

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.



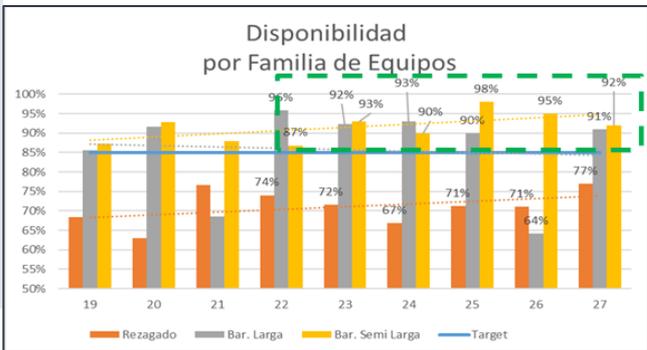
Key Objectives

- ▲ 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.

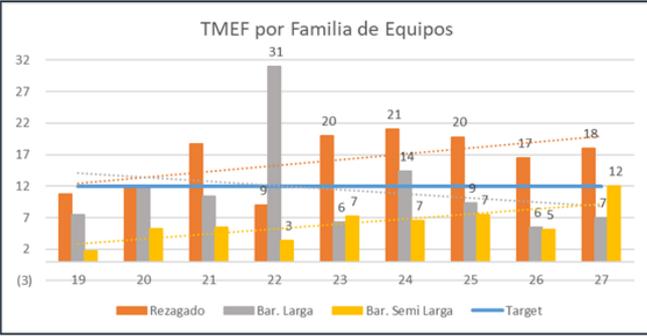
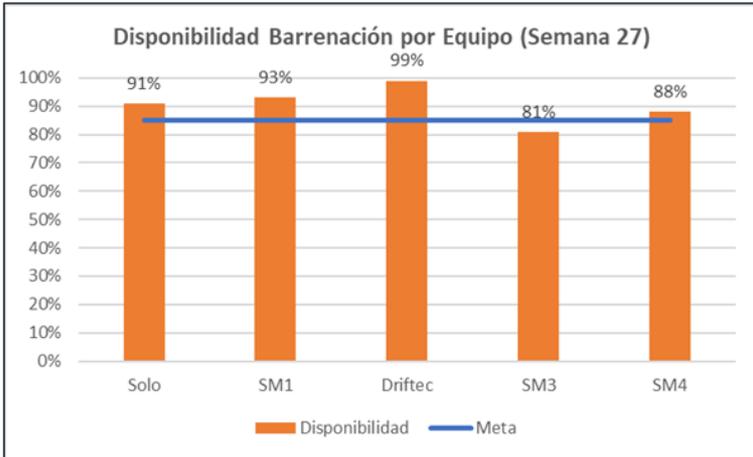
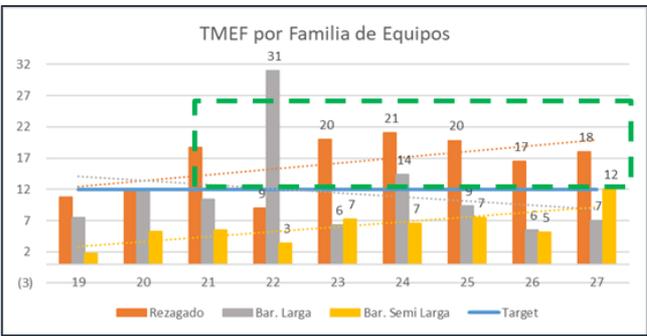
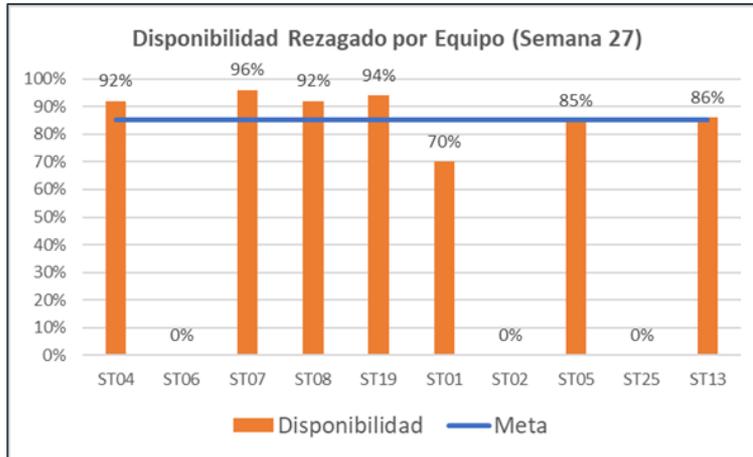
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Reliability and Availability Overall Results



