

# **La società cambia con la Trasformazione Digitale: Algoritmi Predittivi per ridurre gli NPT**

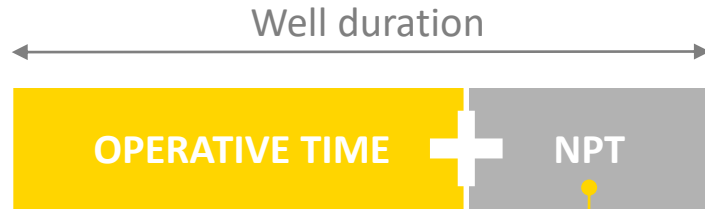
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*16 Maggio 2019 – Milano*

# What and Why?

## Non Productive Time



Any interruption of a planned operation, resulting in a time delay

The main causes of NPT are related to:

- **Well problems**
- Downhole equipment failure
- Surface equipment failure
- Rig failure

Well problems related NPT have major impact on

**Safety**

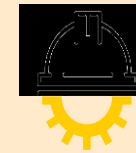
**Efficiency**



Creation of **predictive algorithms** based on **machine learning** able to prevent well problems related NPT using **100% of well data**

## Impact on Business

### Safety



**Risk Reduction**



**NPT reduction**



**Improvement in the drilling performances**

**Efficiency**

>130 Gb of raw data crunched

Several geographies

## Machine Learning Models

>7.000 variables mapped

>1.000 events verified

>200 wells analyzed

75% accuracy achieved





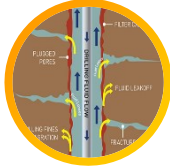
# e-NPT: Suite of Predictive Models that Helps to Avoid NPTs Related to Well Problems

## "e-NPT" objectives

### Predict & prevent well problems NPTs



Fluid Influx



Circulation Losses



Wellbore Stability problems



Stuck-pipe

## "e-NPT" tool characteristics

### User friendly dashboard for monitoring

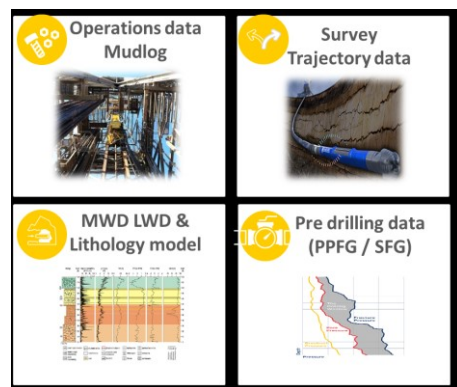


Machine learning  
predictive models

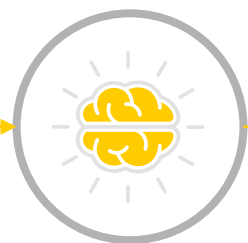
Prescriptive features  
based on Eni procedures  
and best practices

# How Machine Learning Models Work: e-NPT Tool Example

## 1 Past Wells data base

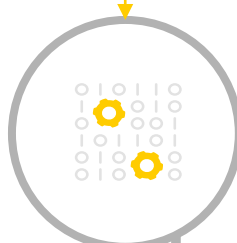


Model Offline Training

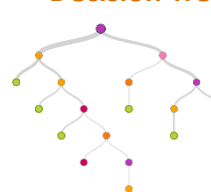


The prediction is done by constructing a set of **if-then split rules** with each variable to give the **probability of an NPT event occurrence**. These are organized in different levels to combine pairs of variables, forming a tree-like structure

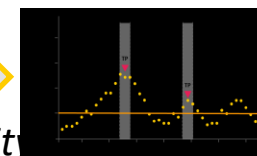
Machine learning algorithms



Decision Tree



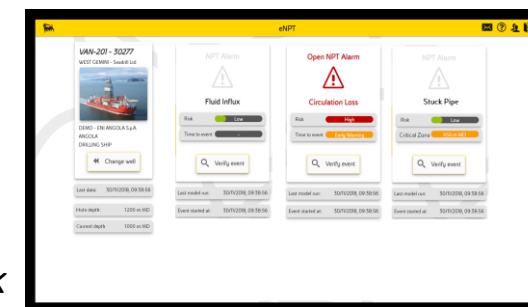
Probability



Alarm

Feedback

Dashboard on the rig



## 2 Live Wells data



e-Hawk

Data Standardization  
System



Circulation Losses



Fluid Influx



Wellbore Stability



Stuck-pipe

The algorithms give as output a **probability** of occurrence of the event that **triggers an alarm** if **above a pre-set probability threshold**

