and Maintenance (IRM) of the equipment they install, while mining houses currently perform the balance. This of course varies from OTM to OTM depending on the level of sophistication of the equipment as well as the willingness of the OTMs to pass over this function to their customers.

While some small differences in required skill sets differ from OTM to OTM, the role profile of the CPS IRM Technician is fairly standard across CPS technology. Given that the function of the equipment is fairly limited, the IRM function is reasonably routine and easily trained.

Based on our research the CPS IRM Technician is drawn from candidates with qualifications ranging from a Grade 12 (Matric) to Electrical Artisan level.

Product specific training is provided to the technicians. Training is a combination of On-line, Classroom based and Field training. Classroom and On-line training vary between 1 week and 1 month, but full competency can be reached between 3 and 6 months.

In some cases, IRM tasks are split between the following requiring appropriate levels of seniority:

- Tier 1 – Basic inspection and parts replacement
- Tier 2 – Fault finding
- Tier 3 – Installation, Calibration & Analysis

The maintenance schedules and intervals also vary from OTM to OTM from once per month per device to six monthly depending on the level of equipment sophistication.

Future Scenario

In evaluating the options of insourcing the skills of the CPS technicians, and the training thereof, it is useful to consider the matrix depicted under section 4.1.2.

Based on the interviews with the various OTMs it was apparent that the business model of each of these suppliers differed, most notably, those suppliers who had invested heavily in their products and developed a fairly resilient product which required less IRM intervention.

In evaluating their options, mining houses should consider the complete life-cycle costs of both the equipment and the maintenance thereof. The matrix spells out the high-level interpretation of the considerations required in such a choice.

Clearly, whichever level of technology investment the mining houses choose, the investment in an in-house IRM capability must evaluate the following:

- The required frequency of inspection and maintenance
- The willingness of the OTMs to relinquish this function
- The legal and liability related requirements
- The in-house safety protocols, standards and history thereof
- The degree to which the skills supply can be both scaled (via training and knowledge transfer, job descriptions, etc) and maintained (via succession and career planning) by the mining house.

Certain OTMs are not in favour of the in-sourcing of training citing loss of control and consequential reputational damage that may occur should product failures occur as a result of poor IRM protocols

In general, these options need to be evaluated on an OTM-by-OTM basis. A list of key considerations that need to be considered is included in section 5.2.

Most of the mining houses have established Human Resource departments with the capability to provide CPS technicians with long term careers beyond their immediate roles. In addition, these large mineral resource organisations have well equipped training facilities that can provide basic training on the operation and maintenance of these devices.

SAMI is not currently equipped to ensure that all TMM, new or legacy, is equipped with CPS devices within the 3 months stipulated by the amendments to the regulation. In this regard, it is recommended that all mining houses embark on gaining an understanding of the contents of this study and utilising the tools developed to determine the approach, cost, timelines and resource implications of compliance should legislation be implemented.

8. Appendices

8.1. Appendix A – job description and other job requirements

Job Description

Job Title

Collision Protection System (CPS) technician

Job Purpose

To Install, Repair and Maintain (IRM) Collision Prevention Systems (CPS) on Trackless Mobile Machinery (TMM)

Generic Equivalent

- Trade-tested Artisan – Electrician / Auto Electrician/Instrument Mechanician.
- Patterson Band – C1/C2

Minimum Technical Skills

- Product Knowledge
- Basic computer knowledge
- Basic TMM machine knowledge
- Basic IT and Electronics (Hardware, Software and Networks)
- Hand tools

Desired Experience

- Supervised experience in the IRM of the relevant technologies as guided by the OTM training guidelines
- Control Instrumentation background / RF experience beneficial
- 3-4 years' experience with installations / maintenance of control & instrumentation systems.