Availability Results Week 27



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Opportunity

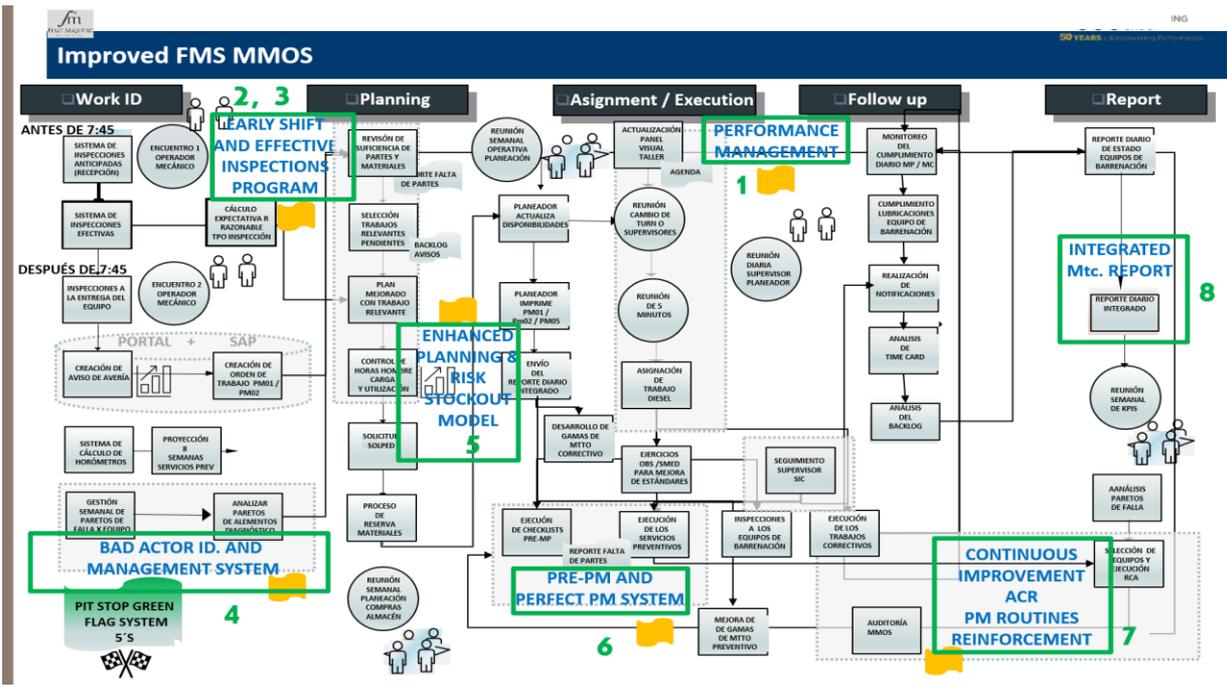
FMS Maintenance Management Operating System needed to be enhanced to ensure the right maintenance in the most efficient manner for the most critical mobile equipment (Drills and Scoops).

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.

