BTECH

FINAL YEAR PROJECT
PROGRAMME 2023

Project on:

Drill spare consumption and measures for reduction

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OBJECTIVES

To study the spare parts consumption in Cost-Cap and In-house maintained drills

To study the over use of sub-assemblies by FMC based drills

Suggesting measures to reduce the consumption of spare parts

Predictive analysis of most consumed spare using Tableau

3 Agreement under which all the Drill Machine run in both Q-AB & Q-SEB

In-House Maint.

- Full maintenance provided by TSL
- Spares provided by TSL Inventory
- Operational Failure/Accidental Damage is sole responsibility of TSL
- 2K03,2K04,2K05

Cost-Cap

Cost-Cap Sup

- Maintenance by TSL
- Spares, GETs, Sub-assemblies provided by REL
- Cost credited on Fixed cost of Spares and Sub-assemblies, meterage of GETs. Fixed Cost for certain period i.e. 10years
- 2K07,2K08,2K09

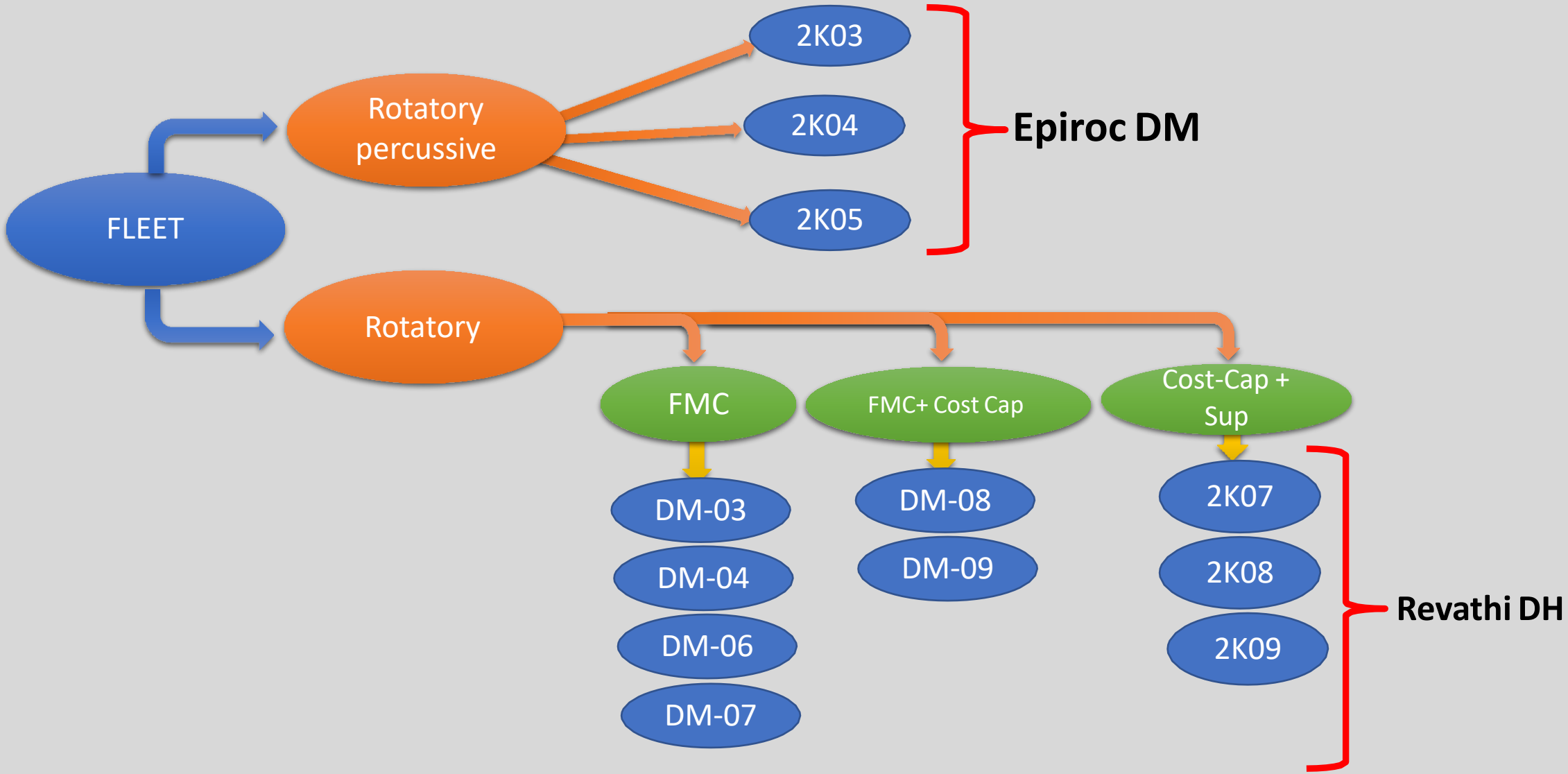
FMC+Cost-Cap

- Maintenance by REL
- Spares, GETs, Sub-assemblies provided by REL
- Cost credited on Fixed cost of Spares and Sub-assemblies, meterage of GETs (DM08,DM09)

