

# Latin America

Country

MEXICO

Sector

MINING AND METALS

Sector

SILVER MINE

Workstream

MOBILE MAINTENANCE

## Keywords

- MOS
- Availability
- MTBF
- MTTR
- Performance Management
- CMMS Data Improvement
- Effective Inspections
- Bad Actor Management
- Shift Change Management
- Work Management Process (planning)
- Supply Chain Stockout Alarm System
- Pre-PM
- PM Routines
- SMART PM
- 5's
- Pit Stop Green Flag System
- Flexibility Matrix

# Constructed and implemented an enhanced Maintenance Management Operating System (MMOS) for FMS Diesel Mobile Maintenance.

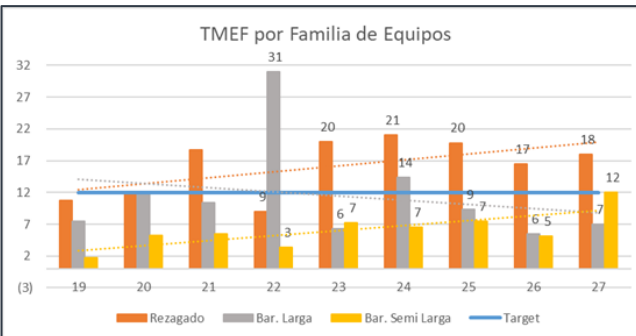
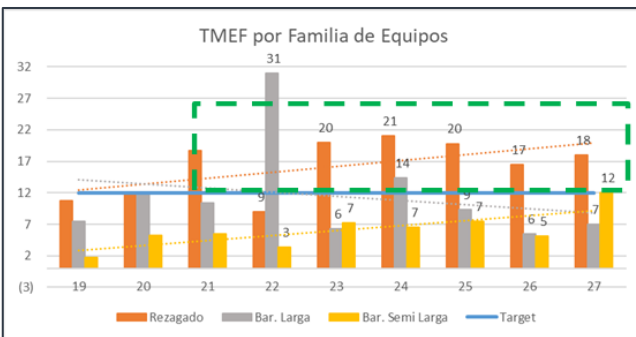
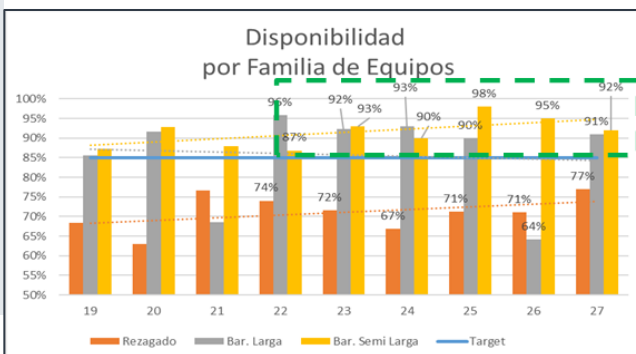
## Key Objectives

- ▲ To improve efficiency, predictability and reliability within the Mobile Maintenance area and equipment.
- ▲ To improve Maintenance planning and operational effectiveness.
- ▲ The delivery of the training and coaching required to enable the changes in behavior needed to ensure the sustainability of the operational improvements.

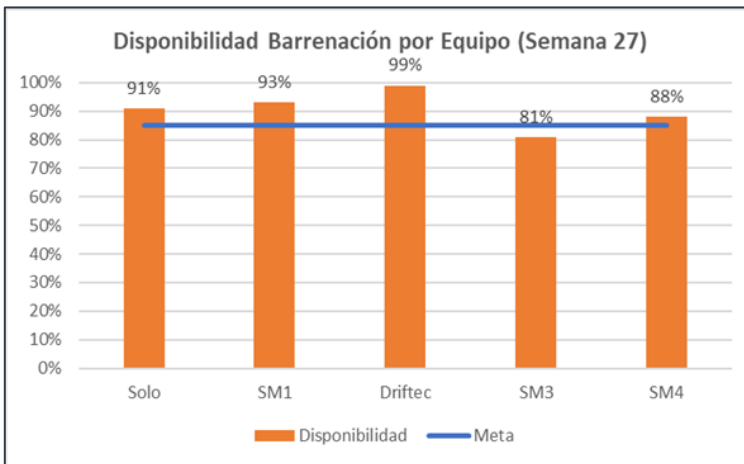
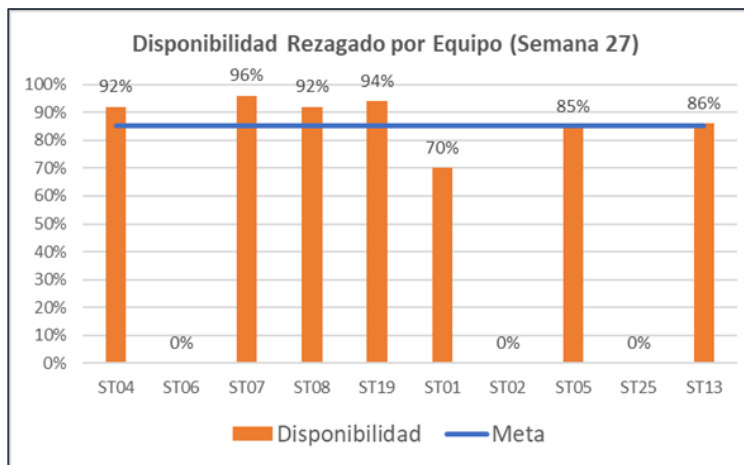
## Results up to Week 16

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## Reliability and Availability Overall Results