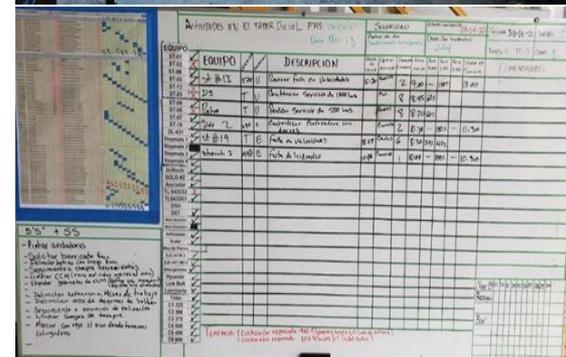
The Team Approach

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 in to 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 DE INICIO	FECHA DE FIN	TIPO DE TRABAJO
1
2
3
4
5
6
7
8
9
10



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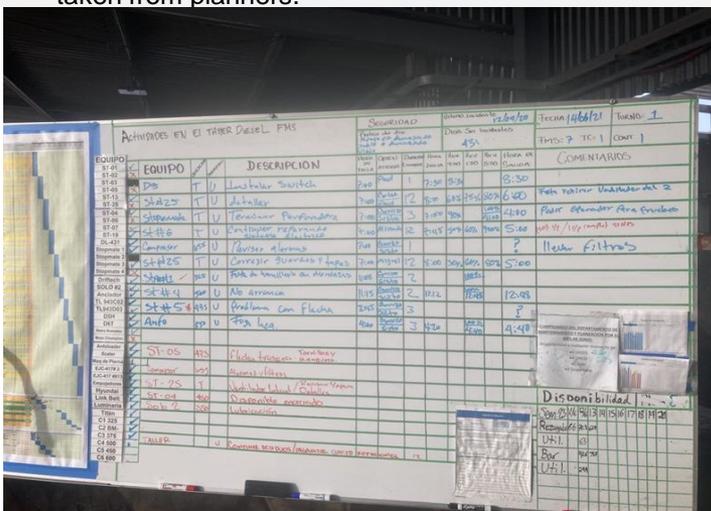
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Performance Management focused in improving data entry and better information flow *(continued)*

- ▲ 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.



Reporte Integrado de Mantenimiento Diesel															
Jun 21															
Días: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15															
Disponibilidad Barreración	%	97.2%	82.5%	94.2%	96.7%	92.9%	85.0%	87.5%	85.4%	78.3%	76.7%	75.0%	77.5%	74.2%	77.4%
Disponibilidad Resagado	%	69.2%	69.2%	75.4%	79.8%	78.6%	72.7%	71.9%	76.6%	64.8%	65.8%	63.5%	70.8%	67.3%	70.2%
Disponibilidad Acarreo	%														
Disponibilidad Eq's Prod Mina	%	83.2%	75.8%	84.8%	88.2%	85.8%	78.8%	79.7%	81.0%	71.5%	71.1%	69.3%	74.2%	72.4%	73.8%
Disponibilidad Superficie	%	80.4%	85.3%	81.6%	86.9%	85.2%	86.3%	83.6%	84.6%	82.4%	76.5%	74.8%	69.8%	69.9%	70.1%
Disponibilidad Servicios Mina	%	95.8%	98.6%	98.6%	95.8%	95.8%	94.4%	94.4%	81.3%	83.3%	80.6%	78.5%	95.8%	97.9%	93.8%
Disponibilidad General	%	85.6%	83.9%	87.4%	89.8%	88.1%	84.6%	84.3%	81.9%	77.2%	74.8%	72.9%	78.5%	78.2%	77.4%
Utilización Barreración	%	17.5%	6.1%	14.3%	18.5%	15.4%	4.5%	6.8%	8.5%	3.5%	5.2%	10.7%	8.6%	10.1%	5.4%
Utilización Resagado	%	47.2%	58.2%	57.3%	52.2%	48.3%	48.0%	47.1%	48.3%	60.5%	55.6%	52.5%	50.0%	59.6%	43.0%
Utilización Acarreo	%														
Utilización Eq's Prod Mina	%	32.3%	32.2%	35.8%	35.4%	31.9%	26.3%	27.0%	28.8%	32.0%	30.4%	31.6%	29.3%	34.1%	24.2%
Utilización Superficie	%	32.9%	6.5%	7.5%	7.7%	8.2%	9.9%	1.8%	10.2%	6.4%	4.2%	32.5%	5.6%	6.3%	7.1%
Utilización Servicios Mina	%	63.0%	55.1%	92.2%	89.1%	91.5%	83.4%	86.3%	68.8%	63.5%	62.0%	67.6%	79.0%	98.6%	41.5%
Utilización General	%	34.7%	31.5%	42.8%	41.9%	40.8%	38.9%	39.8%	34.0%	33.2%	31.3%	40.8%	35.8%	43.3%	32.4%
INDICADORES DE NEGOCIO															
UM															
Toneladas Extraídas Eq's PM	1	637	877	715	581	915	797	1,105	720	997	1,001	1,021	1,053	1,088	994
Costos	02	9,086	8,626	8,424	8,580	8,281	9,129	9,379	8,040	7,300	9,305	9,219	9,518	8,528	9,581
Costo Real de Mantenimiento	5mm	266	285	58,675	58,713	58,803	62,639	112,963	113,279	113,771	115,472	173,811	125,796	127,237	232,241
Costo Presupuestado	5mm	300,249	300,249	300,249	300,249	300,249	300,249	300,249	300,249	300,249	300,249	300,249	300,249	300,249	300,249
Cumplimiento Costo	%	0.1%	0.1%	19.5%	19.6%	20.9%	37.6%	37.7%	37.9%	38.5%	57.9%	75.2%	75.7%	77.6%	86.4%
Costo / Ore	\$	0.00	0.00	7.9	6.8	7.8	6.9	12.0	14.1	14.4	12.1	15.9	23.7	26.6	24.3
Costo / Ton Ext.	\$	0.4	0.3	82.1	109.1	64.3	78.6	102.2	157.3	114.1	104.9	170.2	214.4	208.9	234.3
SEMANAS															
Def	1	9	16	23											
AL	8	15	22	30											
DESEMPEÑO EQ'S DIESEL															
UM	51	52	53	54	55	Acum									
TMEF Barreración	hrs	6.5	6.5			6.5									
TMEF Resagado	hrs	18.2	17.1			17.7									
TMEF Acarreo	hrs														
TMEF Eq's Prod Mina	hrs	22.4	11.8			17.1									
TMEF Superficie	hrs	18.2	40.5			29.4									
TMEF Servicios Mina	hrs	450.0	213.0			336.5									
Reporte Seguridad Desempeño Gestión Negocio															