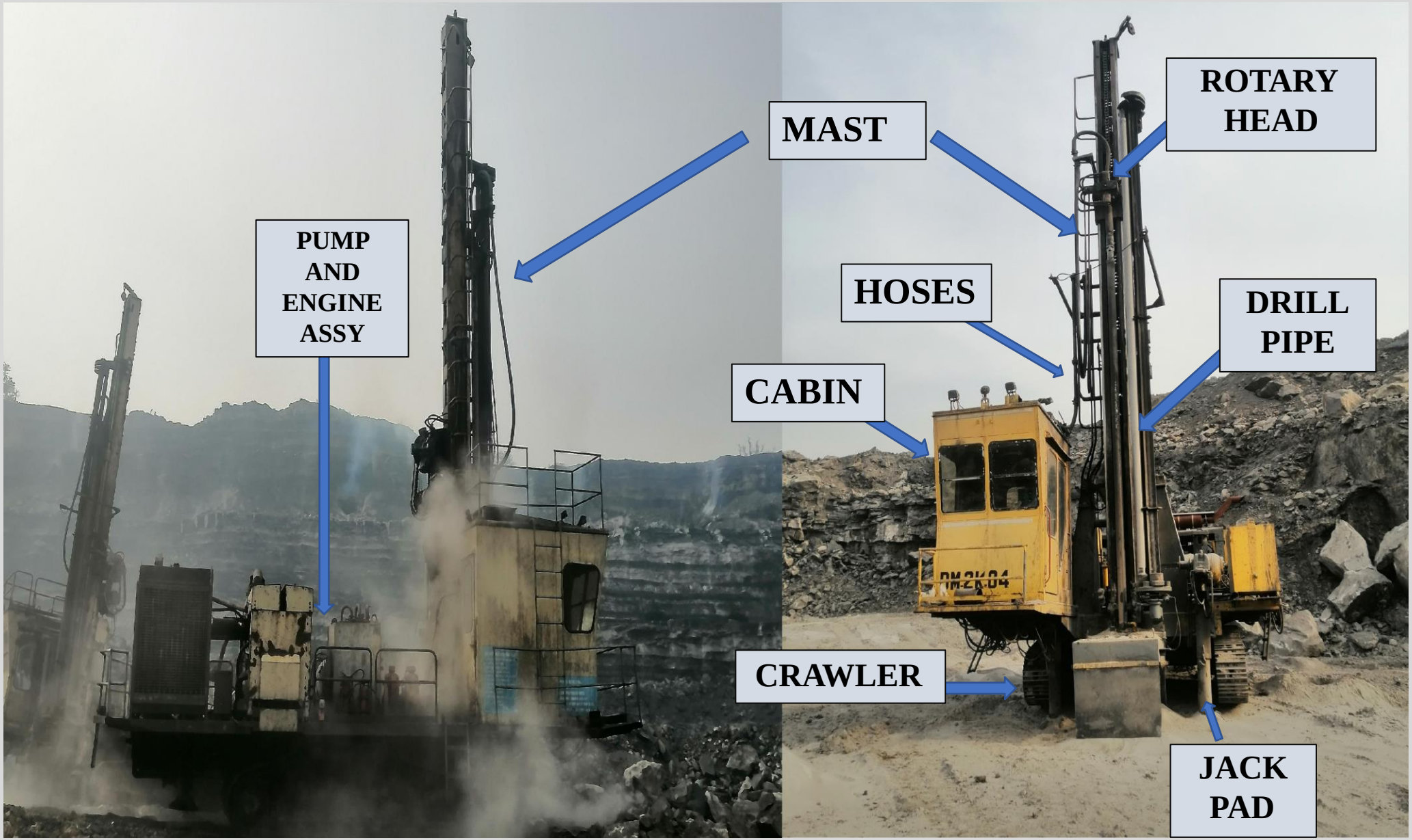
FMC

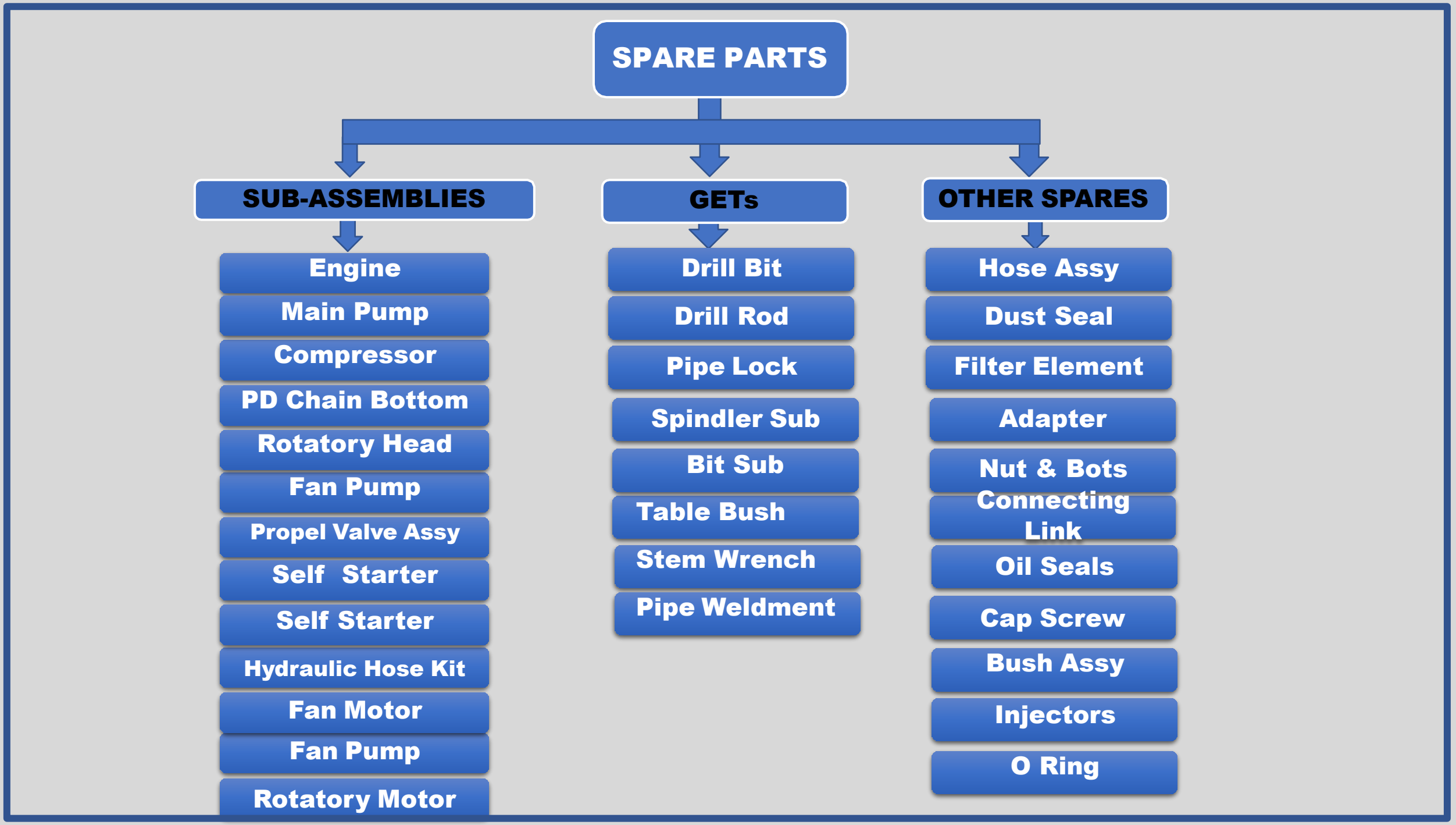
- Full maintenance provided by Revathi
- Spares, GETs, Sub-assemblies provided by Revathi Inventory
- Operational Failure/Accidental Damage is sole responsibility of TSL
- Cost is credited on run hour and manpower for onsite maintenance
- DM03,DM04,DM06,DM07

Drill Machine fleet in both Q-AB and Q-SEB

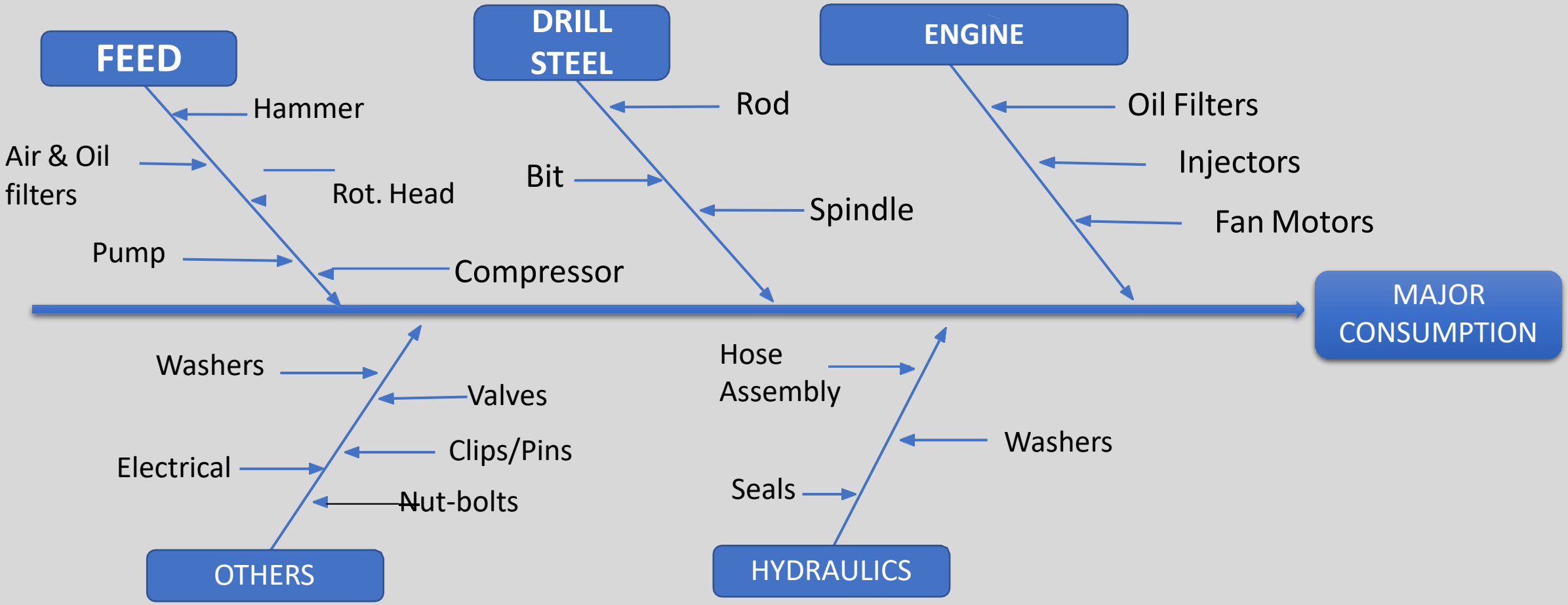


Section of drill with most consumed spares



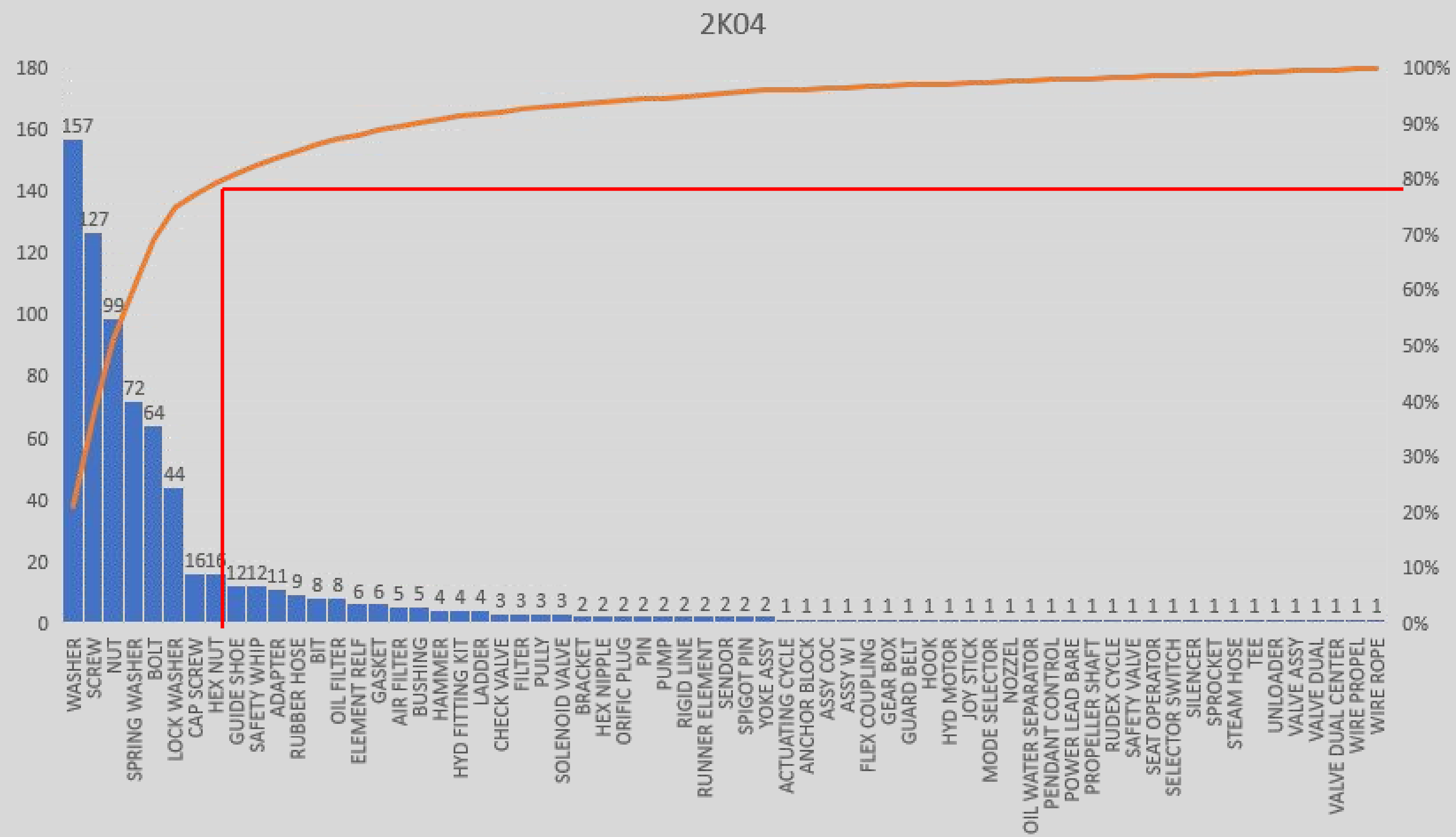

SPARE PARTS
SUB-ASSEMBLIES
Engine
Main Pump
Compressor
PD Chain Bottom
Rotatory Head
Fan Pump
Propel Valve Assy
Self Starter
Self Starter
Hydraulic Hose Kit
Fan Motor
Fan Pump
Rotatory Motor
GETs
Drill Bit
Drill Rod
Pipe Lock
Spindler Sub
Bit Sub
Table Bush
Stem Wrench
Pipe Weldment
OTHER SPARES
Hose Assy
Dust Seal
Filter Element
Adapter
Nut & Bots
Connecting Link
Oil Seals
Cap Screw
Bush Assy
Injectors
O Ring