## Availability Results Week 27



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## Opportunity

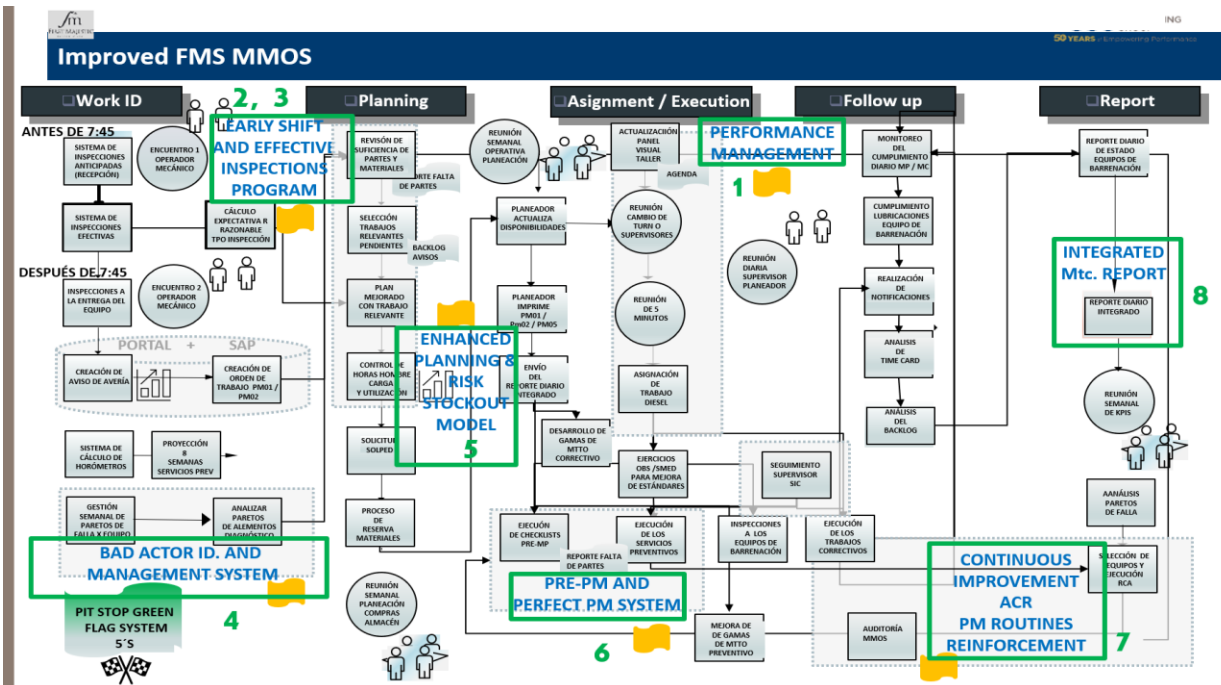
FMS Maintenance Management Operating System needed to be enhanced to ensure the right maintenance in the most efficient manner for the most critical mobile equipment (Drills and Scoops).

The Team built and implemented with FSM Diesel mobile Maintenance team, an enhanced Maintenance Management Operating System (MMOS) for Santa Elena unit. Our most important objective includes, implement an improved mobile maintenance operating system that allows to reverse the large amount of reactive work and turn it into preventive work, where the reliability and availability of critical equipment (drilling, lagging and loading) is monitored and ensured. to achieve operational objectives.

Improved MMOS relies on eight support pillars installed for FMS Maintenance process: Performance Management, Early Shift Inspections and Effective Inspection Programs, Bad Actor Management Process, Enhanced Planning Process, Pre-PM and Perfect PM process and Preventive Routines Improvements Program.

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IMPROVED FMS MMOS

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## Performance Management

### Issue

Visual management did not drive performance to targets between supervisors during the Shift Change Meeting and did not give feedback using variance management practice during the periodic daily dialogues held during the toolbox meeting.

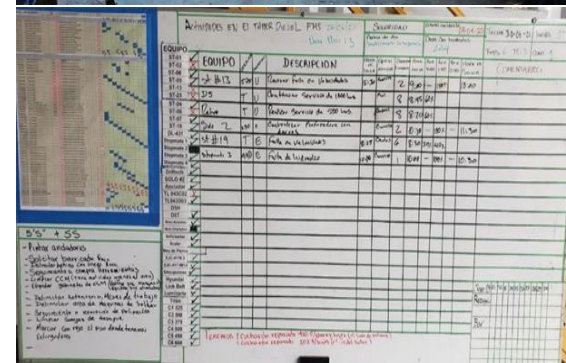
### The Team Approach

Visual Management and Performance Dialogues changed into a very different scheme with the following three key practices: visual management of key metrics, Performance Dialogues and Problem Solving.

## Actions Taken

Visual Management and Performance Dialogues changed into a very different scheme with the following features:

- ▲ Developed an improved Visual Board with physical availability, pending activities, urgent actions, Plan vs Actual Availability and jobs on hold due to parts.
- ▲ Introduced effective Meetings with agenda between supervisors as structured problem solving sessions to systematically improve issues identified on previous shift using the board.
- ▲ Current Board integrates the Short Interval Control (SIC) Tool for work progress control and direct supervision.
- ▲ Enhanced toolbox meeting with focused assignments of Work Orders discussing safety and operational issues to sustain improvements per equipment and eliminate barriers.