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Early Shift Inspections and Effective Inspections Programs Issue

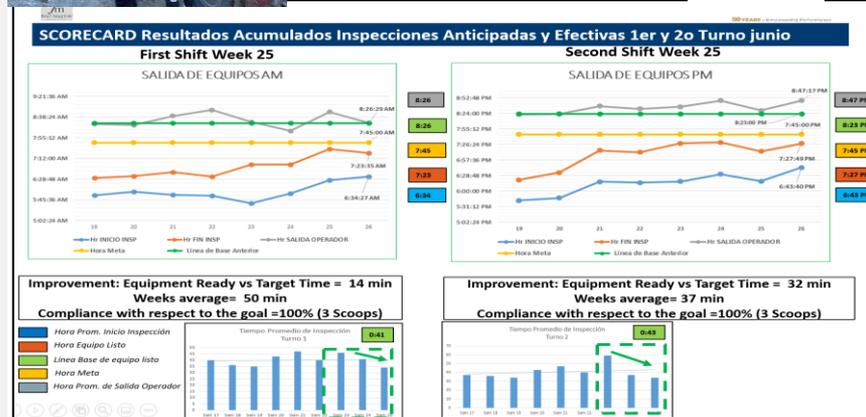
Formal Pre-Op Inspection workflow process and inspection-lubrication procedures varied in how executed. Mechanics were not fully loaded at the beginning of their shift after 7:00 toolbox meeting, and did not have goals or reasonable expectation standard times for an effective inspection.

