Maintenance Specificities in the CERN Cooling and Ventilation Group

I. El Hardouz, U. Epting, S. Poulsen, G. Peon (CERN EN/CV)
Summary

• Definitions and Acronyms
• Introduction to EN/CV
• Overview of EN/CV Maintenance
• CMMS in EN/CV
• Key Performance Indicators
• Meter Readings
• Conditional Maintenance
• Summary
• Conclusions
Definitions and Acronyms

- Position
- Hierarchical structure
  - Parent
  - Child
- MP: Maintenance Plan
- PM: Preventive Maintenance
- CM: Corrective Maintenance
- WO: Work Order
Equipment Structure
Introduction to EN/CV

The CV group is responsible for the CERN Cooling and Ventilation installations:

- ACCELERATORS
- DETECTORS
- EXPERIMENTAL AREAS
- COMPUTER CENTER
- DESIGN
- WORKS
- OPERATION
- MAINTENANCE
Introduction to EN/CV

HVAC:
- Tunnel
- Experimental caverns
- Service caverns
- Pressurized safe areas
- Surface “machine” buildings
- Smoke and Gas Extraction Systems

Water Systems:
- Primary water
- Demineralised water
- Chilled water
- Mixed water
- Reject water
- Sanitary water
- Fire fighting water

Compressed air systems

Electricity Control and supervision systems

A total of 76000 pieces of equipment
Cooling and distribution

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
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<tbody>
<tr>
<td>Cooling towers (450 MW)</td>
<td>22</td>
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<tr>
<td>Chilled water production : 6-12°C (73 MW)</td>
<td>35</td>
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<td>Cooling plants (raw water, demineralized water, C₃F₈, C₆F₁₄)</td>
<td>150</td>
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<tr>
<td>Distribution Pipework</td>
<td>800 km</td>
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<tr>
<td>Total water consumption</td>
<td>5'400 m³/h</td>
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</tbody>
</table>

Equivalent to 10% consumption Geneva Canton
Ventilation, Fluid Systems

HVAC
1’500 units
from 2’000 to 120’000 m3/h per unit

Fire fighting systems
800 points

Compressed air
14 installations
distribution network 200 km

Demineralised water production
20 m3/h - 0.1 μS/cm
Overview of EN/CV Maintenance

• The general activities are covered by just two contractors
• Other particular activities are assigned to specialised contractors, i.e. water treatment
• Their work is divided in geographical areas
  – PS complex plus 50% of the LHC installations
  – SPS complex plus 50% of the LHC installations
• Stand by interventions:
  – PS, SPS: Contractors
  – LHC, CERN Computing Centre: CERN
• Maintenance Budget of 6MCHF/yr
• Asset Value of 600MCHF
Organisation of the Preventive Maintenance

The CMMS creates a Preventive WO according to the MP

Critical installation?

Yes

CV specifies actual dates for the work according to the CERN overall planning

No

CV specifies a period in which the works have to be carried out

The contractor plans the work in CMMS

CV approves the date?

Yes

Request for the material

No

Non

The contractor enters comments and billing codes into the WO

Safety assessment and notifications

Works carried out in the installation

Comments by CV for explanation of rejection

Technical Check

Correct?

Non

Verification of data and billing codes in the WO

Correct?

Non

Comments by CV for explanation of rejection

WO taken into account by the system for payment

Yes

Ready for payment

Yes

Non

13/Nov/2013 AMMW2013

10
Preventive Maintenance
Maintenance Plans

• MPs generates WOs at the level of the Parent
• The WOs point to Maintenance Procedures according to the equipment installed within the Parent
• The MPs automate provisional WO start and end dates
Organisation of the Corrective Maintenance

- Alarm to the CCC
- Discovery by CV operator
- Creation of a WO (indicates date of intervention)
- E-mail and SMS sent to the CV operators and contractor
- Outside working hours?
- Creation of a WO for stand-by service
- Breakdown solved
- Intervention by the corrective team
- Acceptance of the WO by contractor
- Breakdown solved
- Comments in WO to explain rejection
- Entry of the WO comments and billing codes

- Intervention of the corrective team
- Parts available?
  - Yes
  - Non
- Magasin process demand
- Request / Wait
- access possible?
  - Yes
  - No
- WO taken into account by the system for payment

- Technical check
  - Correct?
    - Yes
    - Ready for payment
    - Non
- Verification of data and billing codes in the WO
  - Correct?
    - Yes
    - Ready for payment
    - Non
- Comments in WO to explain rejection
- Entry of the WO comments and billing codes
CMMS in EN/CV

- CV utilizes mainly the following modules in INFOR EAM

**Equipment**
- Assets
- Positions
- Parts
- Structure

**Works**
- Work requests
- Work orders (WO)
- Maintenance plans
- Inspections
- Meter readings

**Stores**
- Spare Parts
- Pick Tickets
- Reservation
- Requisition
- Purchase orders
- Parts labelling
- Minimum stocks
Information in the WOs

Dates in WOs
- Filled by the system
  - Event date: date of WO creation
- Filled by CV personnel
  - Requested start date
  - Requested end date
- Filled by contractors’ personnel
  - Schedule start date
  - Schedule end date
  - Actual start and end dates
  - Request and delivery of spares

Other Information:
- Filled by CV personnel
  - Information to assess the work
  - Contact person
  - Particular safety issues
- Filled by contractors’ personnel
  - «Assigned to»
  - Booked hours for a particular employee and day
  - Description of the work done
  - Spare parts used
  - Tests carried out
  ...
**ODM COMMENTS**

---

**User Info** | **Comment Text**
---|---
Created: 28-JUN-13 by FJUBAN | suite a entretien entreprise trane, ils ont decouvert que le pressostat ne fonctionne plus, demande pour changer le pressostat.
ne prevenir avant intervention.  

