

AB-CO MTTR & Spare Part Policy for the LHC Injectors, Experimental Areas & other Facilities

*ATC-ABOC Days
Jan 23rd, 2008*

Agenda

- Injector Complex Controls Infrastructure
 - What is coming up?
 - Today's reality
- CO Majors Components
 - Inventory
 - Spare Parts Policy
 - MTTR
 - Specific Risks
- CO First line Support
- Conclusions

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WHAT IS COMING UP?

- Controls infrastructure model and practices used for LHC will progressively be applied to the injector complex
 - CO provides core hardware and software components
 - Front-end, back-end and console platforms with O/S
 - Standard collection of hardware modules
 - FESA RT software framework
 - Equipment groups rely on AB-CO for the procurement and installation of hardware components and FESA framework for their specific developments (BI, BT, RF)
 - For some systems, CO has full responsibility for the installation and operational support of complete control solutions (LHC WorldFIP for PO and QPS, Machine protection, Cryogenics, etc)

WHAT IS COMING UP?

- Consequences

- We move, for all machines, towards a unique and coherent model of shared responsibilities between Eq.Groups and CO (prepared at CO3, under ABMB approval)
- CO involvement for SPS will increase
 - FESA as RT software framework
 - Layout and asset management DBs
 - Front-end Hardware renovation
- EQ.Groups involvement at PS front-end level will increase
 - Progressive re-engineering of GM classes
 - Development and deployment of FESA classes
 - CO still in charge of > 40 FESA classes over a total of 125

TODAY'S REALITY

- PS complex
 - CO group is still in charge of almost all front-end hardware and software systems
 - CO « piquet service » as first line support to OP
- SPS
 - Lighter HW and SW involvement of CO compared to PS
 - CO list of experts, best effort
- In general for all injectors
 - Hardware obsolescence is a concern and must be addressed
 - Poor layout and asset management compared to LHC
- Large Initiatives will be taken by CO already in 2008 in order to deploy new FE solutions from 2009 onwards

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MAJOR COMPONENTS

- Front-end Systems
- Machine Timing System
- PLCs
- File and Application Servers
- On-line Databases
- Operator Consoles
- Machine Interlocks
- Application Software

For each layer : Inventory, Spare Policy, MTTR, Risks

MAJOR COMPONENTS

- Front-ends

- Inventory

- 800 operational diskless FE systems for the entire Accelerator complex:

- LHC : 380 (185 VME, 185 Industrial PC, 10 cPCI)
 - SPS : 190
 - PS Complex : 220

- Hardware Components:

- VME and cPCI complete systems (crates, CPU, etc)
 - Industrial PCs (2U crate + motherboard)
 - AB-CO "Standard LEGO" of about 50 VME and PCI modules

- » Timing receiver modules (CTR-x)
 - » DAC and ADCs, Scopes, Function generators, etc

MAJOR COMPONENTS

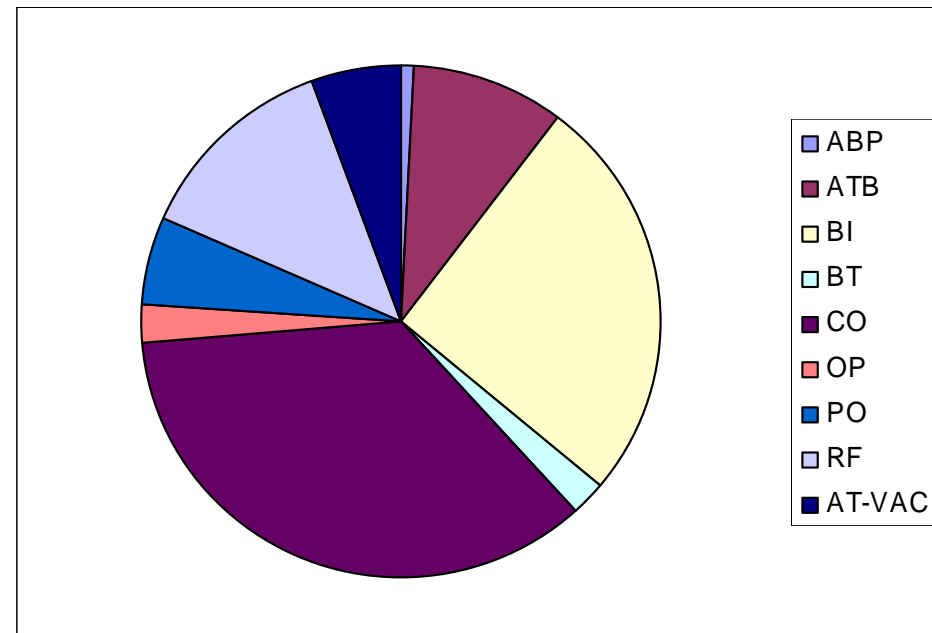
- Front-ends

- Inventory

- Software Components

- About 125 different Equipment classes written in GM
 - GM to FESA adaptor for new FE upgrades