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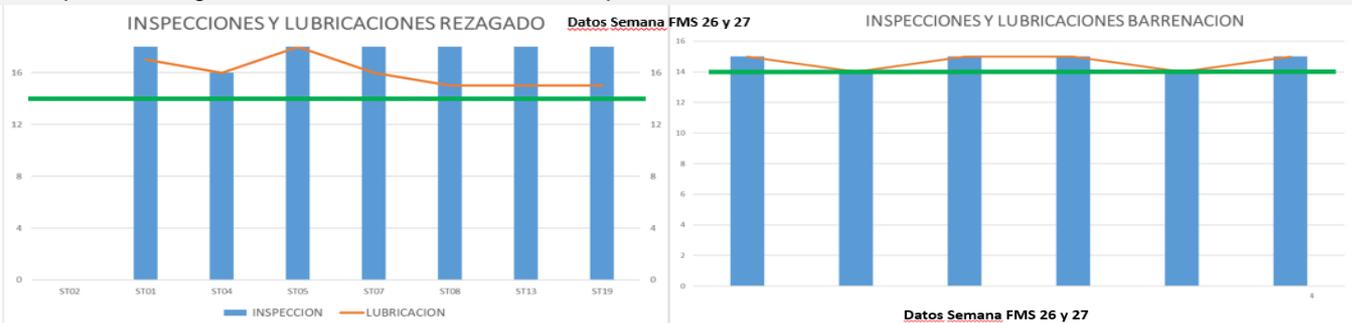
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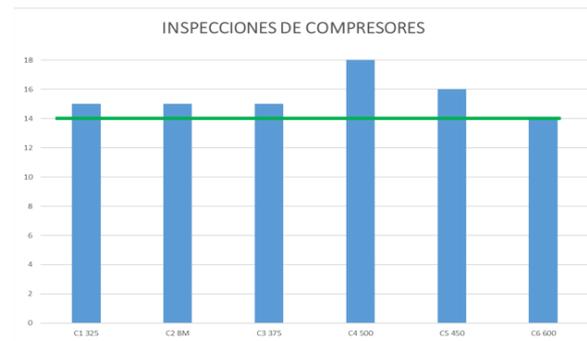
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Early Shift Inspections and Effective Inspections Programs (*Continued*)

- ▲ 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.



EQUIPO	LUNES			Martes			Miércoles			Jueves			Viernes			Sábado			Domingo			
	insp	lub	man	insp	lub	man	insp	lub	man	insp	lub	man	insp	lub	man	insp	lub	man	insp	lub	man	
ST01																						
ST02																						
ST04																						
ST05																						
ST07																						
ST08																						
ST13																						
ST14																						
ST25																						
Equipamnt																						
C16 325																						
SPRINT4																						
Drinch																						
Solo2																						
Arndor																						
C1 325																						
C2 314																						
C3 375																						
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C5 450																						
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CF																						



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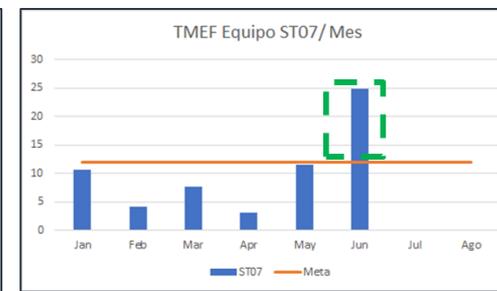
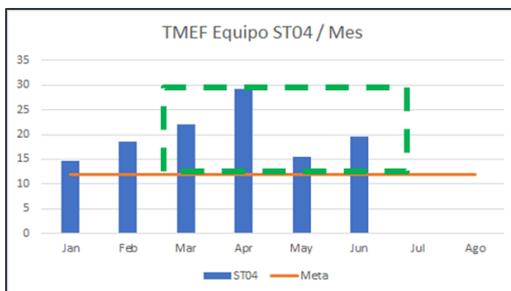
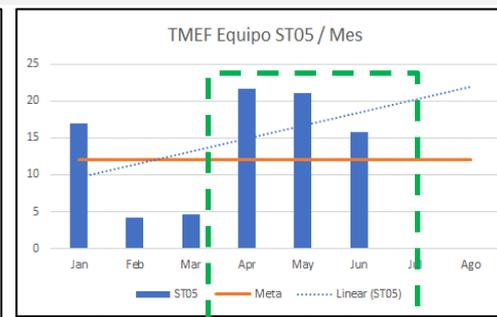
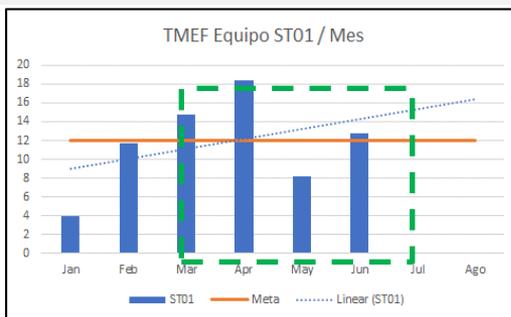
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Bad Actor Equipment ID and Management *(continued)*