Representation of consumable spares grouped separately



SPARE CONSUMPTION REPORT OF 2K04(IN-HOUSE MAINTAINED DRILL) FOR FY'21

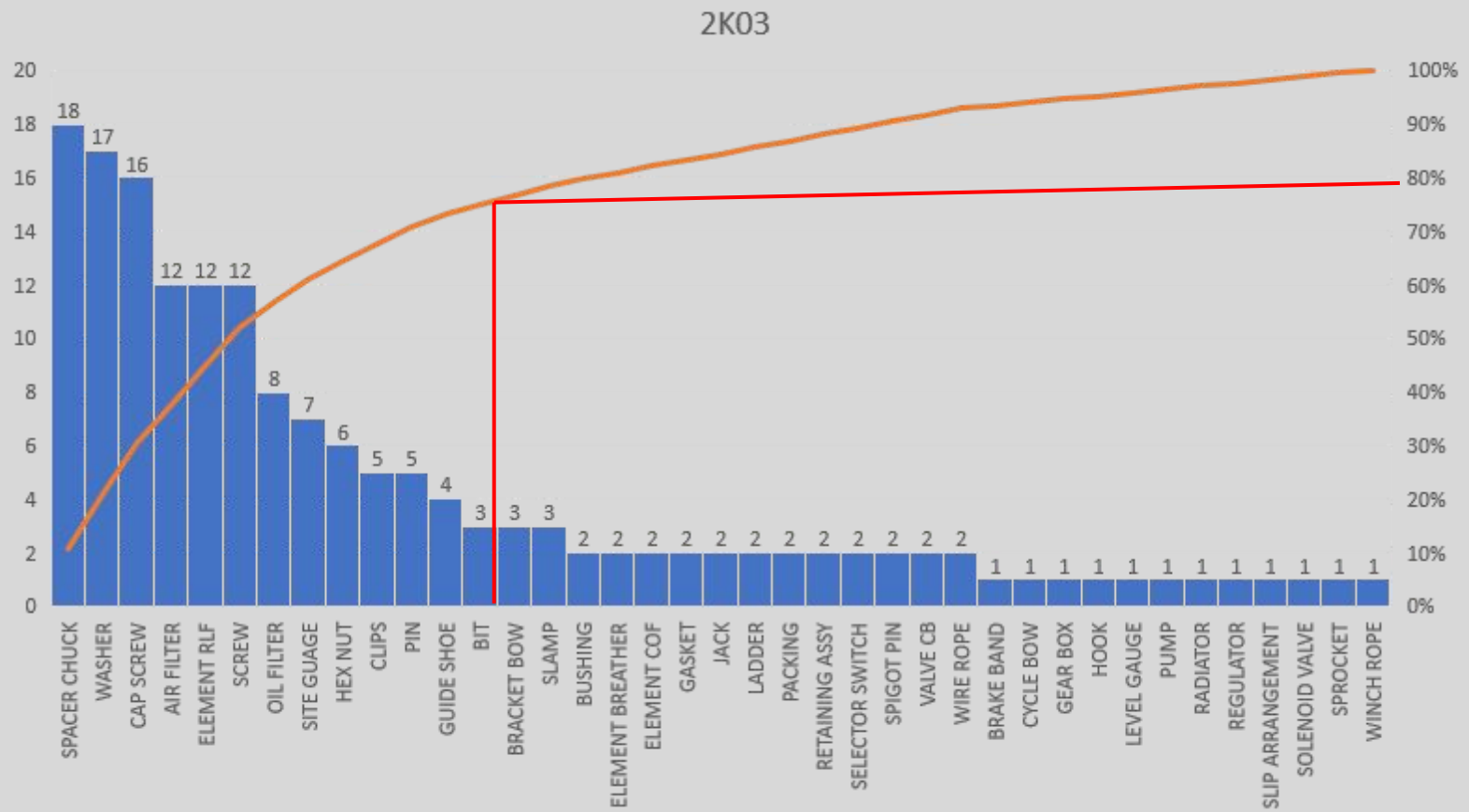
PARTS	QTY
WASHER	157
SCREW	127
NUT	99
SPRING WASHER	72
BOLT	64
LOCK WASHER	44
CAP SCREW	16
HEX NUT	16
GUIDE SHOE	12
SAFETY WHIP	12
ADAPTER	11
RUBBER HOSE	9
BIT	8
OIL FILTER	8
ELEMENT RELF	6
GASKET	6
AIR FILTER	5
BUSHING	5
HAMMER	4



- Here top 80% of spare consumption of drill are very basic equirement of the operation i.e. washer, nut and bolts
- Aim is to analyse the consumption of Bits, Adapters and drill rod
- Here, consumed number of part by the drill
    - **ADAPTER-9**
    - **BITS-8**

SPARE CONSUMPTION REPORT OF 2K03(IN-HOUSE MAINTAINED DRILL) FOR FY'21

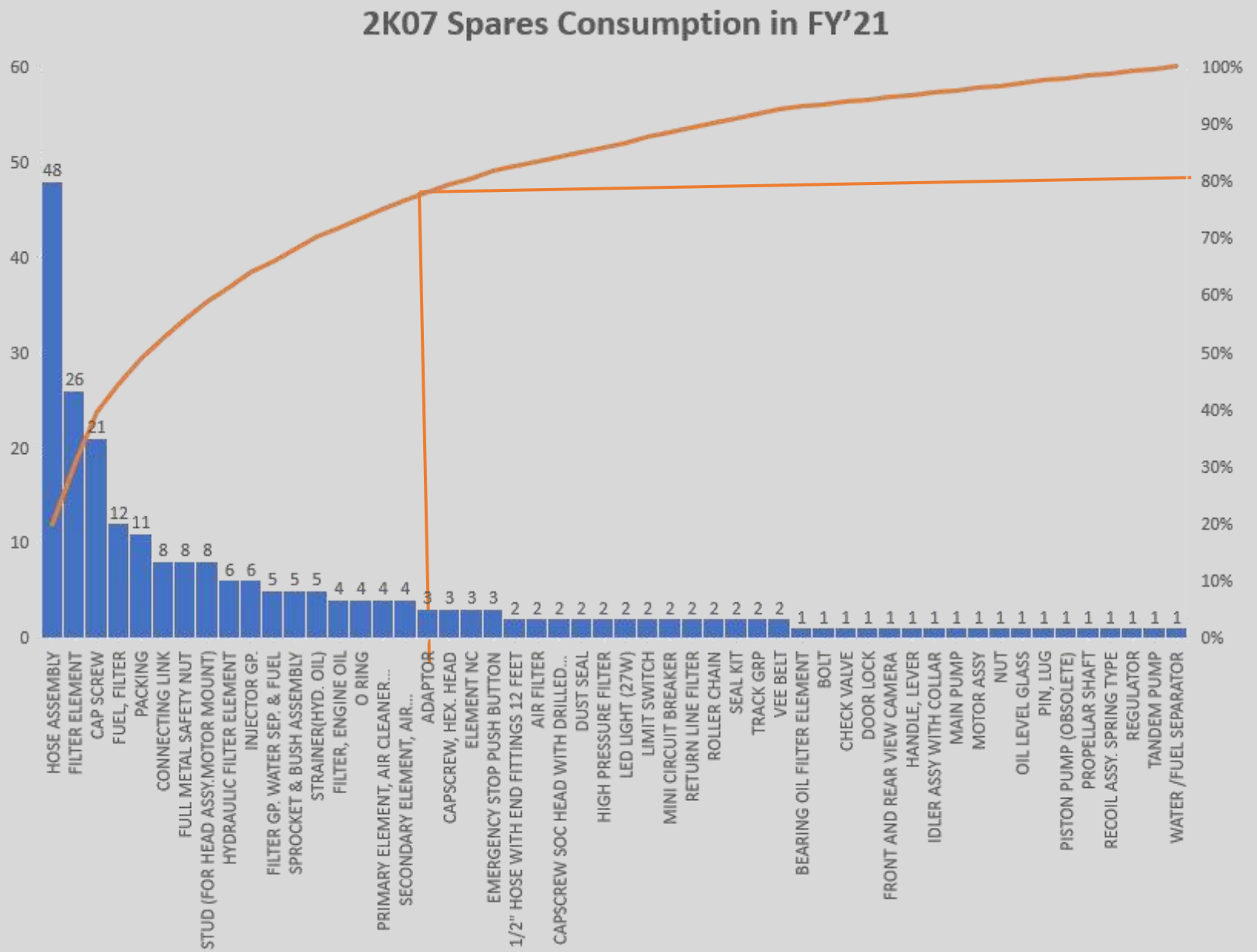
PARTS	QTY
SPACER CHUCK	18
WASHER	17
CAP SCREW	16
AIR FILTER	12
ELEMENT RLF	12
SCREW	12
OIL FILTER	8
SITE GUAGE	7
HEX NUT	6
CLIPS	5
PIN	5
GUIDE SHOE	4
BIT	3
BRACKET BOW	3
SLAMP	3
BUSHING	2