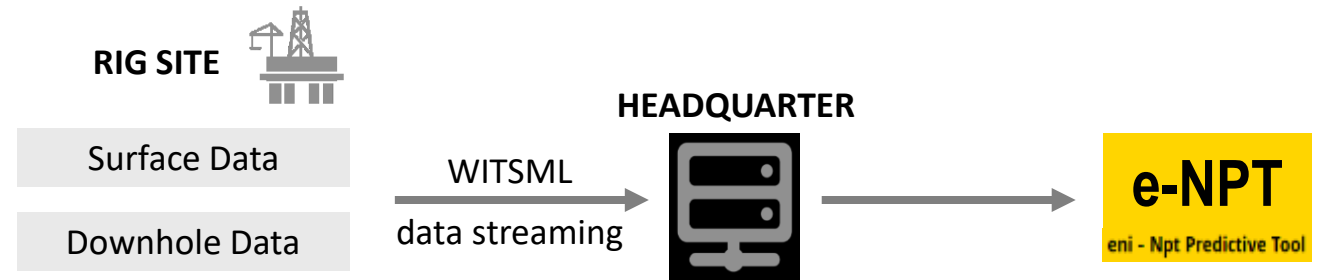
# Big Data: Predictive Algorithm to Decrease NPT

## Target

Non Productive Time events avoidance

- Predictive Algorithms to **prevent NPT** related to well problems
- **Currently available** for Stuck-pipe, Circulation losses and Fluid Influx events
- Additional Algorithm to reduce NPT: Borehole stability

## e-NPT – Eni Proprietary tool for NPT predictive analysis in real time



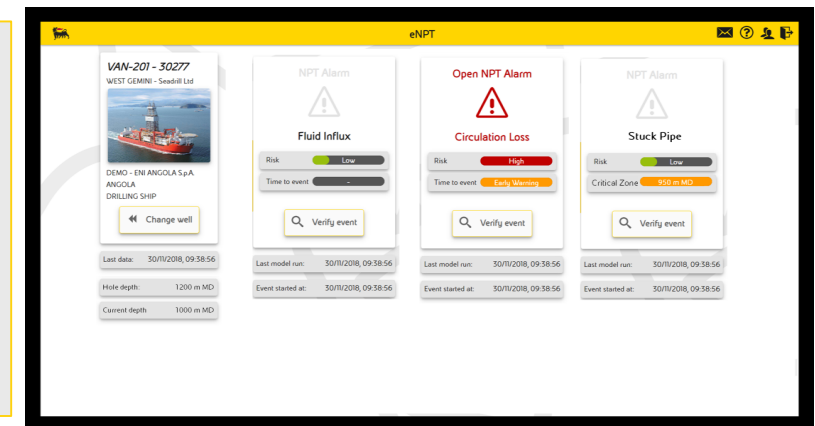
## Tool capabilities

**Big data approach** to identify well problems related events using **100% real time data** from mud logging unit

**Alert system** to dedicated personnel via SMS/Mail

**Real Time Analysis** through Dashboard

## Dashboard



# New Way of Working for NPT Management

Up to date...