- ▲ 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

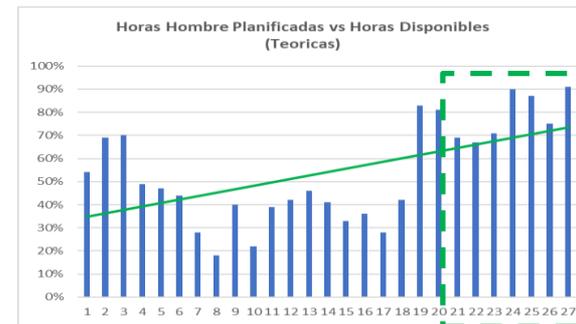
Planning area was only planning for 62% of the available man hours of the crew. The man-hour source to assign preventive work, was based on standard times that did not reflected real times of execution. (Variability was 20% between plan vs actual man hours).

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*)

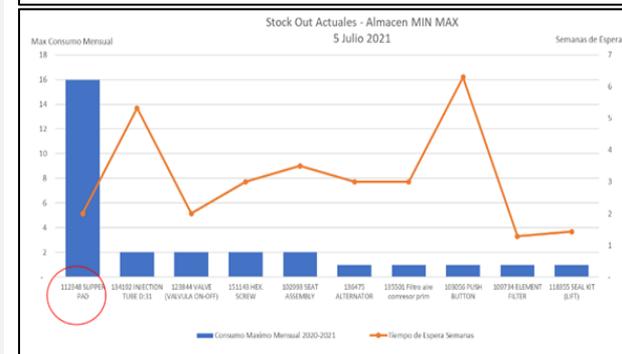
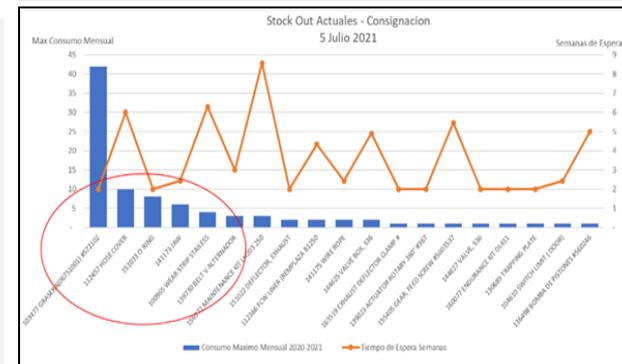
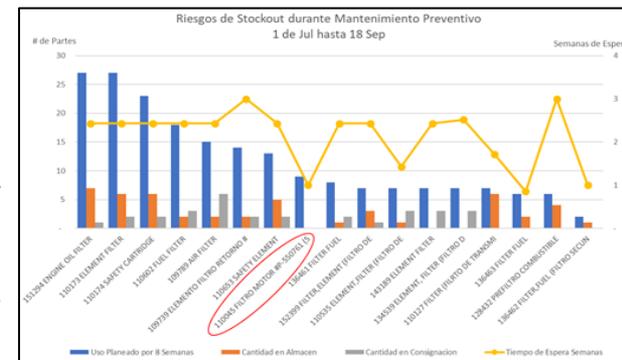
Issue

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.



