



# **ATC/ABOC Days Summary Session 5**

## **MTTR & Spare Policy: TS Groups**



# Talks session 5

- **TS/EL** *by Felix Rodriguez Mateos*
- **TS/CV** *by Joaquin Inigo Golfin*
- **TS/ASE** *by Rui Nunes*
- **AB/ABP** *by Richard Scrivens (summing up presented by S.Myers)*
- **Maintenance management with D7i**  
*by David Widegren*

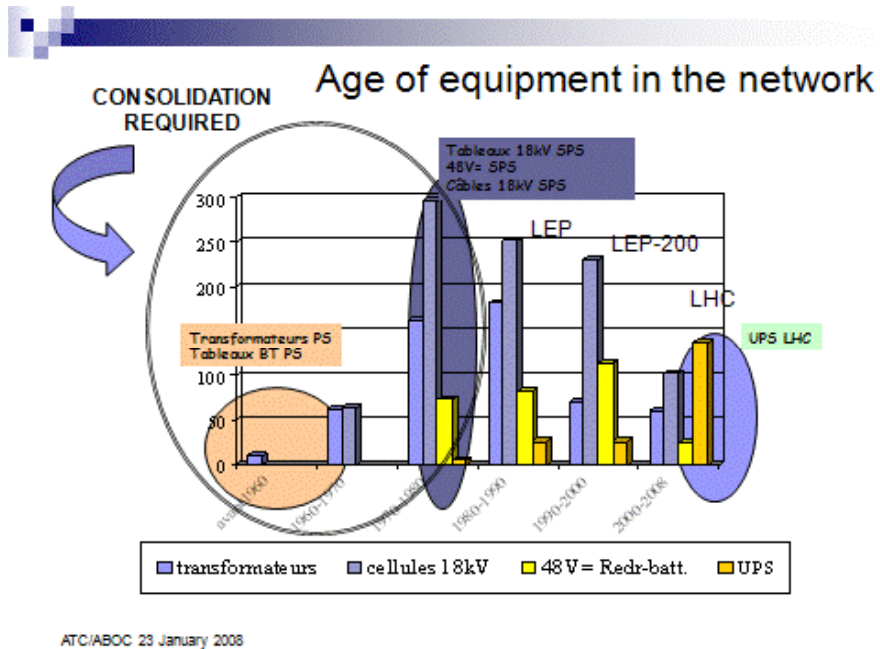
## ■ Design principles for minimizing MTTR

- Re-powering by reconfiguration of the network. n+1 redundancy.
  - 400kV power transformers and breakers, SVCs in BE, most of the cables in SPS, 18 kV inter-site links, 48V safety control systems
- Repair/replacement of equipment there where no n+1 redundancy exists
  - Transformers, many UPS, HV and LV breakers, the SVC for the LHC even points and Meyrin site, filters, capacitors, PLC, etc...
- Single point failures (a few examples)
  - Incoming 400 kV line, 38 MVA Transformers, 66kV Cables, 18 kV Cables for the pulsed BE-BA4 link, Bus bar failures in HV or LV switchboards

# TS/EL F. Rodriguez-Mateos

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## Evolution of the maintenance budget



Year	MCHF/y
2001	1,70
2002	1.70
2003	2.10
2004	2.50
2005	2.30
2006	2.90
2007	3.45
2008	3.60

## ■ Spares

□ Transformers – *No spares, consolidation studies, gentlemen agreement with RTE*

- Existing 110 MVA x 2, 90 MVA x 3, 70 MVA x 2, 38 MVA x 5
- A single failure of 110 MVA, 90 MVA or 70 MVA can be remedied by re-configuration
- **A double failure would compromise CERN's mission for approximately 2 years**
- **Single failure of any 38 MVA transformer stops the LHC operation for 2 years (see EDMS 812542)**
- Distribution transformers – spares for some types

- Spares exist for
  - HV breakers – Spare parts, not spare units
  - SVCs – SVC3 in operation week 6, SVC1 “hot spare”
  - Harmonic filters
  - ENS (control system)
  - 48V DC power supplies
  - UPS
- Hot stand-by UPS systems required for LHC