Key Responsibilities

1. Inspect CPS equipment at intervals determined by the site-specific maintenance agreement or maintenance schedule as determined by the Task Based Risk Assessment specific to the machinery on which the CPS devices are installed and the mining conditions peculiar to the mining operation in question.
2. Repair and/or replace, as required, any devices, or device components that fail afore-mentioned inspection.
3. Upload program upgrades within a period of time agreed between the device manufacturer (OTM) and the operation to which the CPS Technician is assigned
4. Download diagnostic data as required by the operation and analyse as required

Organisational Interfaces

- Supervisor: Taking instructions and amended instructions, Reporting back IRM schedules and anomalies, Reporting of schedule interference.
- TMM Operators: Communication of schedules and amended schedules, delays. Understanding operational priorities. Stop and Fix instructions.
- Shift Bosses and Supervisors: Coordination of IRM activities, Stop and Fix instructions.
- H&S Representative: Coordination of IRM schedules, anomalies, Stop and Fix instructions.

Figure 10

Functional Related Key Performance Indicators

Key Performance Areas	Cluster	Key Performance Indicators	Competencies
Safe and effective installation, repair, and maintenance of devices	Solving Problems	• Resolve problems that occur during the shift • Resolve problems picked up during maintenance	• Knowledge of job • Technical knowledge • Knowledge of relevant SOP's/COP's • Quality adherence • Planning skills • Organising skills • Controlling skills • Assertiveness • Conscientiousness • Problem solving skills
	Adaptability	• Ensure availability of material, tools and equipment	
	Delivering Results	• Output achieved within given guidelines • Comply with set standards and practices of the job • Time frames are adhered to • Check the Accuracy of the completion of Log books, permits and other documents	
Comply with provided systems, practices, methods, standards, and procedures of the work	Delivering Results	• Comply with standards, methods and procedures of the job • Attend to breakdowns promptly to minimise down time • Repair equipment and machinery promptly to ensure production targets are met • Conduct fault finding and repair installations according to schedule and company specific standards	• Job knowledge • Technical skills • Risk Assessment skills • Knowledge of standards, methods and procedures of the job • Ability to apply knowledge of standards, methods and procedures • Ability to apply fitting knowledge and skills • Inspection skills • Diagnostic skills • Communication skills

Figure 11

Safety Related Key Performance Indicators

Key Performance Areas	Cluster	Key Performance Indicators	Competencies

Safe and effective installation, repair, and maintenance of devices	Delivering Results	• Comply with electrical and mechanical standards, standard procedures and codes of practice to achieve zero harm
		• Comply with mine health & safety management systems & standards
		• Follow basic health and safety practices
		• Ensure compliance with gas safety rules / guidelines.
		• Ensure that PPE is used in accordance with standards and procedures
		• Submit accident/incident report in writing when required
		• Follow safety protocols when detecting unsafe working conditions
		• Comply with health & safety campaigns
		• Apply first aid as and when required
		• Ensure good housekeeping in area of responsibility
			• Knowledge of health & safety systems & standards
			• Understanding of "right to withdraw" procedure
			• Attentiveness
			• Mine health and safety awareness
			• Communication skills
			• Set example
			• Basic legal understanding
			• Risk management skills
			• Hazard identification skills
			• Problem solving skills
			• Literacy and numeracy skills
			• Writing skills
			• adaptability
			• Knowledge of the mines health and safety policies
			• Knowledge of safety campaigns
			    • First aid skills
			    • Housekeeping skills

	Influencing People	• Report unsafe behaviour, acts and conditions immediately • Lead by example and walk the talk; Be your brother's keeper	

Figure 12

Behavioural Framework

Figure 13 illustrates a behavioural competency profile for a generic CPS technician. The competencies described below are based on the *Saville Behavioural Competency Model,* more detail on this model is available in appendix D.

The categorisation of the competencies into ***essential, important***, and ***less important*** is based on a generic understanding of the role. However, the categorisation may take a different form depending on the context in which it is applied.