EQUIPO	DESCRIPCION	ESTADO	FECHA	RESPONSABLE
1	Trabajo pendiente	En proceso	15/06/2023	J. Lopez
2	Trabajo pendiente	En proceso	15/06/2023	J. Lopez
3	Trabajo pendiente	En proceso	15/06/2023	J. Lopez
4	Trabajo pendiente	En proceso	15/06/2023	J. Lopez
5	Trabajo pendiente	En proceso	15/06/2023	J. Lopez
6	Trabajo pendiente	En proceso	15/06/2023	J. Lopez
7	Trabajo pendiente	En proceso	15/06/2023	J. Lopez
8	Trabajo pendiente	En proceso	15/06/2023	J. Lopez
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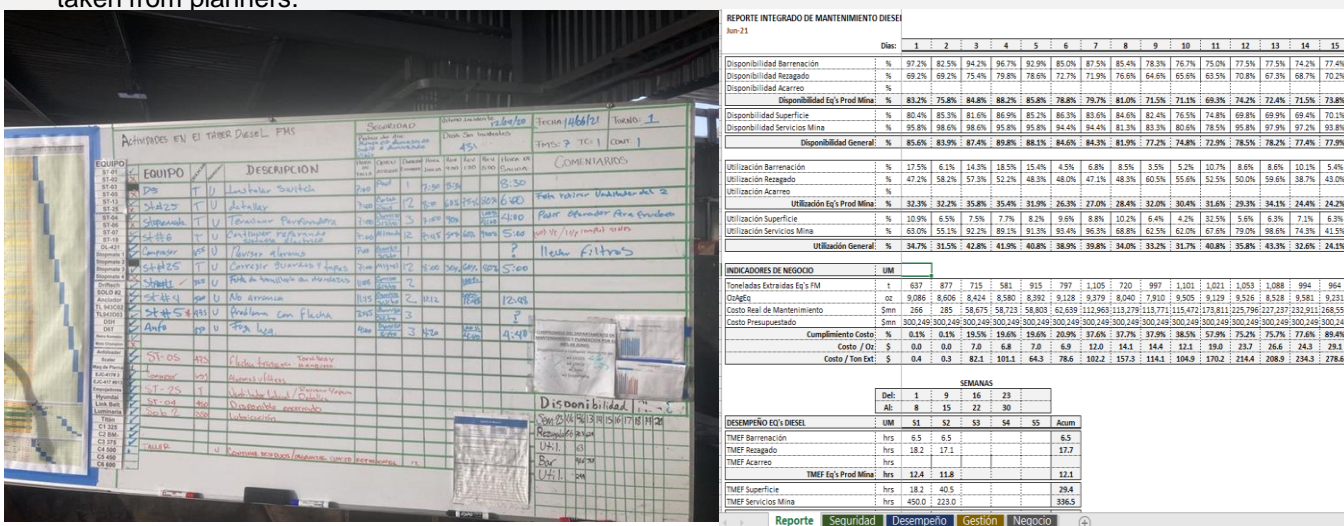
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**Performance Management focused in improving data entry and better information flow**  
(continued)

- ▲ New installed Visual Management has contributed to reinforce the culture of routinely discuss improvement opportunities as a normal way of “doing business”.
- ▲ Visual Management helps the coordinated with Planning department to define priorities based on the weekly and operations requirements.
- ▲ The action log is part of the board design for work prioritization.
- ▲ One of the more important benefits is the contribution to a better more accurate downtime registration for Availability and Reliability KPIs calculation purposes.
- ▲ Developed an optimized effective supervision process to achieve target focusing the first 120 minutes of each shift to check for quantity and quality of the jobs being performed.
- ▲ Improved hand-off process to ensure work-in-progress continued from shift to shift and crew to crew.
- ▲ Refined the Communicator Handover process to address safety, current mining stats against shift requirements, and any issues that might impact the oncoming crew.
- ▲ Performance Management actions include the integrated report with a better information flow and less time taken from planners.



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## Early Shift Inspections and Effective Inspections Programs Issue

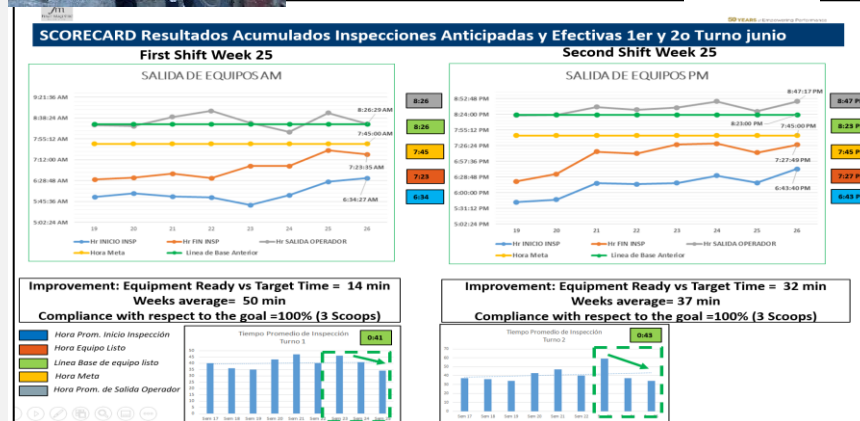
Formal Pre-Op Inspection workflow process and inspection-lubrication procedures varied in how executed. Mechanics were not fully loaded at the beginning of their shift after 7:00 toolbox meeting, and did not have goals or reasonable expectation standard times for an effective inspection.

## The Team Approach

Early Shift Inspection Program (ESIP) was installed by achieving anticipated shift change starting time (5:00) for a crew of 3-4 persons, including the supervisor, specialist and 1-2 mechanics. This approach contributed to gain additional potential utilization for operations and to have more productive work hours per day on planned inspection and lubrication work orders by mechanical Maintenance crews. Wrench time improved by having more time on tools by the outgoing mechanic crew. ESIP evolved into an effective inspections program with standard times for scoops lubrication.