# SPS 18kV Cables: strategy

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- Replacing all cables is too costly (15 MCHF)
  - Consolidation includes BA6-BA7 plus one additional equivalent length (total of 2 MCHF)
- We have to get re-powering redundancy everywhere => consolidation for BA4 urgent, foreseen end of 2008
  
- TTR a faulty cable varies from 1 week to 1 month
  - Many variability factors (location, weather, access rights to locations,...)
  - In the meantime, operation in open loop configuration
  - Double faults kill this possibility, low probability which will increase with time...
- 30% of the cables have been replaced in SPS loops, none for the SMB cables
- BA6-BA7 can be used as a “pilot programme” for the future procedure
  - Cables will be laid within PVC pipes
- A new procedure “Guide pour la réparation des câbles du SPS” has been prepared, will soon be published



# TS/CV

J. Inigo-Golfin

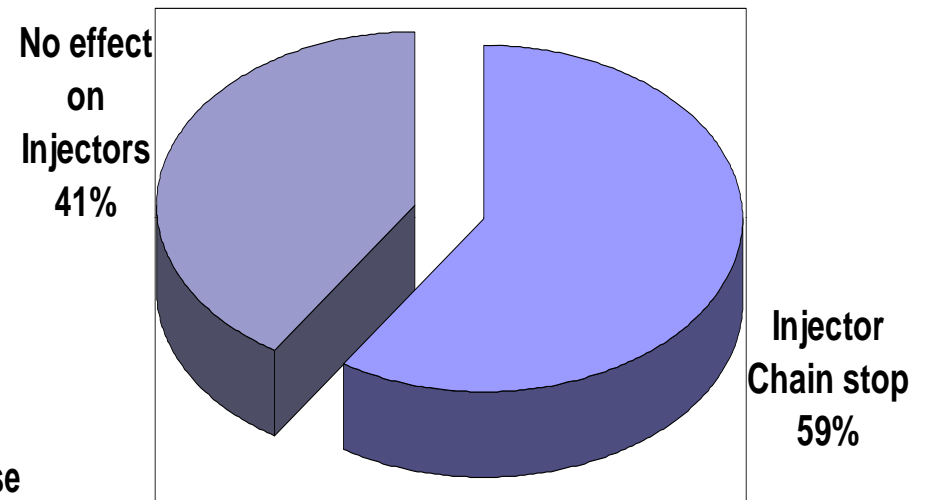
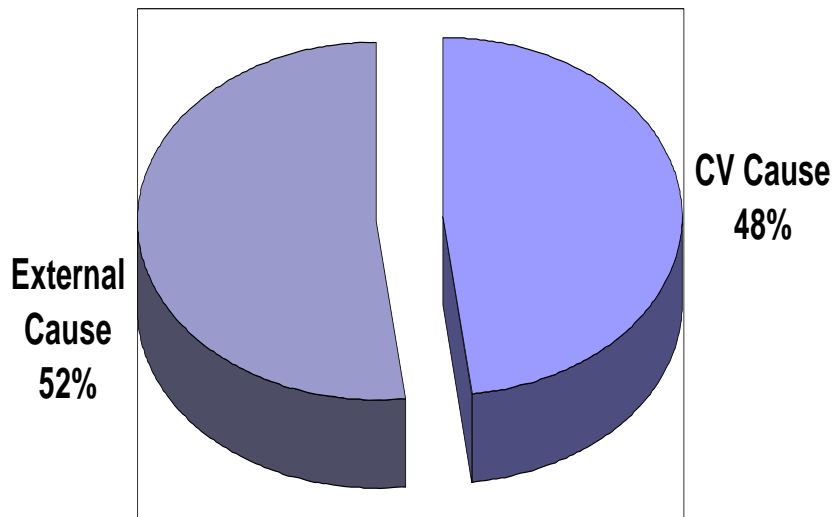
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- N+1 principle
  - Should not be tampered with (for savings)
  - Where reasonably possible (i.e. not for towers)
- Many different installations
  - Analysis of major events show no trend in faults
- Ventilation is not a safety system
- Legionella risk
  - Not only CV, but also user problem (no flow)