Cluster	Dimension			Cluster	Dimension		
Solving Problems	Examining Information	Developing Expertise	Generating Ideas	Adapting Approaches	Conveying Self Confidence	Thinking Positively	Understanding People
	Documenting Facts	Adopting Practical Approaches	Exploring Possibilities		Showing Composure	Embracing Change	Team Working
	Interpreting Data	Providing Insights	Developing Strategies		Resolving Conflict	Inviting Feedback	Valuing Individuals
Influencing People	Interacting with People	Convincing People	Making Decisions	Delivering Results	Meeting Timescales	Managing Tasks	Taking Action
	Establishing Rapport	Articulating Information	Directing People		Checking Things	Upholding Standards	Seizing Opportunities
	Impressing People	Challenging Ideas	Empowering Individuals		Following Procedures	Producing Output	Pursuing Goals

Key

- Essential
- Important
- Less Important

Figure 13

Typical working conditions that a CPS Technician needs to be accustomed to

Environmental	Physical	Emotional	Mental	General

• Underground/Surface
• High risk
• Dusty
• Noisy
• Heat
• Radiation
• Low illumination
• Working at heights
• Uneven/slippery surfaces
• Travelling ways
• Material ways
• Back and abandoned areas
• Occasionally exposed to fumes
	• Endurance
	• Walking
	• Standing
	• Sitting
	• Operating Equipment
	• Physical Strength
	• Climbing ladders
	• Finger dexterity
	• Hearing and visual acuity
		• Stressful
		• Consequences can be severe
		• Time constraint: High to Severe
		• Emotionally Stable
			• Moderately cognitive
			• Moderately complex
			• Thinking
			• Reasoning
			• Awareness
			• A wide range of choices and decisions within predefined scope
			• Discretion
			• Basic Analytical Skills
				• Knowledge of the requirements of:
				  • The MHSA Health & Safety system
				  • Policies & Procedures
				  • Codes of Practice
				  • Standard Operating Procedures
				• Able to perform routine work
				• Available for Standby/Call Outs & Unplanned Overtime

Figure 14

8.2. Appendix B - Training Matrix

This matrix depicts the general training that CPS technicians undergo to equip them to perform the roles determined by their job description. The specific time periods are OTM dependant and can also vary according to the number of OEM equipment types that they are interfaced with. Training media is a combination of on-line, classroom based and practical.

Mine Specific Training	Product Specific Training	Practical Training	Ongoing
Risk Propensity Assessment and Training	System Introduction	Diagnostics	Annual / Bi-Annual Refreshers
The MHSA	Component Overview	System Checks	Competency Assessments
Health & Safety system	Installation & Configuration	Lamp Room Checks	Technical Reviews
Policies & Procedures	Operation	Fault Finding	Product Specialist Meetings
Codes of Practice	Geofences & Zone Adjustments	Replacement	
Standard Operating Procedures	Exclusion Zones	Software Uploads	
	Security Features	Data Downloads and Analysis	
	Maintenance		
	Troubleshooting		
	Technical Specifications		
Timelines may differ per mine	1 Week to 3 Months	2 Weeks to 6 Months	Annually or Bi-Annually

Figure 15

CPS Technician Training

The Recruitment Process: Upskilling & Reskilling

- The recruitment and basic training of CPS Technicians is done by the mines. This focuses their training to site requirements and procedures
- When mines identifies the suitable candidates for training, they consider the following: Mining Experience; Qualifications; Competency Levels
- Ideally a suitable candidate would be an Electrical Artisan, with minimum N4 and a Trade Test, which makes them a Skilled Worker
- In that way this ensures that they can read engineering drawings esp. electrical & electronics; they are familiar with the dynamics on the mine
- Before they are sent off to an OTM for product training, they cover the following: different types of machinery; mining operations; zoning
- They'd be taught about the basics on: how the magnetic field generation works; warning lights and alarm systems; lights and different signal
- They would also go back to their diagnostics tools to practice on how it works with CPS equipment e.g. Multi-meter etc