## Actions Taken

- ▲ Early shift start from 7:20 to 5:00 am has generated daily average of 3 Scoops ready before 7:45 according to the Shift Startup Mine Process.
- ▲ Introduced improved inspection checklists for better operator and mechanic first interaction.
- ▲ Early shift inspection tracker installed to ensure reliable starting and finishing inspection times.
- ▲ Introduced the concept of effective inspections checking on the quality of them.
- ▲ Both programs have contributed to an immediate Work Requests increase made by maintenance supervisors, leading into an improved information system for equipment diagnose and potential failure analysis.



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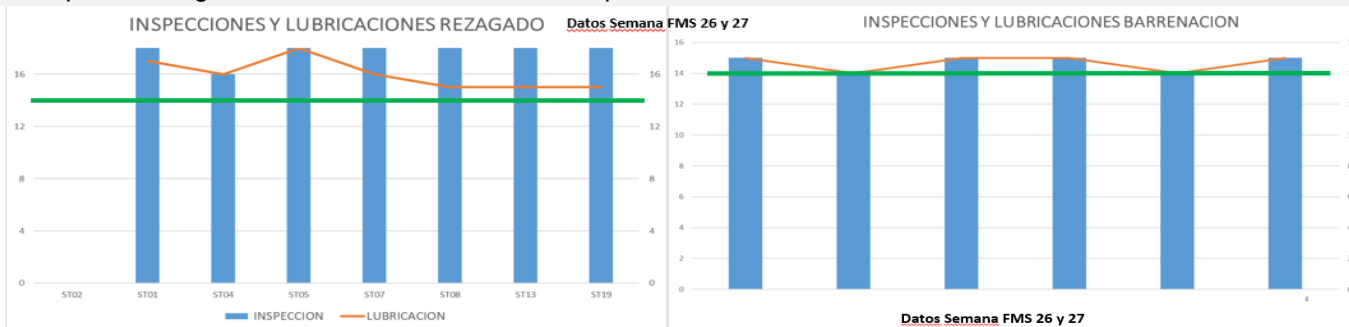
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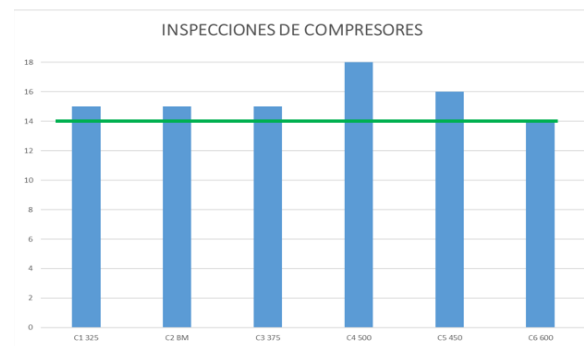
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## Early Shift Inspections and Effective Inspections Programs (Continued)

- ▲ Installed a Daily Compliance Effective Inspections and Lubrications for Drills
- ▲ By using this tool and the activity reinforced by Fernando Palacios, Chief of Diesel Maintenance, achieved 100% lubrication compliance for drills for the first time and 100% for scoops for 3 weeks.
- ▲ Effective inspections also covered a quick project result, which has been the increase of reportability from the operator to the mechanic. We have a better interaction between operations and maintenance: Every day there is an interaction between the operator and the mechanic at the moment in which the equipment is left for inspection. Fresh and recent information from the operator, allows the raising of more timely warnings with the precise diagnostic elements to attack the root problem.



	LUNES	Martes	Miércoles	Jueves	Viernes	Sábado	Domingo
EQUIPO	TRAP	TRAP	TRAP	TRAP	TRAP	TRAP	TRAP
ST01							
ST02							
ST04							
ST05							
ST07							
ST08							
ST13							
ST14							
ST25							
Barrenad.							
CR01 AHS							
SPRINT4							
Drinch							
Solo2							
Arbolad.							
C1 325							
C2 8M							
C3 375							
C4 500							
C5 450							
C6 600							
ST							





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## Bad Actor Equipment ID and Management System Issue

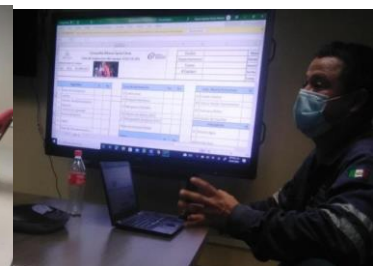
While about 44% of the reported work orders were reactive, a big amount of unplanned work was completed without the creation of a work order. Incomplete Work Order Requests (*Avisos*) without including parameters such as: Object Part, Failure Symptom and Root Cause led into a lack of accurate information impeded precise RCA, and reliable managed weekly prioritized work at an equipment level.

## The Team Approach

A new potential failure identification system has been established, with more Work Requests than before, resulting in more reliable Pareto study. We have called this system the Bad Actors Identification and Management System. The identification of the bad actors goes hand in hand with the identification of the Diagnose Elements (Part Object, Symptoms and Causes), in order to obtain from SAP focused and directed relevant work for mobile equipment.