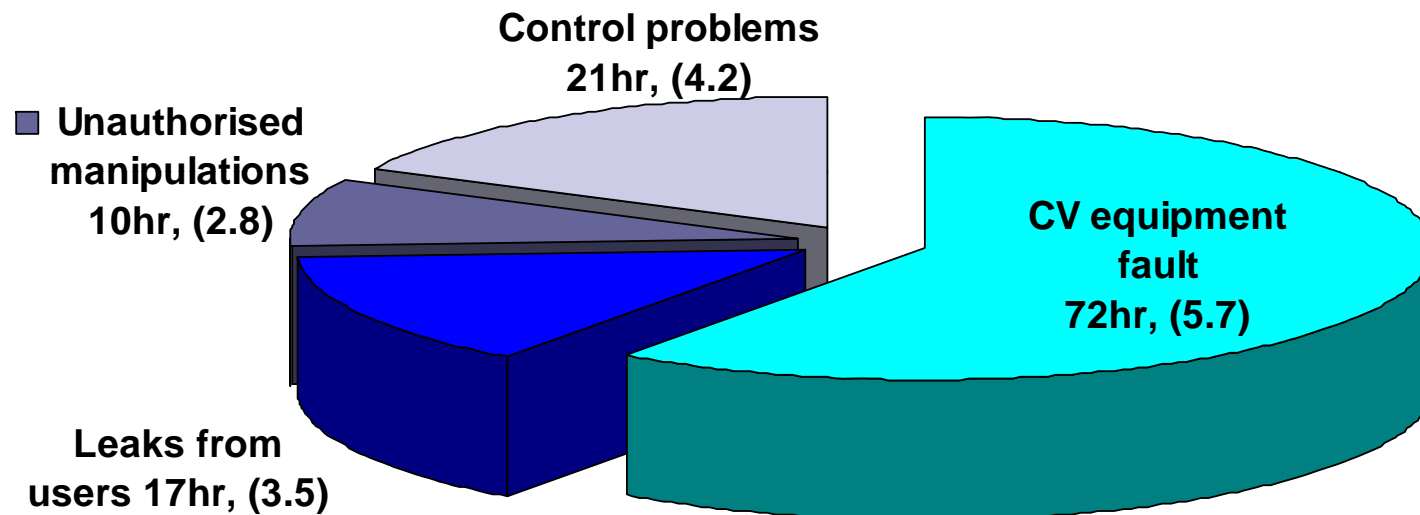
# Major Event Summary – Charts

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# Major events for injectors chain: Summary 3/7

- In the last 3 years 27 major events, with:
  - total time = 120 hr, (MTTR = 4.4)



- Many isolated cases which do not fall easily into any large category:
  - even those falling within the same category have little resemblance (lack of maintenance, aging equipment)
  - new category with radiation damage!



CERN/TS/HDO/PC/2007-051  
Date : 2007-07-04

## MEMORANDUM


A / To : J-J. Blaising / PH, Ph. Lebrun / AT, S. Myers / AB  
De / From : P. Ciriani / TS  
C/c : *TS Group Leaders*  
Objet / Subject : Restrictions on the manipulation of CERN cooling circuits

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Numerous stops of the cooling facilities have been observed in the past, due to manipulations on the circuits (opening or closing of valves, filling-in of equipment, draining of circuits, etc.) without the knowledge or authorisation of the TS department.

The circuits being complex and large, many different users are usually connected to the same distribution lines, and these unauthorised manipulations provoke stops affecting other users, sometimes during critical periods of tests or operation. In the case of the LHC it can be difficult for users to realise what has happened as the experimental area circuits are sometimes also used for machine equipment.

TS confirms that all cooling installations are in operation and that no manipulations are allowed without the prior approval of the TS/CV group representatives (via the control room - CCC). I would be grateful if you could inform your personnel of these instructions.