Reactive and  
experience based



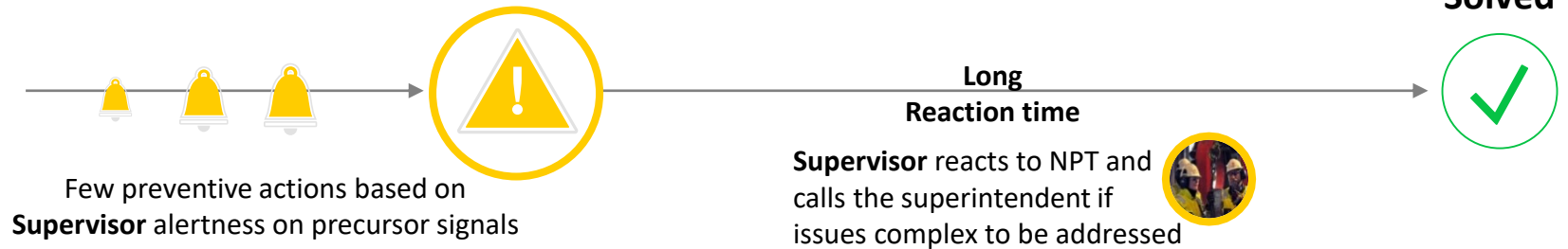
Supervisor

NPT prediction

NPT  
event

NPT solution

NPT  
Solved



...from now on!

Predictive alert &  
prescriptive support  
from NPT models  
integrating Supervisor  
experience



Supervisor



NPT model

NPT  
Prediction



Action  
time

Prescriptive tool

Solved?

No

Yes

NPT  
Avoided



NPT detected



Faster  
Reaction time

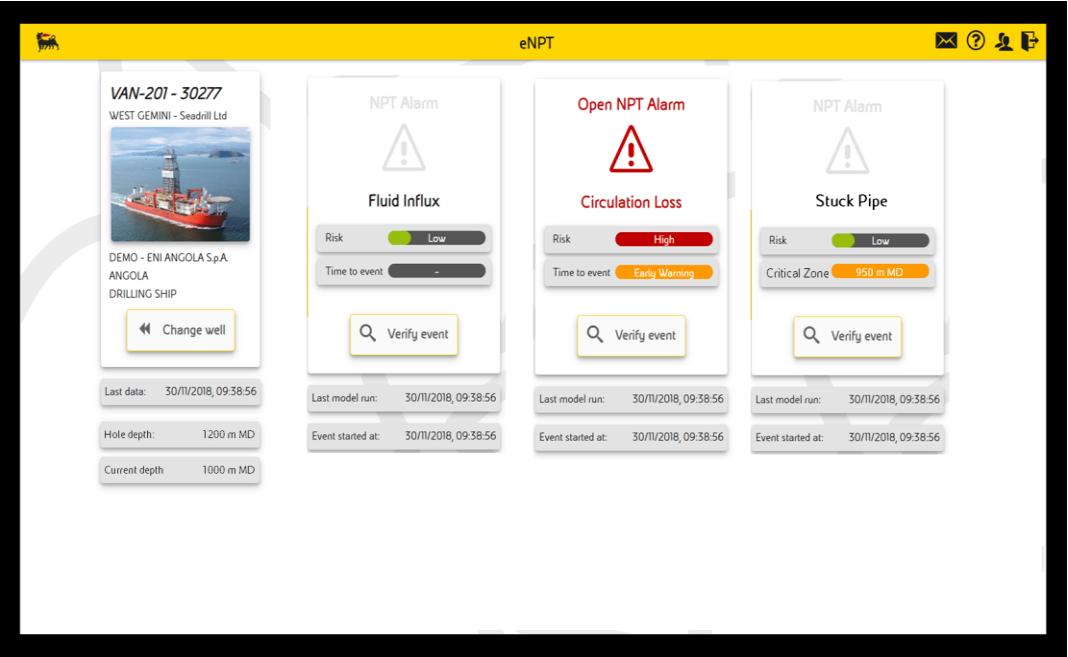
NPT  
Solved



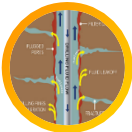
Reminder Eni Std procedures to be implemented based on  
tool classification from detection model features