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

Key Objectives

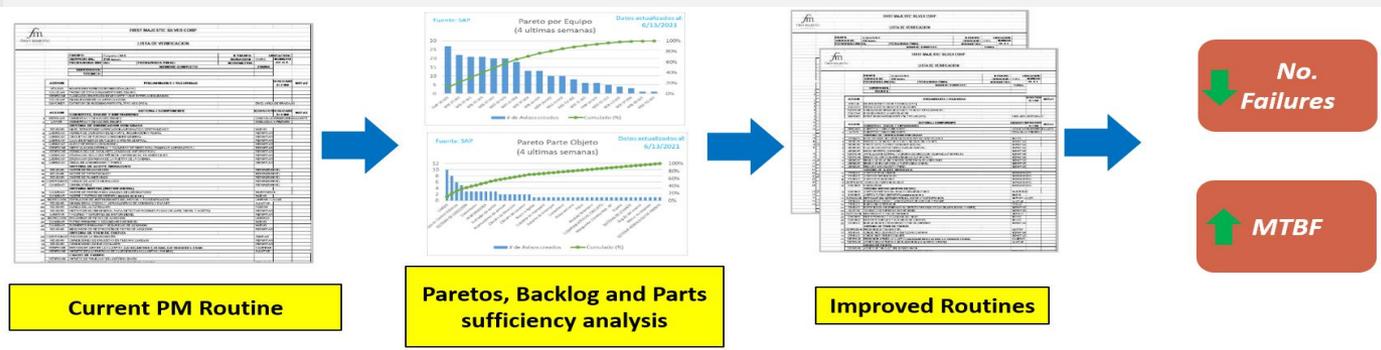
- ▲ To improve efficiency, predictability and reliability within the Mobile Maintenance area and equipment.
- ▲ To improve Maintenance planning and operational effectiveness.
- ▲ The delivery of the training and coaching required to enable the changes in behavior needed to ensure the sustainability of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



Inspección de Pre-Mantenimiento y Seguridad
LH410LH203

¿Qué está inspeccionando?	¿Qué está buscando?	Comentarios
SISTEMA ELECTRICOS		
Check	Diagnostico excesivo, falta conexiones	
Tablero Placa de indicaciones	Diagnostico excesivo, falta conexiones	
Conexiones (Batería Controlador de velocidad)	Diagnostico excesivo, falta conexiones	
Conexiones de la cabina	Diagnostico excesivo, falta conexiones	
Estados de comandos	Diagnostico excesivo, falta conexiones	
Control de frenos	Diagnostico excesivo, falta conexiones	
Sistema de arranque	Diagnostico excesivo, falta conexiones	
Tablero eléctrico	Diagnostico excesivo, falta conexiones	
Cableado de arranque	Diagnostico excesivo, falta conexiones	
FRENOS		
Estado de Sistema de Frenos	Revisar Condicion	
Etapas de frenos	Revisar Condicion	
Presion de los frenos	Revisar Condicion	
VELOCIDADES		
Presion de las baterias	Revisar Condicion	
Etapas	Revisar Condicion	
"LIMITO Scoop"		
Control de Velocidad	Revisar Condicion	
Etapas de frenos	Revisar Condicion y Conexiones	
Sistema Electrico de Dirección	Revisar sistema y Conexiones	
Etapas de frenos	Revisar Condicion	
"LIMITO HAYO Scoop"		
Control de Velocidad	Revisar Condicion y Conexiones	

- Strengthen electrical inspection ranges and routines. We paid more attention to Brakes, Speeds, Harnesses, Lift and Turn, and Electrical Steering System during each Pre PM Inspection to generate more quality notices

New Improved PM Routines (Electrical part added)