The Training Programme: OTMs and Mines

- Training could be anything from two days to six months depending on the OTM and how sophisticated their technology is.
- Primarily the training programme covers these aspects i.e. Overview of the Technology; Troubleshooting & Maintenance
- It starts with intrinsic safety considerations, ie.: mine gasses and flammable substances esp. for soft rock (coal mines)
- Each OTM offers equipment specific training, with the assumption that the mines will cover the rest of CPS knowledge prescribed
- System components: Cap Lamp; Battery; LEDs; Display Screen; Flasher; Modules for Proximity & Interface; Cables; Generator; Controller Box
- Maintenance: replacing a controller board; fixing the antennae; interpreting fault codes; understanding all LEDs and service signs; wiring
- Typical Faults: generator off (no power); Communication Error (cable damaged)
- Lamp room checks, at the start of the shift and end of shift: Cap Lamp LEDs – understanding the Cap Lamp as a safety device

Duties and Responsibilities: Underground & Surface

- Most OTMs do not certify CPS Technicians as competent. That is done by the mines, in accordance with site/company specific policies
- Only OTM employed technicians handle the commissioning of new installations, not the mine employed CPS Maintenance Technicians
- Installation of new equipment is handled by the mine and OEMs. In that way the shared responsibilities are clear, for accountability purposes
- Commissioning includes: Site Acceptance Procedures; Interlocking Parameters; Setting up of Zones – green; yellow and red, signing off
- Identify/advise on zones: Monitor; Warning; Hazard & Silent – for machines in the area; pedestrians
- Generally, mines prefer that all Artisans (regardless of their trade) have the capability to handle basic CPS fault finding, for productivity reasons
- Newly trained CPS Technicians can handle: interference with the system (cables/wiring cut/damages etc); coil failure; battery charge levels

Figure 16

8.3. Appendix C – Question Examples

The following is a non-exhaustive list of questions that were asked throughout the data gathering process, either through the online question or during interviews

OTMs

1. Please list the roles /job profiles involved in the Installation, Repair and Maintenance (IRM) of your Collision Prevention System/s (CPS)?
2. Please list the core skills required to perform the Installation, Repair and Maintenance (IRM) of CPS technology?
3. What type of prior experience/qualifications is required to be eligible to be recruited for this role?
4. What training program/s do they embark on once employed by you?
5. Is this training provided by you or by a 3rd party?
6. If possible, could we get a copy of the training program indicating modules covered, training times and certification requirements?
7. What percentage of your customers have maintenance agreements with you?
8. If possible, could we get a sample copy of one of these maintenance agreements?
9. What is the minimum qualification(s) required to perform the role of a CPS technician?
10. How often are your CPS devices inspected?
11. What is the ratio of technicians to device?
12. Do the required skills differ per OEM technology or CPS component?
13. Are the skills acquired by technicians transferrable to other technologies, ie other OTM devices?
14. What would be the legal ramifications of providing these skills internally (i.e. by the mining houses)?
15. What sort of certification/proof of IRM competence is provided to those personnel that receive training and the validity period?
16. Are you currently involved in any skills localisation initiatives or plan to be involved in any?
17. What do you see as the key benefits, both to you, your customers and the industry in transferring these skills to the mining houses?
18. What do you see as the key obstacles, both to you, your customers and the industry in transferring these skills to the mining houses?
19. What other considerations are there in transferring these skills to the mining houses?

OEMs

1. What is required from you in order to ensure successful installation of CPS devices on your TMM machinery?
2. What parts of your machinery is interfaced?
3. Once the devices are installed how easily is it to maintain the CPS equipment without a working knowledge of the relevant mechanics of the TMM?
4. Who currently maintains the CPS devices, the OTM or the mining company?
5. Is there any training that you provide in order to upskill the CPS technicians?
6. What do you see as the key benefits, both to you, your customers and the industry in transferring these skills to your customers?
7. What do you see as the key obstacles, both to you, your customers and the industry in transferring these skills to the mining houses?
8. What other considerations are there in transferring these skills to the mining houses?