## Actions Taken

- ▲ Proper Portal training to operations and Maintenance in order to ensure Work Requests quality and better information for pareto development.
- ▲ Introduced 4 week rolling Pareto Study based on Work Requests to be able to identify the focused equipment and repetitive failure systems for the next 10 days, according to the plan cycle.
- ▲ Developed improved drills checklists (SOLO and Stopemate)
- ▲ Training for the use of the improved drills checklist was conducted by Operations trainer to operators for better quality failure reporting.
- ▲ Training for the use of the portal was conducted by Mr. Jaziel Pérez for better quality Work Requests.
- ▲ The pareto study will be the base for better planning





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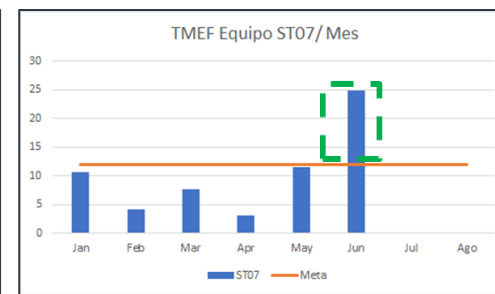
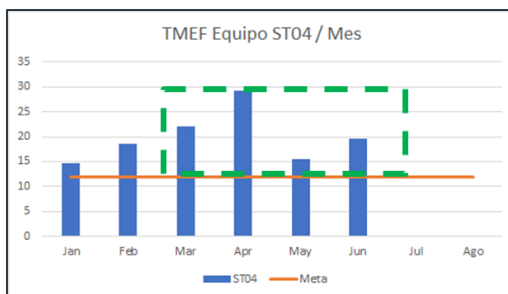
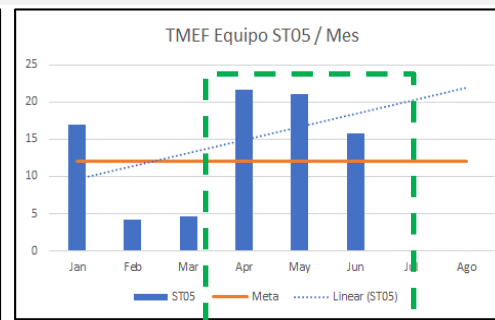
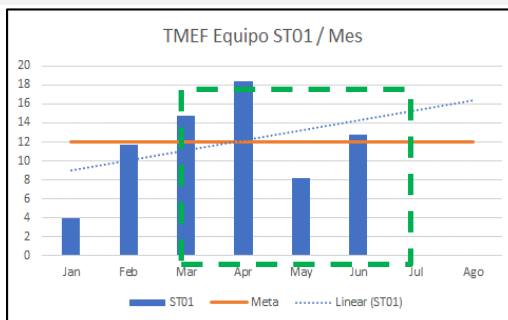
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## Bad Actor Equipment ID and Management *(continued)*

- ▲ By June, the preventive maintenance plan was loaded with fewer Work Requests for some scoops.
- ▲ An increase in their reliability is reflected because they are the ones that received the most attention and with more detail in previous weeks according to the Bad Actors Identification analysis. Their notices are linked to quality pre-inspections (Pre-PM) directly connected to supervisors.
- ▲ As of June, ST05 has an availability of 85% above the goal of the goal (84%), which shows and confirms an increase in its reliability. (79% average).
- ▲ For this same period, there was a 16-hour corrective maintenance plan for ST04 with pre-inspections and regular services of 125 Hr / 250Hr.
- ▲ For ST07 with pre-inspections and regular services of 125 Hr with 23 work orders during June and a part of July for corrective, positively impacting reliability.
- ▲ For week 27 ST04 has an availability of 91% and ST07 of 95% above the goal of the goal (84%), which shows and confirms an increase in its reliability. (93% average).



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## Improved Planning System and Supply Chain Stockout Model

### Issue

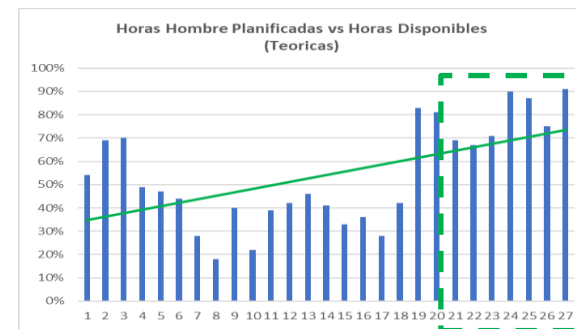
Planning area was only planning for 62% of the available man hours of the crew. The man-hour source to assign preventive work, was based on standard times that did not reflected real times of execution. (Variability was 20% between plan vs actual man hours).

### The Team Approach

Boosted proper manloading and raised to 78% when building the 10 day cycle plan. Based on the Bad Actor Management Methodology, the plan is filled out with relevant work for focused equipment. Less reactive work and more preventive and programmed corrective work is being executed,

## Actions Taken

- ▲ Daily PM / CM Compliance tool installed for supervisory force behavioral change and leverage the sense of urgency within the whole crews. Increased from 40% to 80% daily compliance for the last week of July.
- ▲ Relevant work in a 10 day cycle has been loaded to the plan impacting the performance and reliability of different equipment.
- ▲ Weekly attainment metric also installed achieved 83% for the last week in July.
- ▲ With a man load plan of 91%, we have achieved 791 hours of real executed work.
- ▲ Introduced daily intern-shift planner and supervisor meeting enhancing communication and increased effectiveness related to Work Order Cycle and Parts.
- ▲ Planner Routine was generated and socialized. Still there is a yellow flag due to the fact that some of the new activities related to the new processes don't fit timewise. A need of reinforcement by bringing interns to help the team prevails.