  
P. Ciriani

# Organisation of CV Stand-by service

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- Who intervenes?
  - One team (two people) per zone (LHC, SPS, PS)
  - PS & SPS at the charge of maintenance contractors
  - LHC and 513 in charge of CV staff
  
- How are teams contacted?
  - Stand by phone number available in CCC
  - Contacted mainly by CCC
  
- Interventions timescale?
  - Contractual obligation to arrive on site within 15 min. during working hours
  - 45 min. outside working hours
  - Diagnosis and troubleshooting within 1 h after arrival
  - If no solution is found, escalation procedure
  
- Factors external to CV that could influence MTTR
  - Procedure for intervention in the vicinity of asbestos
  - Procedure for Radio Protection or confined spaces, special access procedures
  - Procedure for interventions in SPS in the vicinity of electrical equipment not defined. "Consignation"
  - Environmental factors (legionella) may require stop of plants

# CV spare parts

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- D7i contains at present information on:
  - List of spare parts available in the CV stores
  - 70% of process components have their associated spare parts defined
  - Four different CV stores totaling 5130 m2, containing 20350 referenced parts. 99096 of these parts available on-site
  
- Foreseen in the mid term:
  - Determine key spares for critical equipment (defined as single point of failure, not following the N+1 general rule)
  - Determine and buy minimum stock of spares
  - Create a list of process control spare parts (common with other services)
  
- Mostly relevant for Preventive maintenance. Troubleshooting based on N+1 redundancy policy
  
- Yearly stores activity:
  - 4800 parts for 1.2 MCHF (bought, accepted, stored and dispatched)
  - 44 shipping for repairs organized
  - 1 person only for this activity as from Jan. 1<sup>st</sup> 2008



# CV conclusions

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- The analysis of the major events shows little repeatability in the breakdowns. Around 1/3 of breakdowns with Physics loss is linked to equipment, rest of stops due to accidental or unauthorised manipulation of the CV systems. Room for improvement
- A comparison between the major events and the numbers of calls from CCC shows that most of the breakdowns and events do not stop the accelerators
- Major effort done to improve the TS/CV policy to reduce MTTR mainly through stand-by duty training
- The spare part management cannot be underestimated, for rapid reaction in interventions
- Effort underway in the identification of critical elements and provision of compensatory measures (replacement equipment or consolidation)
- Experience indicate, that spares play a limited role in the reduction of MTTR. Most stand-by actions consist in troubleshooting, (N+1 warm stand-by policy). Repairs in hidden time



# TS/ASE -- R. Nunes

- Safety and access systems
  - Safety systems → no beam interlock
  - Access systems → beam interlock
- Maintenance
  - External contractors including on-call service
- Spares
  - Safety systems – standard equipment, spares exist
  - Access systems – custom equipment, no spares to buy (PS,SPS)
- Dependencies – Controls
  - Substantial effort to keep computing environment up to date with latest patches
  - Safety and access system dependent on Technical Network
- Consolidation – Equipment should be renewed by 5% per year
  - As it is not, urgent and expensive consolidation works on failure



# Consolidation projects to be started

1. PS primary access (to be started ASAP)
  - Awaiting functional specs/requirements from AB
  - We TS-ASE remain available to advise and guide the technical issues
2. PS & SPS ZORA Video & intercom renewal
  - Service transferred from IT/CS in 2007
  - To migrate to VideoOverIP due to total obsolescence
3. SPS primary access
  - To be started immediately after PS
  - Structure very similar to LHC
4. SPS secondary acces
  - Structure identical to PS primary areas that is functional and working since 1 year now.
5. SPS fire detection consolidation
  - Complete revision of the SPS underground shall be needed to insure performance





# Conclusion

- ASE deals with Safety & Security Systems
  - Maintenance and Consolidation of these systems are strategic for the operation of the machines and for personnel safety
- Maintenance via external contractors allows CERN to optimise internal resources for “core” issues
  
- However these systems are evolving in technology and require an **evolving competence in controls and computing**
  - Networks, automation, databases and SCADA
- **Better usage of tools** (such as D7i) are needed in order **to obtain more significant statistics** and KPI (key performance indicators)
  - This gives better fundamentals for consolidation activities
  - Would be useful that AB/OP logbook refers to specific categories to help the ASE maintenance teams to track OP problems
- **Homogenisation of Access systems** is fundamental for improving the quality of the maintenance service and reducing the impact on operation of machines