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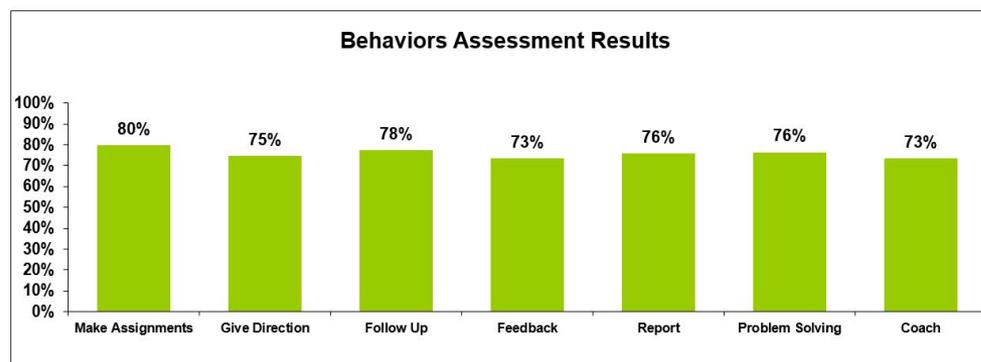
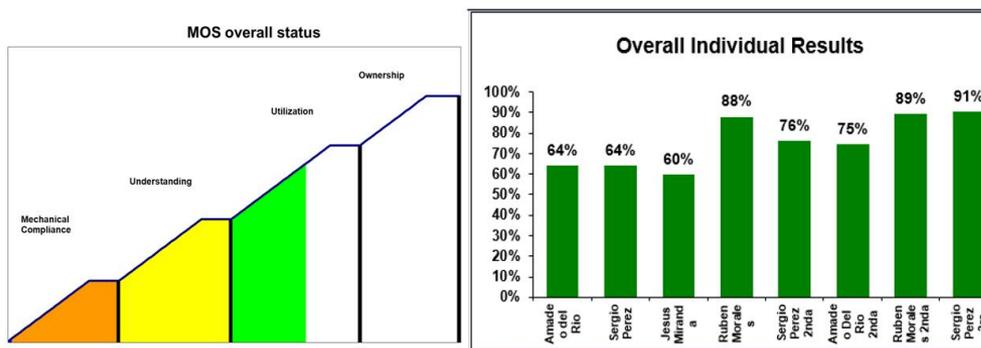
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MMOS Audit System

- ▲ 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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Other Activities

Flexibility Matrix to Develop an improved Training Competences Program .

Matriz de Flexibilidad de Habilidades

Supervisor: Departamento: Mantenimiento Diesel

Area del Rio: Date: 28 Jun

Shift:

Valores: Externado y desde exterior Externado y Calificado Externado No Externado

Nombre	Medicina	Electrica	Electronica	Hidraulica	Llantas	Neumatica	Perforadora	Soldadura	Motors	Aire Acondicionado	Compresores
Carlos Herrera Jelic Cesar											
Francis Valle Jorge Juan											
Miguel Morales Oscar Amador											
Alfonso Moller Carlos											
Este solo solo											
# personas requeridas	5	2	2	3	2	3	2	1	2	1	1
Personal calificado	2	1	1	2	4	4	1	1	1	0	0
Utilizacion											

Equipo Amadeo

Matriz de Flexibilidad de Habilidades

Supervisor: Departamento: Mantenimiento Diesel

Area del Rio: Date: 28 Jun

Shift:

Valores: Externado y desde exterior Externado y Calificado Externado No Externado

Nombre	Medicina	Electrica	Electronica	Hidraulica	Llantas	Neumatica	Perforadora	Soldadura	Motors	Aire Acondicionado	Compresores
Carlos Pacheco											
José Gabriel Miranda Arango											
Yago Santacruz Soto											
Eric Cardel Carmona											
Miguel Alberto Morales Valdez											
Carlos Paul Urzuaes Ibar											
# personas requeridas	5	2	2	3	2	3	2	1	2	1	1
Personal calificado	5	2	2	2	3	4	4	1	0	0	0
Utilizacion											

Equipo Sergio

Matriz de Flexibilidad de Habilidades

Supervisor: Departamento: Mantenimiento Diesel

Area del Rio: Date: 28 Jun

Shift:

Valores: Externado y desde exterior Externado y Calificado Externado No Externado

Nombre	Medicina	Electrica	Electronica	Hidraulica	Llantas	Neumatica	Perforadora	Soldadura	Motors	Aire Acondicionado	Compresores
Vladimir Alvarado											
Roberto Ojeda Lopez											
Carlos Roberto Alvarado											
Alfonso Hernandez Maldonado											
Osvaldo Manuel Cardozo Ojeda											
José Enrique Casero Ibarra											
# personas requeridas	5	2	2	3	2	3	2	1	2	1	1
Personal calificado	5	2	2	2	1	0	1	2	0	0	0
Utilizacion											

Equipo Rubén

- 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.