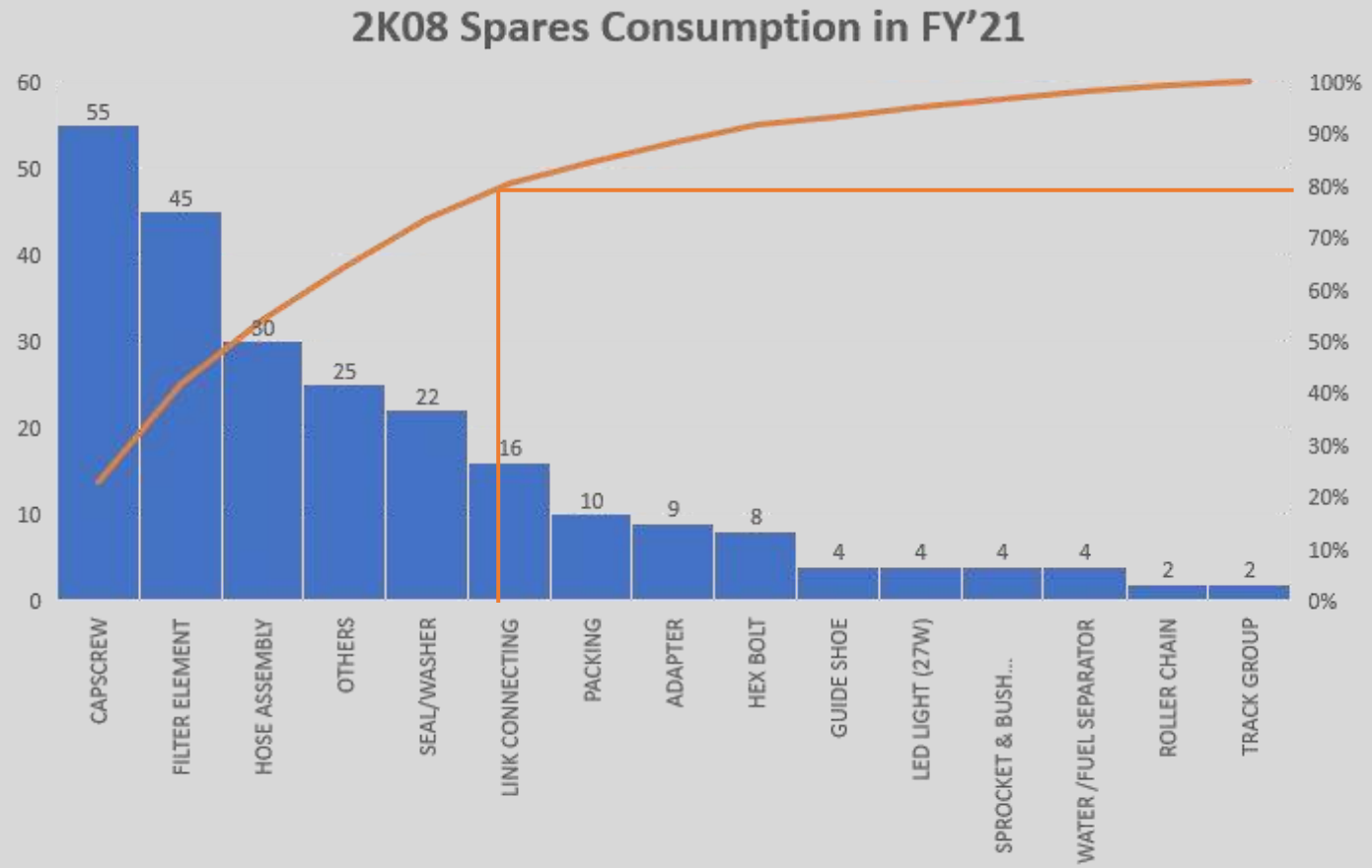
- Due to less run hour and breakdown in the month of October the spare consumption by the drill is less here
- Spacer chuck, bits and filter are of high concern here other parts are the basic requirement during operation and are also in less number

PARTS	QUANTITY (FY'21)
HOSE ASSEMBLY	48
FILTER ELEMENT	26
CAP SCREW	21
FUEL, FILTER	12
PACKING	11
CONNECTING LINK	8
FULL METAL SAFETY NUT	8
STUD (FOR HEAD ASSY.MOTOR MOUNT)	8
HYDRAULIC FILTER ELEMENT	6
INJECTOR GP.	6
FILTER GP. WATER SEP. & FUEL	5
SPROCKET & BUSH ASSEMBLY	5
STRAINER(HYD. OIL)	5
FILTER, ENGINE OIL	4
O RING	4
PRIMARY ELEMENT, AIR CLEANER (ENGINE)	4
SECONDARY ELEMENT, AIR CLEANER(ENGINE)	4
ADAPTOR	3

Pareto Analysis show the 80% of the whole spare consumption lead by Hoses and Filter Elements

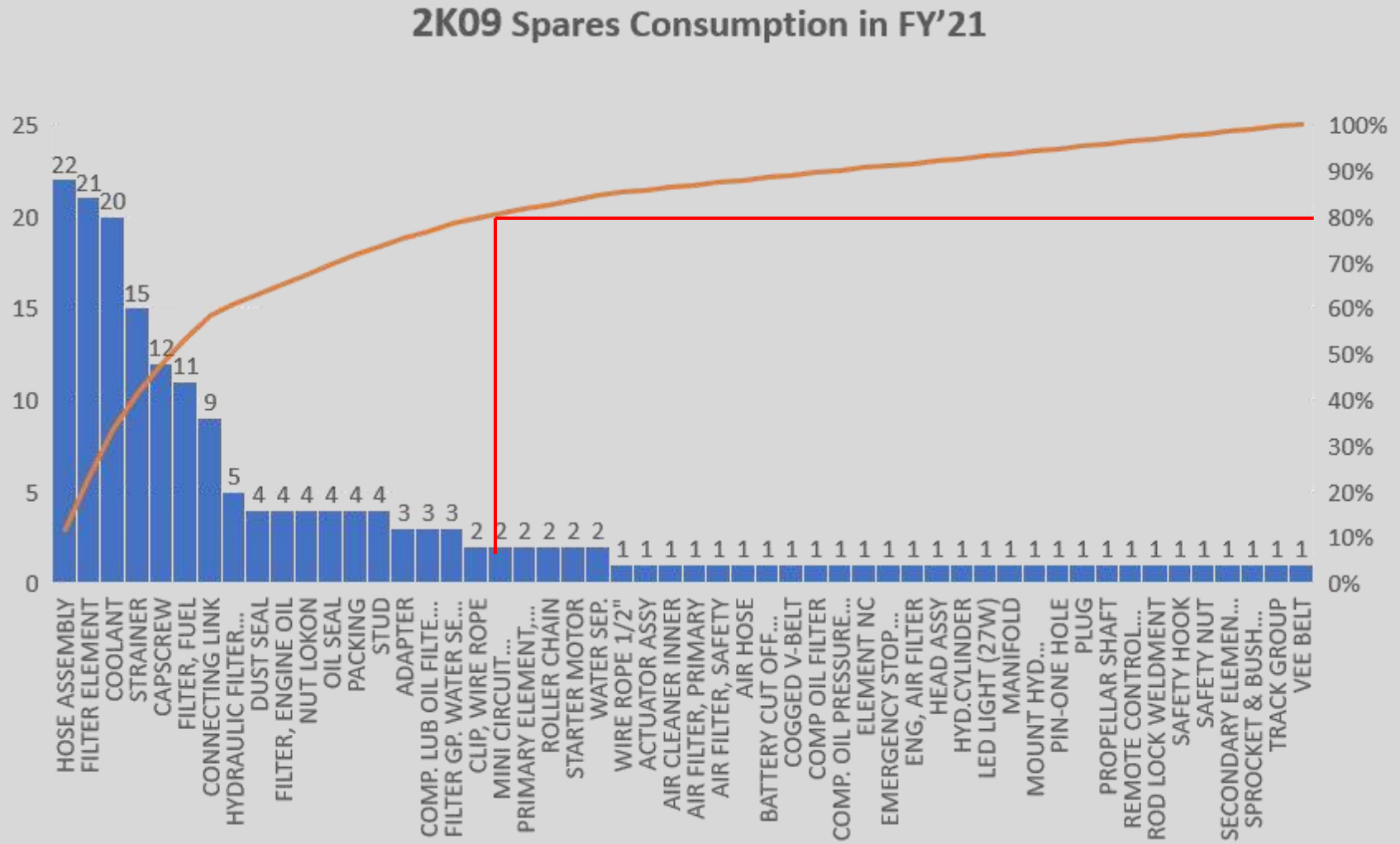


PARTS	QUANTITY (FY'21)
CAPSCREW	55
FILTER ELEMENT	45
HOSE ASSEMBLY	30
OTHERS	25
SEAL/WASHER	22
LINK CONNECTING	16
PACKING	10
ADAPTER	9
HEX BOLT	8
GUIDE SHOE	4
LED LIGHT (27W)	4
SPROCKET & BUSH ASSEMBLY	4
WATER /FUEL SEPARATOR	4
ROLLER CHAIN	2
TRACK GROUP	2
TRACK BUSHING REGULAR	1
TOTAL	241