Avoid NPT & Faster Reaction Time

# e-NPT Dashboard



Fluid Influx



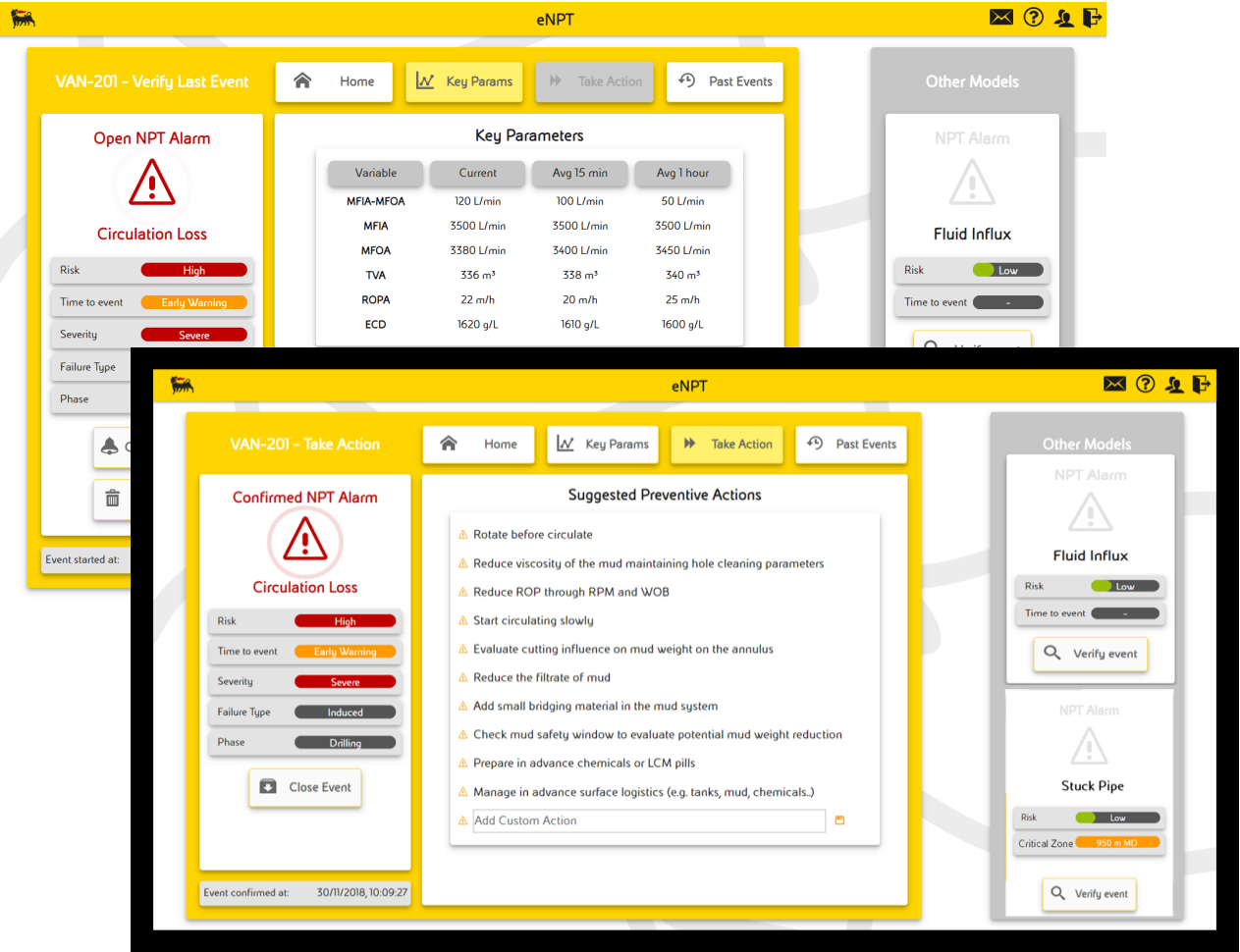
Circulation Losses



Wellbore Stability problems



Stuck-pipe problems





# Verify Alarm through tailored key parameters

Other models are always visible to maintain a 360° vision on potential NPT

eNPT

VAN-201 - Verify Last Event

Open NPT Alarm

Circulation Loss

Risk

High

Time to event

Early Warning

Severity

Severe

Failure Type

Induced

Phase

Drilling

Confirm Event

False Alarm

Event started at: 30/11/2018, 09:48:06

Home

Key Params

Take Action

Past Events

Key Parameters

Variable	Current	Avg 15 min	Avg 1 hour
MFIA-MFOA	120 L/min	100 L/min	50 L/min
MFIA	3500 L/min	3500 L/min	3500 L/min
MFOA	3380 L/min	3400 L/min	3450 L/min
TVA	336 m³	338 m³	340 m³
ROPA	22 m/h	20 m/h	25 m/h
ECD	1620 g/L	1610 g/L	1600 g/L