Mining Houses (Customers)

9. Who currently performs IRM on their CPS equipment (internal/OTM/OEM/3rd party)?
10. Do they have the capacity to perform this function internally?
11. What would be needed to establish this, including timelines?
12. What skills would be required (refer to the presentation re suggested title/grade etc)? Is this correct?
13. Would they be able to skill up existing resources as part of their current functions or would they need additional staff?
14. Could they take over the OTM/external staff?
15. Who would train them? (Internal, OTM, 3rd party)?

8.4. Appendix D – Mine Health and Safety Act, 1996 (Act No 29 Of 1996) Regulations Relating To Machinery And Equipment (Amendment Of Chapter 8 Of The Regulations)

TMM regulations were promulgated under notice N.R. 125 in the Government Gazette, on the 27th of February 2015. The TMM Regulations form part of chapter 8 of the regulations made under the MHSA. The regulations came into operation three (3) months after the date of publication in the Government Gazette, with the exception of sub-regulations 8.10.1.2 (b) and 8.10.2.1 (b), which deal with the slowing down and stopping of diesel-powered TMM.

The amendments to Chapter 8 of the MHSA 1996 require all mining operations to take "*reasonably practicable measures*" to prevent accidents involving mobile machinery within their operations.

Accidents are defined as being between:

- Trackless vehicles and people (pedestrians)
- Trackless vehicles and other trackless vehicles
- Trackless vehicles and rail-bound vehicles
-

Solutions to prevent accidents in this regard have to be compliant in terms of these amendments, and requires three components:

- A proximity detection device identifying the existence of people or other vehicles in the vicinity
- A mechanism to alert the machine operator and the nearby people / vehicles of each other's presence
- An automated system to slow the vehicle to a safe speed without human intervention if no corrective action is taken

8.5. Appendix E - Saville Behavioural Competency Model

Personality Style Language				Competency Potential Language				TTS Competency Definitions
Clusters	Sections	Dimensions	Facets	Facets	Dimensions	Sections	Clusters	
Thought	Evaluative	Analytical	Focused on Information Analysis	Processing Information	Examining Information	Evaluating Problems	Solving Problems	Analyses and processes information; asks probing questions; strives to find solutions to problems.
			Probing	Asking Probing Questions				
			Solution Focused	Finding Solutions				
		Factual	Focused on Written Communication	Writing Fluently	Documenting Facts			Writes fluently when documenting facts; understands arguments logically; focuses on finding facts.
			Logical	Understanding Logical Arguments				
			Fact Finding	Finding Facts				
		Rational	Data Oriented	Quantifying Issues	Interpreting Data			Interprets data rationally by quantifying issues; applies technology as a means to evaluating data; evaluates information objectively.
			Technology Aware	Applying Technology				
			Objective	Evaluating Information Objectively				
	Investigative	Learning Oriented	Open to Learning	Taking Up Learning Opportunities	Developing Expertise	Investigating Issues		Is open to taking up learning opportunities; is quick in acquiring knowledge and skills; develops expertise by updating specialist knowledge.
			Quick Learning	Acquiring Knowledge and Skills				
			Prefers Learning by Reading	Updating Specialist Knowledge				
		Practically minded	Practical	Applying Practical Skills	Adopting Practical Approaches			Applies practical skills when investigating issues; prefers to learn by doing; is practically minded and applies common sense.
			Prefers Learning by Doing	Learning by Doing				
			Common Sense Focused	Applying Common Sense				
		Insightful	Focused on Improving Things	Continuously Improving Things	Providing Insights			Is focused on continuously improving things; provides insights by identifying key issues; makes intuitive judgements.
			Discerning	Identifying Key Issues				
			Intuitive	Making Intuitive Judgments				
	Imaginative	Inventive	Creative	Producing Ideas	Generating Ideas	Creating Innovation		Is creative in producing ideas; assumes an original approach when generating ideas; adopts radical solutions.
			Original	Inventing Approaches				
			Radical	Adopting Radical Solutions				
		Abstract	Conceptual	Developing Concepts	Exploring Possibilities			Is conceptual when developing ideas; applies theories to problem solving; prefers to learn by thinking and identifying underlying principles.
			Theoretical	Applying Theories				
			Prefers Learning by Thinking	Identifying Underlying Principles				
		Strategic	Focused on Strategy	Forming Strategies	Developing Strategies			Is focused on developing strategies; thinks in the longer term and anticipates trends; envisages the future and adopts a visionary approach.
			Forward Thinking	Anticipating Trends				
			Visionary	Envisaging the Future				