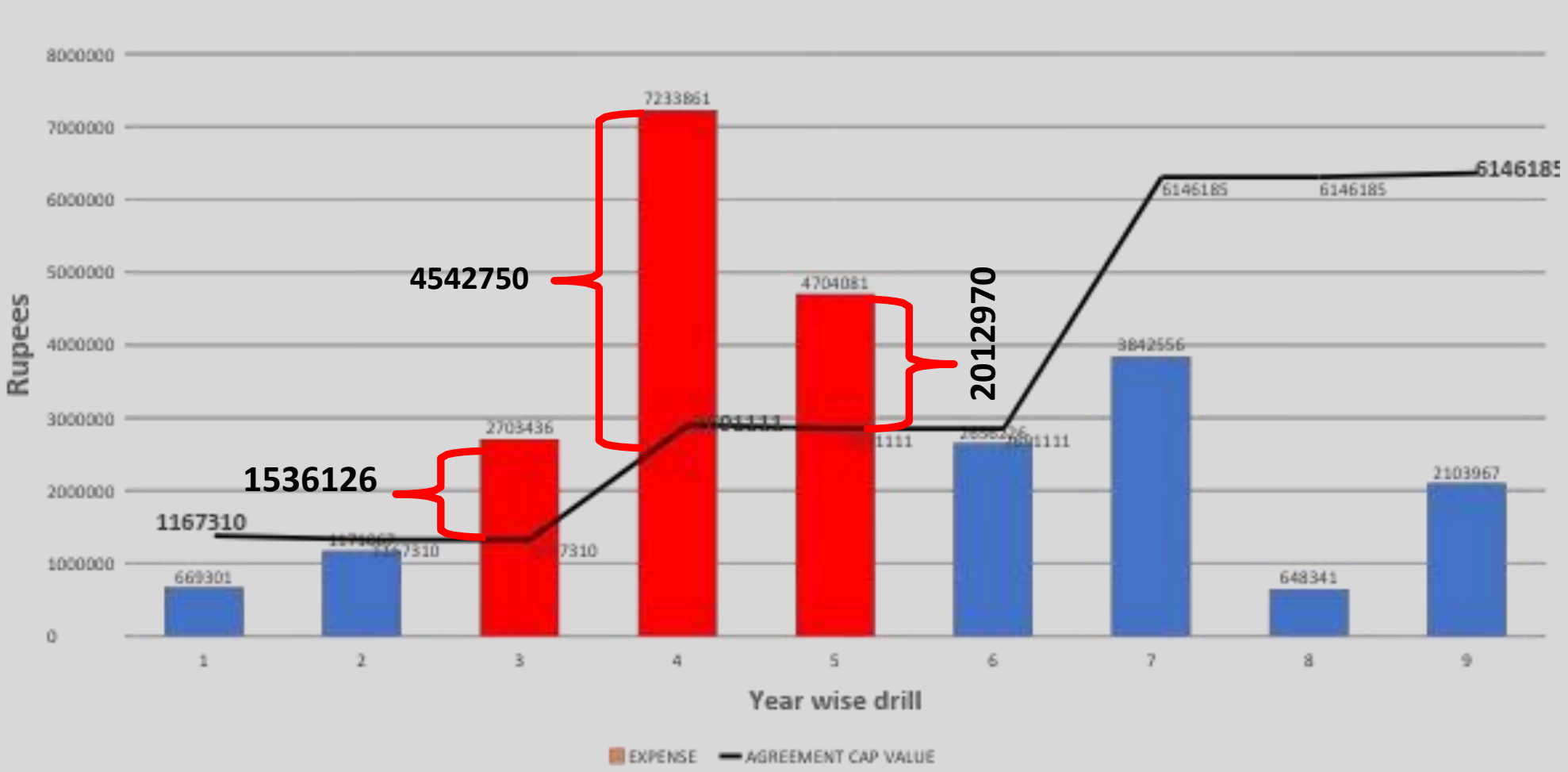
Pareto Analysis show the 80% of the whole spare consumption lead by Hoses and Filter Elements and Cap Screws

PARTS	QUANTITY (FY'21)
HOSE ASSEMBLY	22
FILTER ELEMENT	21
COOLANT	20
STRAINER	15
CAPSCREW	12
FILTER, FUEL	11
CONNECTING LINK	9
HYDRAULIC FILTER ELEMENT	5
DUST SEAL	4
FILTER, ENGINE OIL	4
NUT LOKON	4
OIL SEAL	4
PACKING	4
STUD	4
ADAPTER	3
COMP. LUB OIL FILTER ELEMENT	3
FILTER GP. WATER SEP. & FUEL	3
CLIP, WIRE ROPE	2



Pareto Analysis show the 80% of the whole spare consumption lead by Hoses and Filter Elements and Coolant

CAP VALUE AND EXPENDITURE COPARISION OF 2K-SERIES



2K09:
Rot. Motor
Gear Box

2K07:
Feed Pump
Rot. Motor

2K08:
Pump mod
Gear box

2K07 started on July'19,2K08 and 2K09 on Sep'19

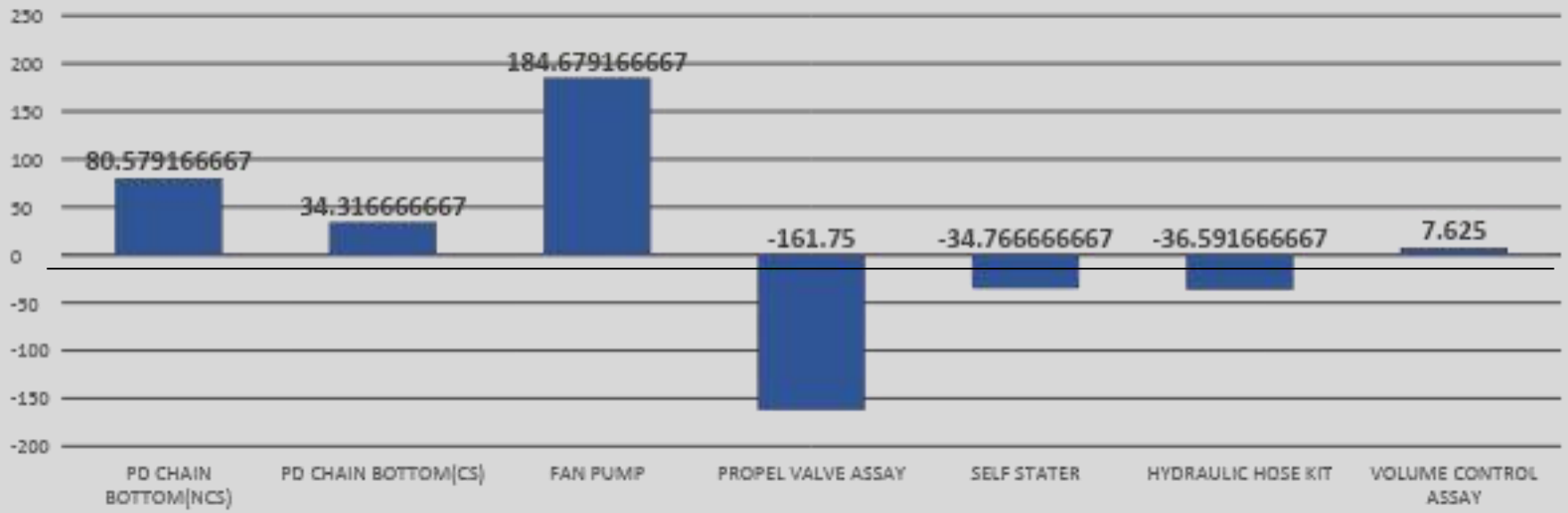
Only the consumption of 2K07 surpasses the limit by Rs.17,41,112 due to a leap in the second year

The gross expenditure of all drill is under limit which is Rs.2,57,32,836 against the total cap- value of Rs.3,00,13,818

DM-03 SUB-ASSEMBLIES CONSUMPTION (FMC BASED)

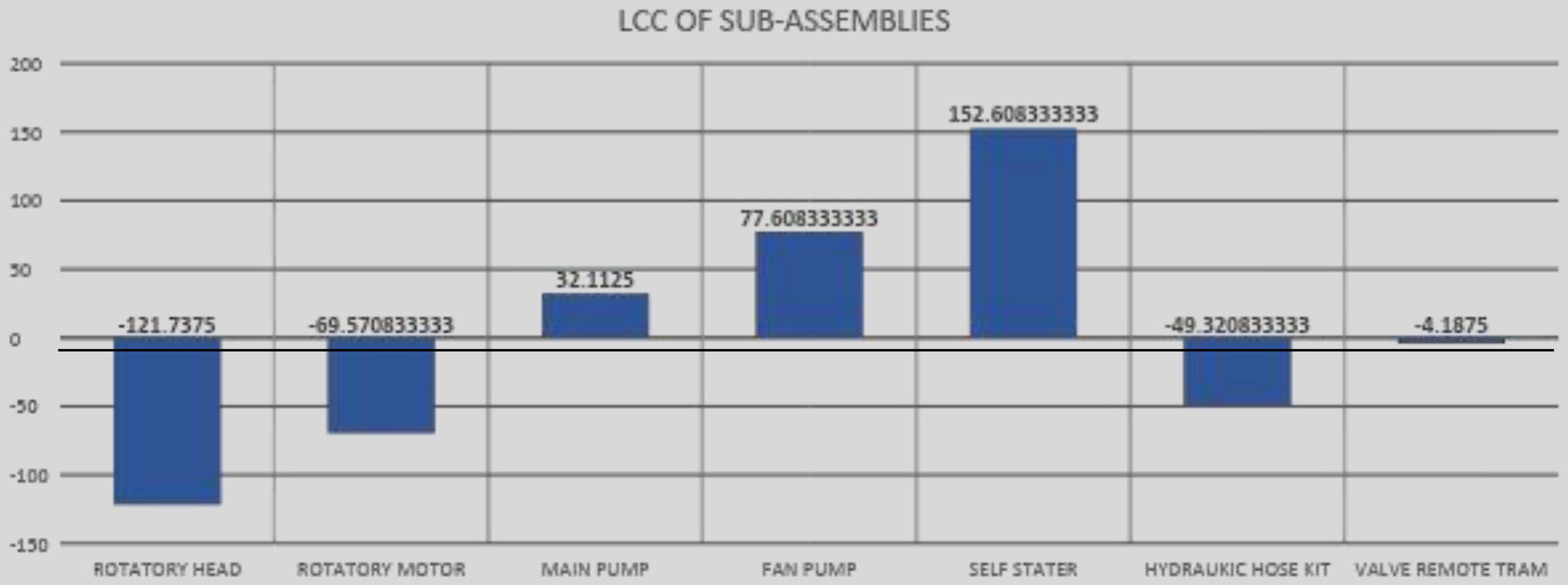
PART	RATED	FITMENT HMR	DUE HMR	CHANGED AT	BALANCE	DAYS
PD CHAIN BOTTOM(NCS)	3500	28739.8	32239.8	30305.9	1933.9	80.57917
PD CHAIN BOTTOM(CS)	3500	27629.5	31129.5	30305.9	823.6	34.31667
FAN PUMP	5500	29244.3	34744.3	30312	4432.3	184.6792
PROPEL VALVE ASSAY	4000	22430	26430	30312	-3882	-161.75
SELF STATER	5000	24256.3	29256.3	30090.7	-834.4	-34.7667
HYDRAULIC HOSE KIT	5500	24244.3	29744.3	30622.5	-878.2	-36.5917
VOLUME CONTROL ASSAY	8000	22430.2	30430.2	30247.2	183	7.625