Created: 05-JUL-13 by BCHOLLAT | Pick Ticket 14162

Created: 05-JUL-13 by BCHOLLAT | 05/07/2013  
Relève de references sur site  
Recherche CVDB et commandes INFOR  
En cours

Created: 29-JUL-13 by BCHOLLAT | 29/07/2013  
Appro materiel au 939  
Acces installations  
Appel CCC  
Consignation electrique du pressostat  
Depose et decablage du pressostat HS  
Echange, preparation, montage, raccordement, cablage du nouveau pressostat  
Reglage et controle de fonctionnement  
Essai concluant  
Installation laisse en mode automatique  
Rangement materiel  
Appel CCC  
Intervention terminee
## BOOKED HOURS

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<tr>
<th>Person</th>
<th>Date</th>
<th>booked hours</th>
<th>MRC</th>
<th>Trade</th>
<th>Activity</th>
<th>Rate</th>
<th>Cost</th>
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<td>3</td>
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<td>EEM</td>
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**report total:** 8

## PARTS USED

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## AUDIT VALUES

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<td>R</td>
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</table>
Main KPI: Contractor Performance

\[ KPI_3 = \frac{\text{Completed PM WOs}}{\text{Total no. of Requested PM WOs}} \]

\[ KPI_5 = \frac{\text{Completed PM WOs}}{\text{Total no. of Planned by Contractor PM WOs}} \]

\[ KPI_7 = \text{Delay in Preventive Maintenance (days)} \]

\[ KPI_{10} = \text{No. of non-approved WO} \]
Main KPIs: Equipment Condition

$KPI_{13} = \text{Top 10 positions creating CM}$

$KPI = \text{No. of WOs per Cause Code}$
Main KPIs: Reactivity

$KPI_{15} = \text{Delay in WOs verification}$

$KPI_{17} = \text{MTTR}$

$KPI_{18} = \text{MTTC}$
Main KPIs: Overall performance

\[ KPI_1 = \frac{\text{Completed CM WOs}}{\text{Total no. of Completed WOs}} \]

\[ KPI_5 = \frac{\text{Delay in PM (days)}}{\text{Total no. of days between two PM}} \]

\[ KPI_7 = \text{No. WOs waiting for access} \]

\[ KPI_{11} = \text{No. WOs waiting for spare parts} \]
Examples of two KPIs over time
Meter Readings in the CV group

• Meter readings for different equipment
  – Air Compressors
  – Trane Chillers
• Frequency
  – Different intervals: e.g. weekly, twice per year
  – Configured via Infor EAM PM Schedules
• Visualization
  – Infor EAM Custom Tab: “Inspections & Readings”
• Tools for data entry
  – GS-ASE Infor EAM Mobile (Psion handheld)
  – EN-CV smartphone application
Meter Readings: CV Smartphone Application

- Webpage application optimised for smartphones
- It organizes the data collection by PM Schedule (can comprise equipment of different Classes)
- No investment required for proprietary equipment and can be on operators personal device (Bring-Your-Own-Device)
- It can also be used from any platform with a Web browser (including Psion Ikon)
- It works off-line in areas without GSM/WiFi
- It is very responsive
Meter readings: Ex. Historical data of chiller FCK-00030
Mechanical revision 40000h and cleaning of a chiller in bldg. 355, 378

... before and after cleaning bldg. 378
Conditional Maintenance: Vibration analyses
Conditional Maintenance: Vibration analyses
Conditional Maintenance: Vibration analyses

Pumps online UW 25

Sensors / Cable - Measurement

- VIB 6.122: 36x, FFT/SPM 10816/cavitation
- VIB 301040-6: ca. 216m, Coaxial Cable
- VIB 90081: ca. 60m, Triaxial Cable
- VIB 5.890-3: 1x, Signalmaster
- VIB 8.306: 6x, Mux
- Strings: 2x
- Pumps: 9x
- Speed: fix
- Power: 10 to 200 kW

IP 172.18.30.15

Sting 1

FPMA202

Sting 2

MUX 1.2.1
Conditional Maintenance: Vibration analyses
Summary

• EN/CV utilises the main modules of INFOR EAM
• Information entered by the System, CV staff and Maintenance contractors is crucial to assess the different actors in maintenance
• CV makes use of tailored made KPI to pinpoint weak and strong points in the Maintenance activities
• *Particular Meter Readings* are valuable information to trigger conditional maintenance in some equipment such chillers and compressors
• A specific project has been made for *Conditional Maintenance* based on Vibration measurements
Conclusions

• Structure of equipment reduces the intervention time for all the maintenance participants

• KPIs, utilised to better monitor the Maintenance Activity and plants condition to:
  – Support the decisions by the CERN management
  – Take actions by Stores and Operations
  – Manage of Contractors
  – Repair and improve the installations

• Meter readings
  – Faster data entry and interpretation of results
  – Clearer vision of the equipment utilization over time

• Vibration analysis
  – Detect risk and allow for intervention before breakdown
THANK YOU FOR YOUR ATTENTION!!