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## Improved Planning System and Supply Chain Stockout Model (*continued*)

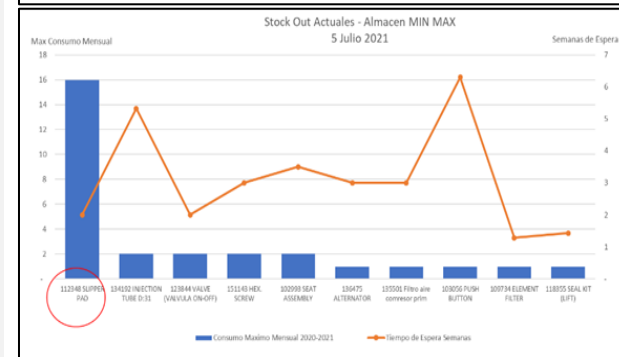
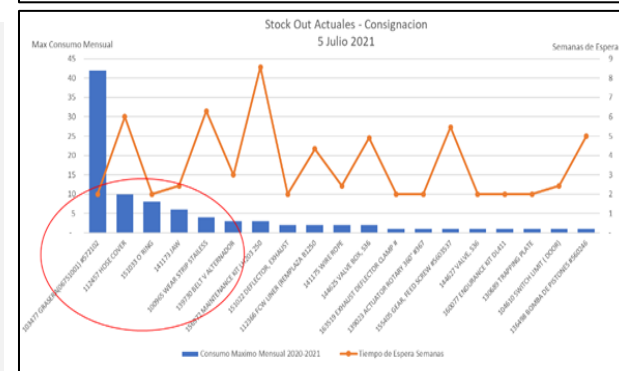
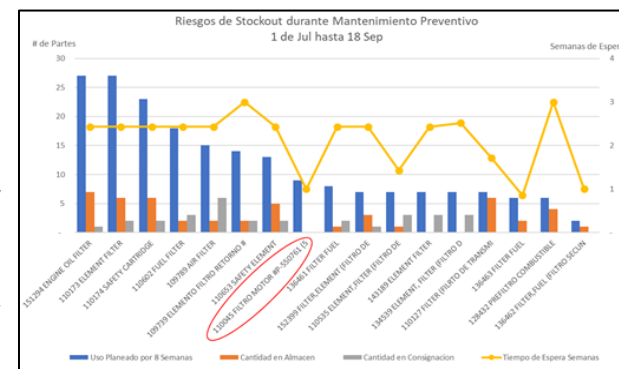
### Issue

Based on The Team observations during the Feasibility Study, Supervisors spent the largest portion of their shift searching for, getting, and delivering parts to the Maintenance Crews, or Admin. time on work orders. Sometimes SAP system reported existence of an item that was actually not in inventory.

Because parts and materials are not often kit and staged, Crew Members and Supervisors are often spending NVA time looking for parts and materials.

## Actions Taken

- ▲ Contributed to Min-Max definition for Sandvik Stock (Strategic and Non strategic Parts).
- ▲ Stockout model implemented for stockout risk periodical analysis. The model interacts within the 8 week PM projection for Preventive Maintenance. This model was also used for Sandvik consignment parts.
- ▲ Thanks to the model no lack of parts for Hourly PM for equipment has been raised.
- ▲ Finally, developed some inventory control studies in which the opportunity of lower inventory levels by \$1M, with the same level of service at 99%.
- ▲ Service level is set to 99%. This represents a 1% likelihood of stockout of any given part based on the standard deviations of statistical historical consumption patterns and lead times.





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## Pre-PM and Perfect PM Model / PM Routines Reinforcement

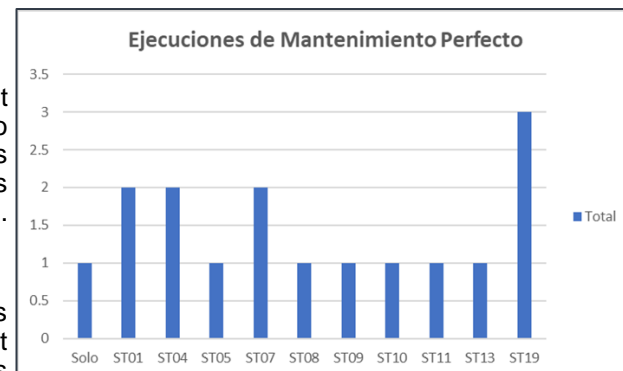
Even though the routine for hourly PM has been consistent throughout 2020 for equipment, compliance was low due to reactive work and lack of parts. Kitting process for PM work was not in place at that moment. 39% of the backlog work was attributed to “waiting on parts” status within warehouse. (November 2020).

## The Team Approach

Installed a Pre-PM process two weeks prior to a PM that allows to have every part needed in place and additional relevant corrective work from Backlog. Perfect PM concept implies parts sufficiency, productivity and efficiency by having kits ready in a designed shop area to be used but also all the work needed to ensure reliability and availability.

## Actions Taken

- ▲ 8 Week projection developed to be able to forecast due dates of every equipment.
- ▲ Bad Actor Management Pareto's review process is executed to be able to prioritize equipment that need more attention. Then Kit Parts verification process and provisioning is conducted.
- ▲ Pre-PM prototype process installed including more robust inspections in order to define additional work.
- ▲ Achieved compliance of 15/15 equipment through the Pre-PM process and 100% of compliance for the first 9 equipment enrolled in the Perfect PM program. Zero lack of parts status achieved.
- ▲ Kitting process in place for all Scheduled Perfect-PM work.
- ▲ The planners have been given a calendar with the routine of actions to be completed prior to the services. Add object cause Pareto's to the Pre - MP in order to review the areas with the greatest failures to generate new Work Requests that resolve these problems .

[illegible]

# Constructed and implemented an enhanced Maintenance Management Operating System (MMOS) for FMS Diesel Mobile Maintenance.