OVER USE OF SPARE



DM-04 SUB-ASSEMBLIES CONSUMPTION (FMC BASED)

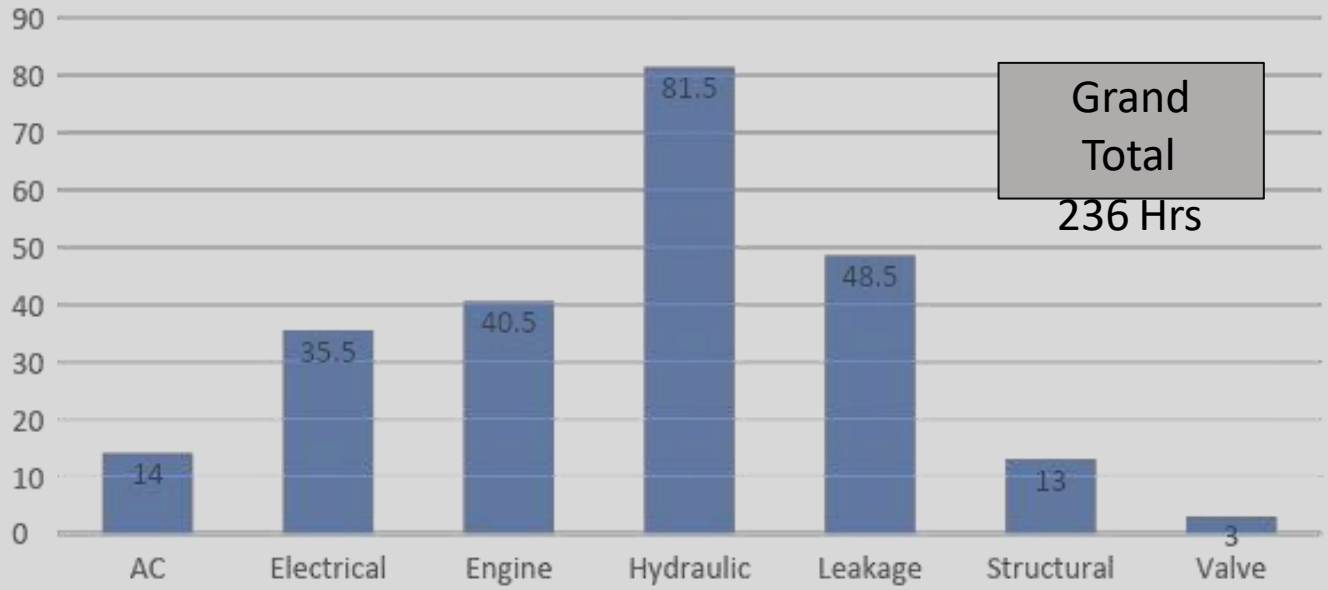
PART	RATED	FITMENT HMR	DUE HMR	CHANGED AT	BALANCE	DAYS
ROTATORY HEAD	3500	19617.5	23117.5	26039.2	-2921.7	-121.738
ROTATORY MOTOR	8000	16369.5	24369.5	26039.2	-1669.7	-69.5708
MAIN PUMP	7000	20072.9	27072.9	26302.2	770.7	32.1125
FAN PUMP	5500	22801.5	28301.5	26438.9	1862.6	77.60833
SELF STATER	5000	23816	28816	25153.4	3662.6	152.6083
HYDRAUKIC HOSE KIT	5500	18473.5	23973.5	25157.2	-1183.7	-49.3208
VALVE REMOTE TRAM	5500	20550.5	26050.5	26151	-100.5	-4.1875



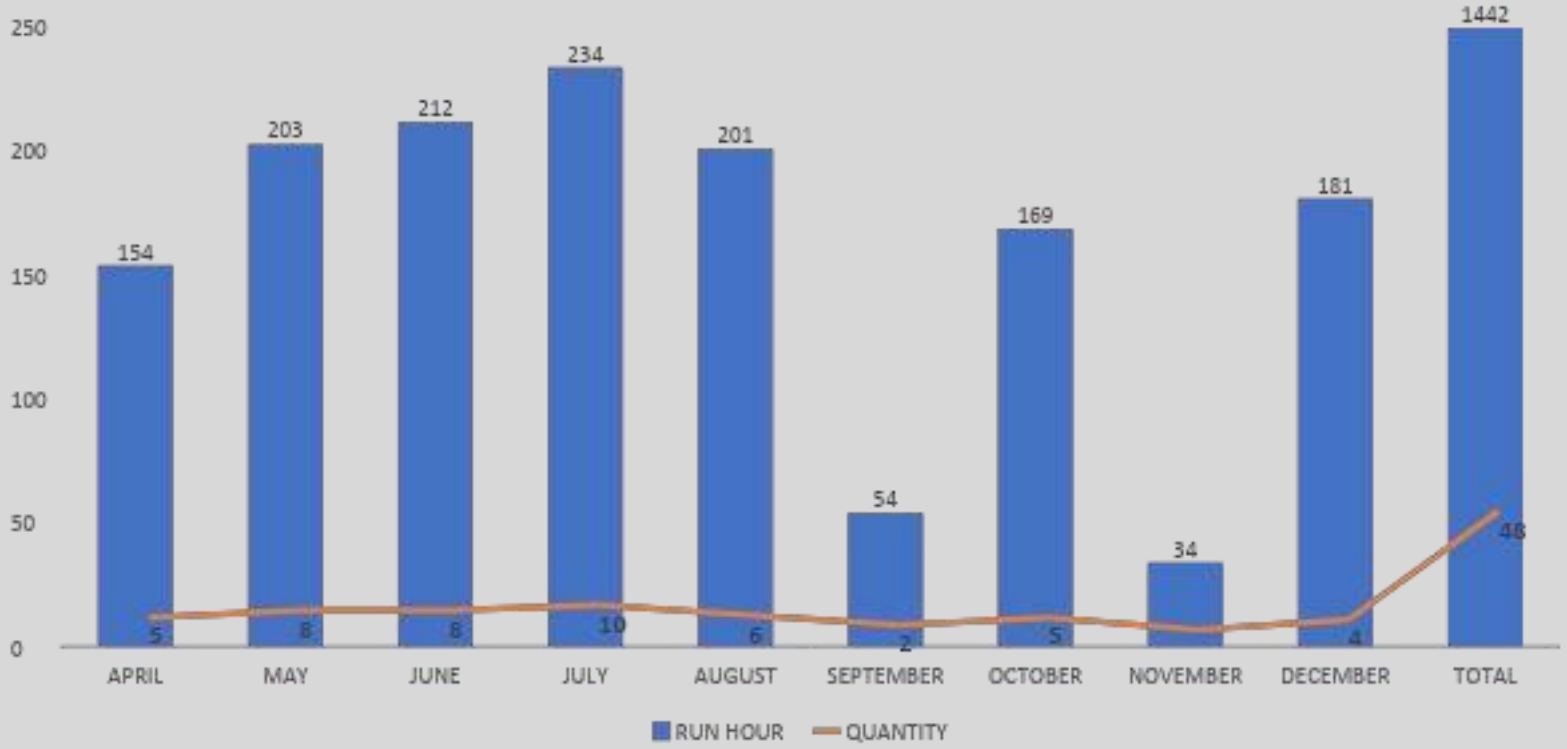
Over used Sub Assemblies by REL FMC based Drills

DRILL	PART	RATED	FITMENT HMR	DUE HMR	TILL JAN,22	CURRENT LIFE(Hrs)	OVER USED(Hr)
DM06	COMPRESSOR	6000	28721.5	34721.5	35883	7161.5	-1161.5
DM07	FEED PUMP	4500	29534.1	34034.1	36960.3	7426.2	-2926.2
	FAN MOTOR	5000	31545.6	36545.6	36960.3	5414.7	-414.7
	PROPEL VALVE ASSAY	4000	32911.6	36911.6	36960.3	4048.7	-48.7
	VALVE REMOTE TRAM	5500	28532.6	34032.6	36960.3	8427.7	-2927.7

- Over used parts cause unplanned breakdown
- Which eventually costs the production due to unwanted downtime and maintenance
- It also decrease the ease of operation e.g. Rotatory Motor slipping