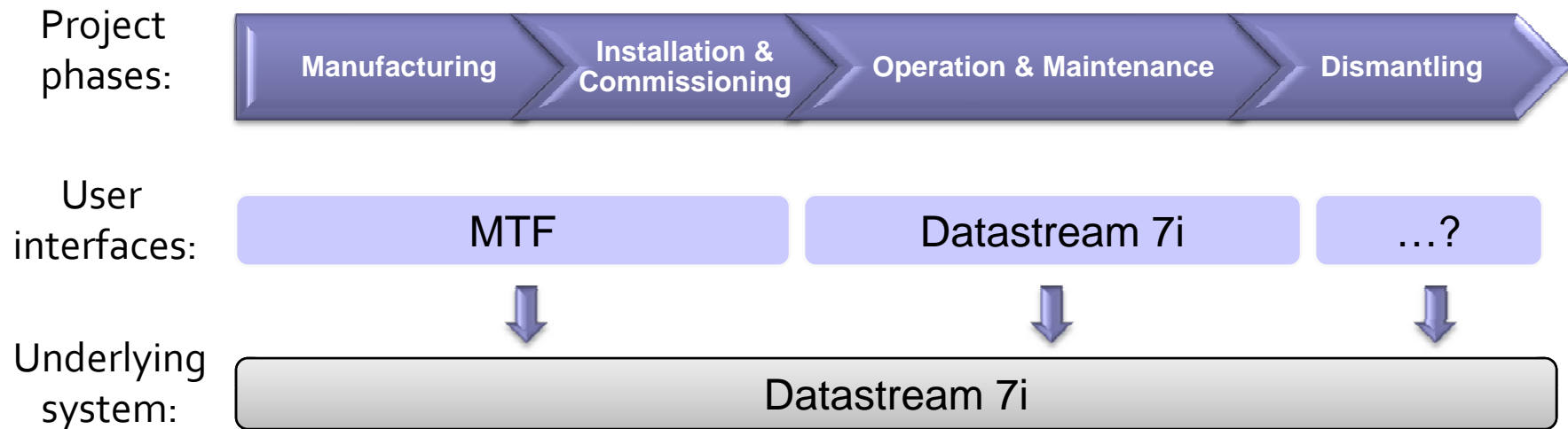


# DataStream 7i – D. Widegren

- Maintenance Management system at CERN for 20+ years
- Used in many groups
  - TS equipment groups, AT/ACR, AT/ECR, via MTF in TS,AB,AT,PH and SC departments
  - A large part of LHC equipment already in D7i through MTF
- Over one million equipment in D7i at CERN
- Oracle database with native and in-house web interfaces

# D7i and MTF

- D7i is the CMMS at CERN but it is also the foundation of the MTF application, which has been used for the manufacturing, installation and commissioning follow-up of LHC .
- This means that all equipment registered and followed-up with MTF are already registered in D7i and ready to benefit from the available maintenance management functionality.
- A complete equipment lifecycle follow-up can be provided – if required!





# D7i

- Asset management
  - Associate technical characteristics with equipment, describe hierarchical relationships, log meter readings, historical tracking, ...
- Work management
  - Preventive and corrective maintenance, work orders, diagnostics, material and task listings,
- Analysing performance
  - Maintenance costs, MTTR, MTBF, ...
- Spare parts management
  - Allocates materials to work orders, identifies materials that needs purchasing according to current stock level, ...
- Reporting
  - Many (100+) reports available, direct Oracle interface for users available



# D7i summary

- D7i has proven to be a very useful tool for improving, automating formalizing and documenting maintenance processes at CERN.
- Significant amounts of time, money and frustration (not finding documentation etc) can be saved if using D7i to organizing the maintenance work.
- D7i is integrated with the EDMS-MTF applications and provides this way a complete platform for managing and tracing information about your equipment throughout their entire lifecycle.
- Help to get started – contact: [cmms.support@cern.ch](mailto:cmms.support@cern.ch)



# GLOBAL REMARKS ON TS' SESSION

- N+1 policy (EL, CV)
- Spare parts policy to consolidate
- Urgent consolidation plan (*approved, to be implemented*)
- CV: users to be “educated” (*fluids distribution and legionella*)
- for on call interventions assistance from AB/OP and priorities list
- D7I as a general purpose tool for maintenance CERN wide