## Key Objectives

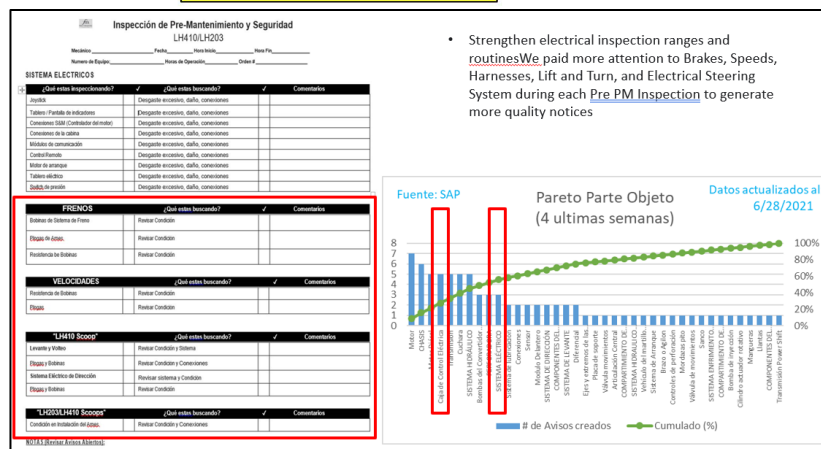
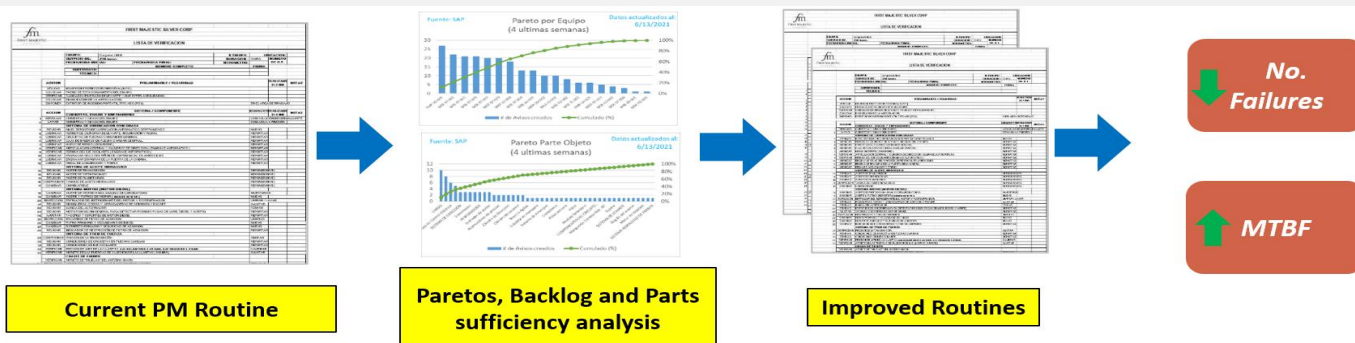
- ▲ To improve efficiency, predictability and reliability within the Mobile Maintenance area and equipment.
- ▲ To improve Maintenance planning and operational effectiveness.
- ▲ The delivery of the training and coaching required to enable the changes in behavior needed to ensure the sustainability of the operational improvements.

## Results up to Week 16

- ▲ Achieved Short range drilling availability to 93% for June. 9 points above the target, and long range drilling availability to 87% for June. 3 points above the target.
- ▲ Achieved MTBF 17 hours for June. 5 points above target.
- ▲ Early Shifts Inspection Program has generated 44 minute average of additional potential scoop utilization.
- ▲ 3.33% of real utilization for Scoops generated by improved shift management initiatives.
- ▲ Established a 40 min std effective inspections.
- ▲ Achieved 100% lubrication compliance for drills for the first time and 100% for scoops for 3 weeks.
- ▲ Manloading has raised to 77% avg. from 40% before generating 700 MH avg of real executed hours.
- ▲ 100% Pre-PM and Perfect PM compliance for equipment.

## Pre-PM and Perfect PM Model / PM Routines Reinforcement (*Continued*)

- ▲ Once a failure is detected after a PM a revisión process has been installed in order to identify gaps within the initial inspection. For instance, electrical system and hidraulic leaks revision were not included in some cases.
- ▲ ACR conducted and PM routines are reinforced with pertinent work related to the previous analysis.



## New Improved PM Routines (Electrical part added)

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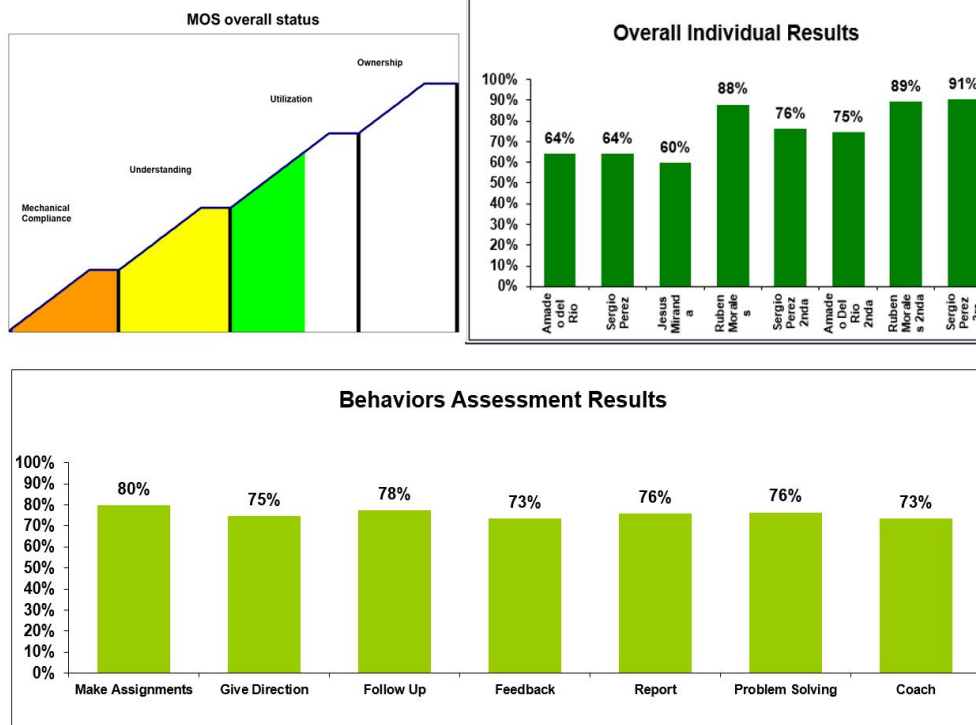
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## MMOS Audit System