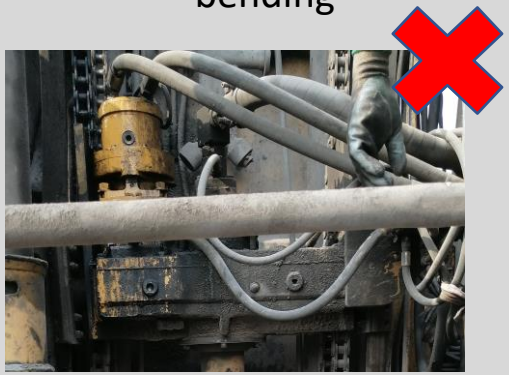
HOSE ASSEMBLY CONSUMPTION ANALYSIS(2K07)



Temperature -40°C to 95°C + Tube Erosion + Failure at fitting and Bending + Maintenance = Hose Failure

Recommendations:

Using polyethylene spiral wrap
to avoid external damage and damage from bending



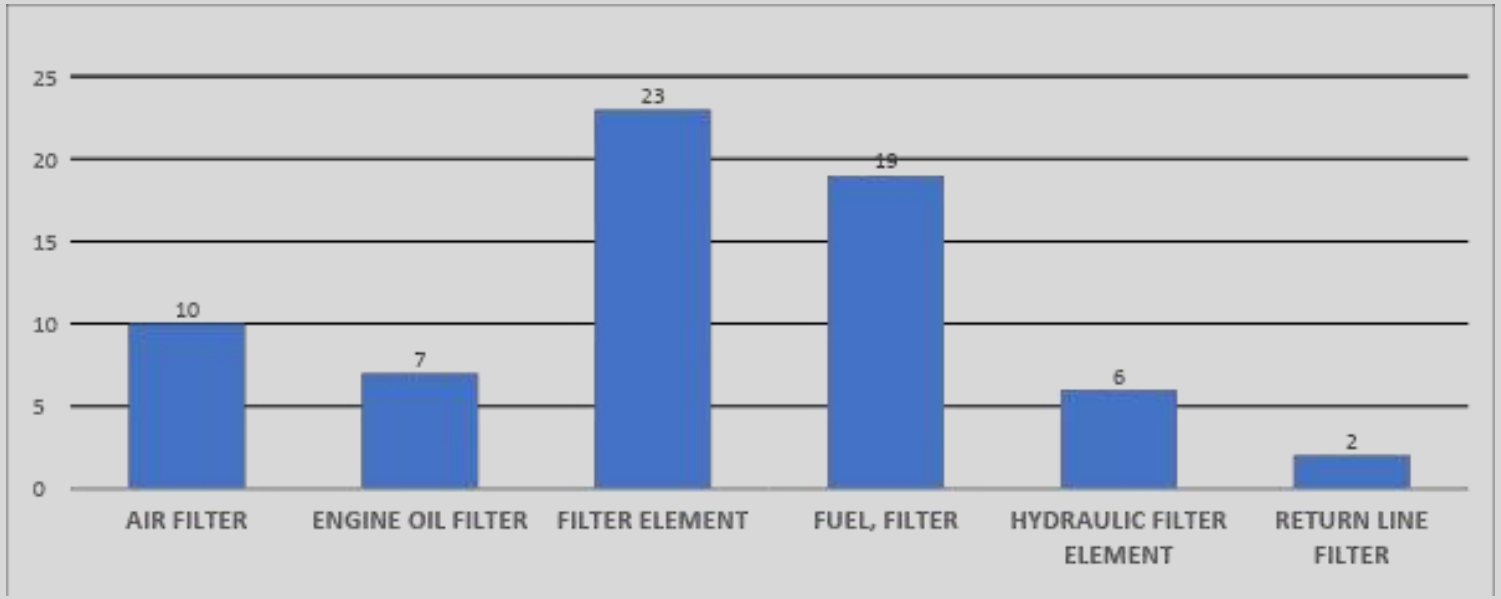
Avoid sagging of hose above limit and also avoid more than 5 degree bending which can reduce the life by 70%

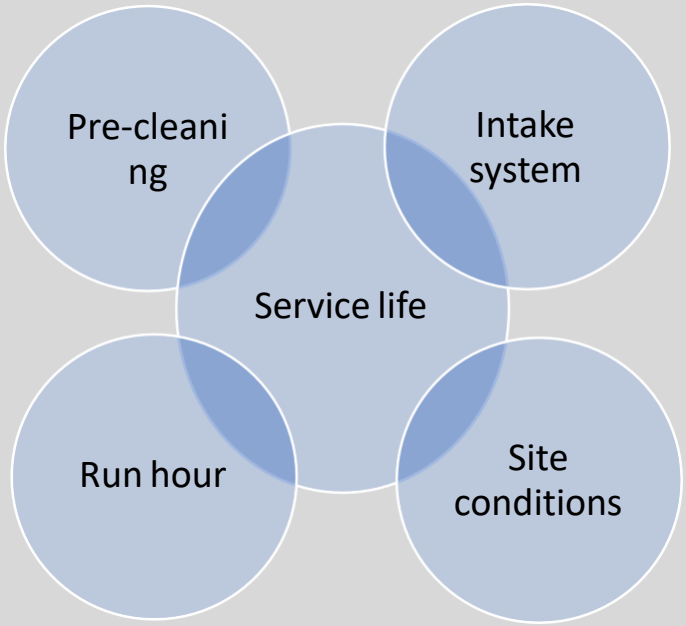
Properly clamping of hose must be ensured to avoid spillage of oil and to be checked daily

Duct tape, polyethylene seals should be used to repair even small puncture or wear out of hose

FILTER CONSUMPTION ANALYSIS(2K07)

1. Water separators
2. Fuel Filters
3. Engine-oil filters
4. Hydraulic oil filters
5. Air filters

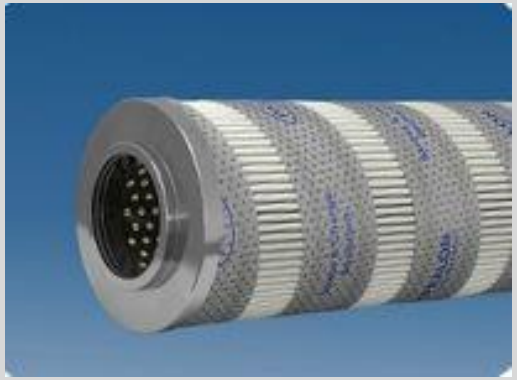




- **Filter elements are basic elements of a engine**
- **CAT C9 engine use NanoForce hydraulic filter which has normally works 1.5times more than the rated service life**
- **Consumption can be reduced by monitoring onsite operation and intake system**

Recommendations:

Using oil filtration unit to clean hydraulic oil, engine oil and gear transmission oil
e.g. KLEENOIL SMFS(1000LPH)

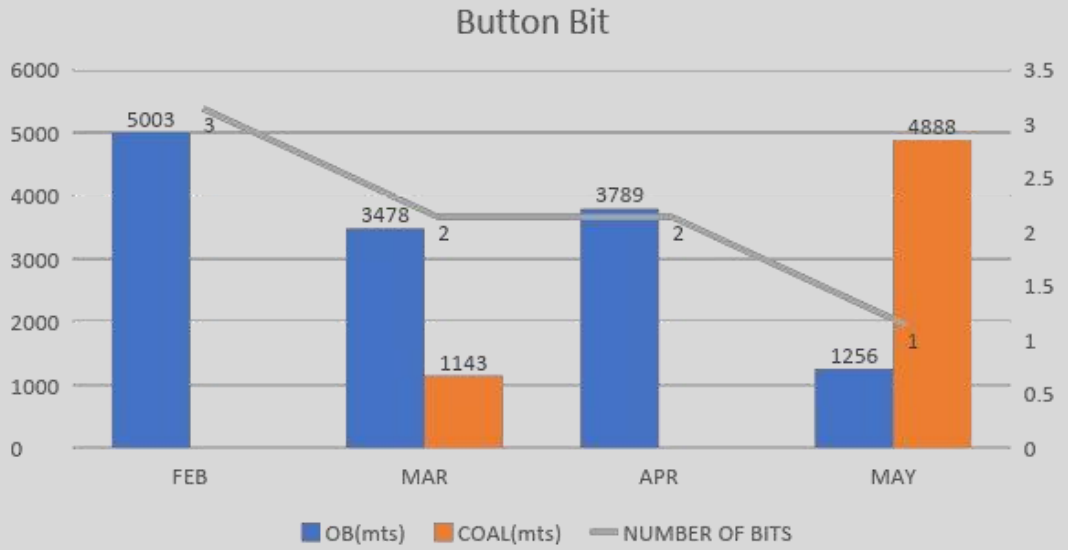


Using more reliable filters which can resist the stress due to impact of fluid flow
(Recent development Pall Supralon Filter)

During daily maintenance checking of the filters should be made mandatory and proper training should be given for changing the filters

DRILL BIT CONSUMPTION ANALYSIS(2K04)

MONTH	OB(mts)	COAL(mts)	NUMBER OF BITS
FEB	5003	0	3
MAR	3478	1143	2
APR	3789	0	2
MAY	1256	4888	1
TOTAL	13526	6031	8
AVG METERAGE			2444.625



Every time there is a hike in over burden meterage the drill bit consumption increases

Cause of Bit Failure:

Tooth Loss

Tooth Fracture

Tooth wear

Recommendations:

Re-sharpening of drill bit before the flatness of the top increases 1/3rd of the tooth diameter

Training to the drill operators regarding the feed pressure and rotation speed. Too slow and too fast can both cause premature failure

Implementation of latest developed multi dome bits which provide better penetration, chipping, chip flushing and increases the life by 30% due to double radius
(RockMore)