Personality Style Language				Competency Potential Language				TTS Competency Definitions
Clusters	Sections	Dimensions	Facets	Facets	Dimensions	Sections	Clusters	
Influence	Sociable	Interactive	Lively	Projecting Enthusiasm	Interacting with People	Building Relationships	Influencing People	*Is lively and projects enthusiasm; is talkative in making contact; is focused on interacting and networking with people.*
			Talkative	Making Contact				
			Focused on Networking	Networking				
		Engaging	Rapport Focused	Putting People at Ease	Establishing Rapport			*Builds rapport and puts people at ease; is engaging and welcomes people; finds it easy to make friends.*
			Initial Impression Oriented	Welcoming People				
			Friendship Seeking	Making Friends				
		Self-promoting	Attention Seeking	Attracting Attention	Impressing People			*Is comfortable attracting attention; impresses others by promoting personal achievements; seeks to gain recognition and praise from others.*
			Immodest	Promoting Personal Achievements				
			Praise Seeking	Gaining Recognition				
	Impactful	Convincing	Persuasive	Persuading Others	Convincing People	Communicating Information		*Is comfortable having to persuade others; shapes opinions by being outspoken; seeks to negotiate with others.*
			Outspoken	Shaping Opinions				
			Negotiative	Negotiating				
		Articulate	Presentation Oriented	Giving Presentations	Articulating Information			*Is articulate in giving presentations; is eloquent and explains things well; projects social confidence when articulating information.*
			Eloquent	Explaining Things				
			Socially Confident	Projecting Social Confidence				
		Challenging	Prepared to Disagree	Questioning Assumptions	Challenging Ideas			*Prepared to disagree and question assumptions; challenges ideas and established views; comfortable arguing own perspective.*
			Challenging Views	Challenging Established Views				
			Argumentative	Arguing Own Perspective				
	Assertive	Purposeful	Decisive	Deciding on Action	Making Decisions	Providing Leadership		*Is determined and decides on actions; willingly assumes responsibility; is definitive and stands by own decisions.*
			Responsibility Seeking	Assuming Responsibility				
			Definite	Standing by Decisions				
		Directing	Leadership Oriented	Leading People	Directing People			*Is comfortable leading people; coordinates and directs groups; seeks to control things.*
			Co-ordinating	Coordinating Groups				
			Control Seeking	Controlling Things				
		Empowering	Motivating	Motivating Individuals	Empowering Individuals			*Motivates individuals by empowering them; seeks to inspire people and groups; gives encouragement to others.*
			Inspiring	Inspiring People				
			Encouraging	Giving Encouragement				

Personality Style Language				Competency Potential Language				TTS Competency Definitions
Clusters	Sections	Dimensions	Facets	Facets	Dimensions	Sections	Clusters	
		Self-assured	Self-confident	Projecting Inner Confidence	Conveying Self-Confidence	ence		*Is self-assured and projects inner confidence; is confident and determines own future; values own contributions.*
			Self-directing	Determining Own Future				
			Self-valuing	Valuing Own Contributions				

Figure 17

Personality Style Language			Competency Potential Language				TTS Competency Definitions
…ions	Dimensions	Facets	Facets	Dimensions	Sections	Clusters	
…ious	Reliable	Deadline Focused	Meeting Deadlines	Meeting Timescales	…etails		*Is target focused and meets deadlines; is punctual and keeps to schedule; is reliable in finishing tasks.*
		Punctual	Keeping to Schedule				
		Completion Focused	Finishing Tasks				
		Detail Focused	Finding Errors				