- ▲ Audit System installed for Supervisors.
- ▲ Planners Audit System at 80%
- ▲ Two of the supervisors are already in the Ownership phase.

## Preliminary Sustainability Audit for the Rapid Results phase



## Observations:

- The supervisors have changed their habits when using the installed tools.
- Sergio Pérez was the supervisor evaluated this week in Shift 1. For the third time. He has shown slight improvement.
- The rest of the audits are being populated by system.

**New improved PM Routines (Electrical part added)**



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## Other Activities

### Program 5's and Project for Signage and Parking Management Improvement



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## Other Activities

**Pit Stop Green Flag System for communication improvement using visual Aid.**



100% Cumplimiento del Sistema de ayuda visual utilizando Conos Rojos y Verdes





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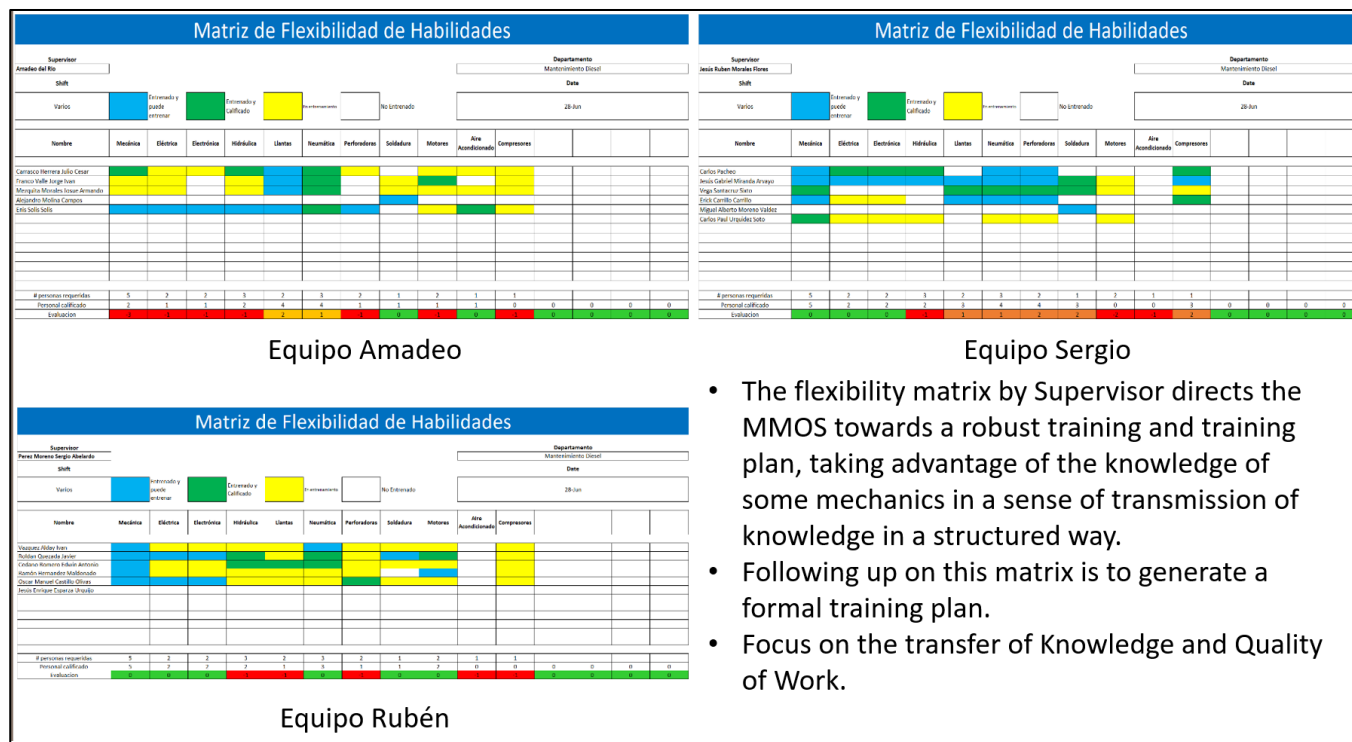
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## Other Activities

### Flexibility Matrix to Develop an improved Training Competences Program .



- The flexibility matrix by Supervisor directs the MMOS towards a robust training and training plan, taking advantage of the knowledge of some mechanics in a sense of transmission of knowledge in a structured way.
- Following up on this matrix is to generate a formal training plan.
- Focus on the transfer of Knowledge and Quality of Work.