Recommendation to minimise Drill Rod failure:

Drill rod bending is one of the reason of its consumption other than completion of its life.
Following precaution can be adopted to reduce the consumption

- Proper Inspection before marching the machine. Sometime the operator from previous shift insert the rod and leaves it
- Pre flushing of water to wet the surface can cause clamping of bit which in turn exerts a pressure on adapter and sometimes breaks the coupling damaging the thread. Instead air can be used for clearing the dust generated will settle as water flushed after penetration starts
- Drill over lose material should be avoided. Proper dozing should be done

General Recommendations:

Implementation of ERP Software to manage day to day spare procurement, compliance and maintain supply chain

Operator reporting the malfunction or damage happened during the operation properly and as soon as possible

“Operator Knows The Health”
Pre-inspection of machine before operation starts can help to reduce the risk of bigger damage

Properly recording the data(DIGITALLY) of spares and to which equipment is installed to know and predict the consumption

Tableau Forecasting Model

Exponential Smoothening Model:

- Time Series forecasting method
- Uses univariate data(**observations on only a single characteristic**)
- Predict with the help of seasonality or trend component

Formula Used:

Prediction for next month

Actual value

$$F_{t+1} = F_t + \alpha(A_t - F_t)$$

Previous prediction

Smoothening constant

$0 \leq \alpha \leq 1$

Here,

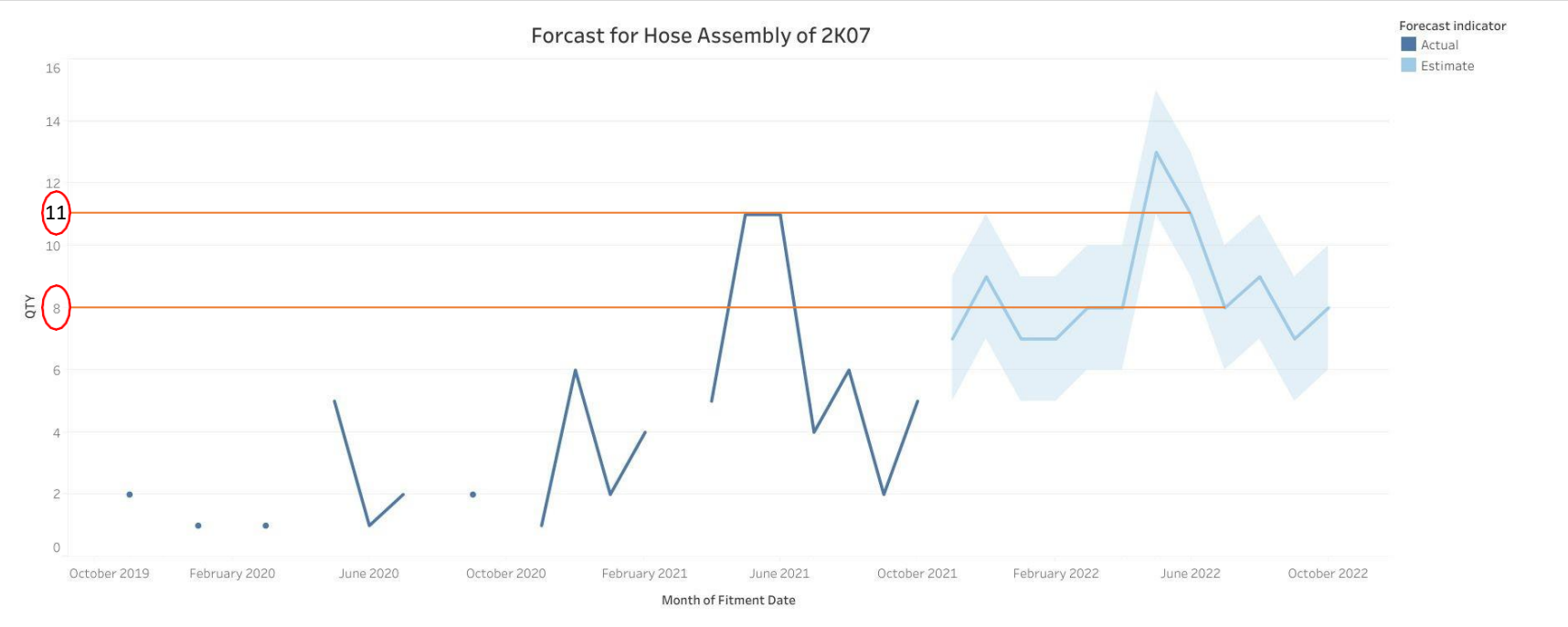
t=Time period of forecast(month)

- Instead of R-Squared value we use
  - Root mean squared error(**RMSE**)
  - Mean absolute scaled error(**MASE**) is used

MASE ≤ 1 is considered as good fit

Inventory Forecast:

HOSE ASSEMBLY



All forecasts were computed using exponential smoothing.

Sum of QTY

Model			Quality Metrics					Smoothing Coefficients		
Level	Trend	Season	RMSE	MAE	MASE	MAPE	AIC	Alpha	Beta	Gamma
Additive	Additive	Additive	2	1	0.35	64.8%	51	0.000	0.043	0.000

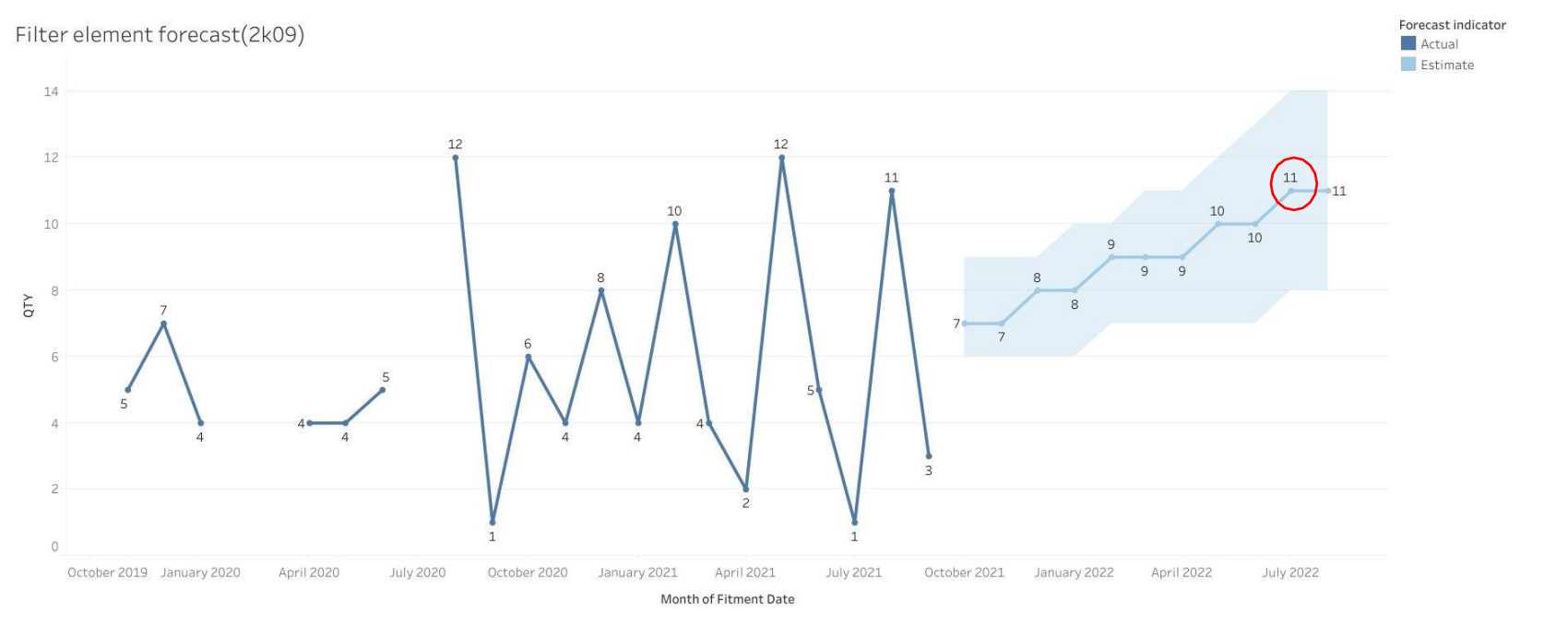
Following the trend of the consumption the model forecast that the availability of filter should be

JULY 2022- 8 units

AUGUST 2022- 7 units

With mean absolute scaled error(MASE) of 0.35 which represent a good fit of the model

FILTER ELEMENT



1. Water separators
2. Fuel Filters
3. Engine-oil filters
4. Hydraulic oil filters

Following the trend of the consumption the model forecast that the availability of filter should be

JULY 2022- 11 units

AUGUST 2022- 11 units

With mean absolute scaled error(MASE) of 0.56 which represent a good fit of the model

THANK YOU!

FILTER S

Air Filters

Oil Filter

Fuel Filters

Oil-water separator

Strainer

HOSES

Good

Damaged

OTHERS

Adapters

Spindles

Bit Shaft

Epiroc DM30 specification

Specification	Measure
Rod length	6m,8m,9m
RPM	0-160rpm
Pull Down Force	133.4kN
Mast	9m
Feed Speed	30.5m/min
Type	DTH
Depth	8.5m-45.5m
Drill hole diameter	127-229mm
WOB(Weight of bit)	14395kg
Engine	CAT C15

Revathi DH specification

Specification	Measure
Rod length	6m,8m,9m,12m
RPM	0-175rpm
Pull Down Force	222.6kN
Mast	9m
Feed Speed	25.9m/min
Type	DTH
Depth	9m-36.5m
Drill hole diameter	159-229mm
WOB(Weight of bit)	24800kg
Engine	CAT C9