Other Models

NPT Alarm

Fluid Influx

Risk

Low

Time to event

-

Verify event

NPT Alarm

Stuck Pipe

Risk

Low

Critical Zone

950 m MD

Verify event

User can confirm the alarm to receive suggested mitigation actions to avoid the NPT

Key real time parameters supports user in the interpretation of the alarm

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# Take actions in order to anticipate NPT event

The screenshot displays the eNPT (Electronic Non-Productive Time) interface. The top navigation bar is yellow and contains the Eni logo, the text 'eNPT', and icons for email, help, user profile, and a share icon. Below the navigation bar, the main content area is divided into several sections. On the left, a yellow box titled 'VAN-201 - Take Action' contains a 'Confirmed NPT Alarm' section. This section features a red warning icon and the text 'Circulation Loss'. Below this, there are five status indicators: 'Risk' (High), 'Time to event' (Early Warning), 'Severity' (Severe), 'Failure Type' (Induced), and 'Phase' (Drilling). At the bottom of this section is a 'Close Event' button. To the right of the 'Confirmed NPT Alarm' section is a 'Suggested Preventive Actions' section, which lists ten actions: 'Rotate before circulate', 'Reduce viscosity of the mud maintaining hole cleaning parameters', 'Reduce ROP through RPM and WOB', 'Start circulating slowly', 'Evaluate cutting influence on mud weight on the annulus', 'Reduce the filtrate of mud', 'Add small bridging material in the mud system', 'Check mud safety window to evaluate potential mud weight reduction', 'Prepare in advance chemicals or LCM pills', and 'Manage in advance surface logistics (e.g. tanks, mud, chemicals..)'. At the bottom of this list is an 'Add Custom Action' input field. On the far right, there is a 'Other Models' section. It contains two 'NPT Alarm' cards. The top card is for 'Fluid Influx' and shows a 'Risk' slider set to 'Low' and a 'Time to event' slider set to '-'. Below these sliders is a 'Verify event' button. The bottom card is also for 'NPT Alarm' and has a 'Verify event' button. Two yellow callout boxes provide additional information. The first callout, on the left, points to the 'Close Event' button and states: 'User can close the warning event in order to allow the model to re-start the monitoring'. The second callout, on the right, points to the 'Add Custom Action' input field and states: 'Possibility to check the actions performed and add custom mitigation actions not available in the Eni Procedures'.

**Confirmed NPT Alarm**

**Circulation Loss**

Risk: **High**

Time to event: **Early Warning**

Severity: **Severe**

Failure Type: **Induced**

Phase: **Drilling**

**Close Event**

**Suggested Preventive Actions**

- △ Rotate before circulate
- △ Reduce viscosity of the mud maintaining hole cleaning parameters
- △ Reduce ROP through RPM and WOB
- △ Start circulating slowly
- △ Evaluate cutting influence on mud weight on the annulus
- △ Reduce the filtrate of mud
- △ Add small bridging material in the mud system
- △ Check mud safety window to evaluate potential mud weight reduction
- △ Prepare in advance chemicals or LCM pills
- △ Manage in advance surface logistics (e.g. tanks, mud, chemicals..)
- △ Add Custom Action

**Other Models**

**NPT Alarm**

**Fluid Influx**

Risk: **Low**

Time to event: **-**

**Verify event**

**NPT Alarm**

**Verify event**

User can close the warning event in order to allow the model to re-start the monitoring

Possibility to check the actions performed and add custom mitigation actions not available in the Eni Procedures

# Predictive Algorithms Roll Out

## Achievement up to date



**First NPT Predictive Algorithms** (Stuck pipe Model) on ~ 26 complex wells  
No Stuck Pipe events recorded



**Suite of predictive algorithms** for well problems completed  
(first roll out Angola)



**5 M€**

*100 % Cost saving*



Deep offshore well  
Angola