ABP	1
ATB	12
BI	32
BT	3
CO	44
OP	3
PO	7
RF	16
AT-VAC	7
Total	125



MAJOR COMPONENTS

- Front-ends

- Spare Parts Policy

- 10% of installed volume

- MTTR

- Hardware

- All hardware components can easily be replaced in case of failure
 - PS complex: Guaranteed "CO piquet"
 - SPS: list of experts, best effort

- Software

- MTTR depends on nature of the problem
 - » Software configuration problems can be fixed by piquet
 - » Specific GM problems handled during normal working hours (very few remaining experts today!)
 - » FESA : dedicated support line during normal working hours
 - CO in charge of ONLY the corrective maintenance of all 125 GM classes, until these will be re-written in FESA

MAJOR COMPONENTS

- Front-ends

- Specific Risks

- Several components are reaching their end of life time

- VME processors and crates (Wes) > 10 years old

- Out of stock for some Obsolete HW modules (GFAs, MIL-1553, ...)

- CO has taken the following actions

- Annual preventive maintenance of FE systems

- Re-engineering of Obsolete core hardware modules such as GFAs, MIL-1553 (mid-2008)

- Upgrade of some operational systems with new HW modules in order to re-establish spare parts for obsolete modules

- Bulk orders for new VME crates (mid-2008)

- Major on-going market surveys for

- » New generation of VME CPUs running Linux (mid-2008)

- » New generation of Industrial PCs (PICMG 1.3) as a more cost-effective platform (mid-2008) that will replace VME when appropriate

MAJOR COMPONENTS

- General Machine Timing (GMT) (1)
 - Inventory
 - VME MTGs Cluster in the CCR
 - Three central timing systems: LHC, the LHC Injector chain (LIC), and the CTF. (LN4 is coming)
 - The LHC and LIC central timing systems have a hot backup that can be switched between in case of failure or maintenance
 - Long distance fibre (SM) distribution from CCR towards SPS surface buildings and Meyrin site
 - Local Copper distribution (repeaters, fan outs)
 - Timing receiver modules in almost every front-end machine (PMC, PCI and VME form factors). There are still many (~150) TG8 modules used especially in the PS complex.

MAJOR COMPONENTS

- General Machine Timing (GMT) (2)
 - Spare Parts Policy
 - 10% of installed volume
 - MTTR
 - List of experts, best effort
 - Hardware failures can be solved quickly
 - Potential Software problems with MTGs managed by HT section
 - Specific Risks
 - Availability of timing experts outside working hours
 - Timing team members can not always replace each other
 - Documented procedures related to specific failure scenarios will be put in place this shut-down to reduce dependencies on experts as much as possible.

MAJOR COMPONENTS

- PLCs
 - Inventory
 - 2 main suppliers (Schneider & Siemens)
 - 300 References for more than 10000 assets for entire CERN
 - ALL components are COTS and can be procured in 2 to 4 weeks
 - Obsolescence survey will be reinforced
 - Spare Policy
 - each equipment group responsible for his PLCs
 - CO has spares components for Cryogenics, PIC, WIC, Collimators
 - However AB-CO is currently organising a central spare policy under the authority of the GUAPI (PLC users group)
 - One central store at CERN for critical components, for all PLC users (Cf LTC 16)
 - accessible 24/24 to all PLC users
 - One store at each supplier premises with a delivery delay of 24 hours max
 - All spares existing at CERN will be Inventoried in D7i (MTF) and a discussion will start on how we (the CERN plc users) will manage them.
 - Target Q1 2008
 - MTTR
 - Hardware failures can be solved quickly, and the components will be available
 - Specific Risks
 - To avoid the loss of application software a new software repository system is being installed

MAJOR COMPONENTS

- File and Application Servers
 - Inventory
 - 150 Proliant machines installed in CCR
 - Used for Cryogenics, LSA, NFS storage, Front-end Boot server, Logging, Fixed Displays, etc
 - Extreme care has been taken for these servers to ensure the lowest downtime
 - Redundant power supply from 2 different power sources
 - Redundant Raid 1+0 disk with hot swap capabilities
 - ECC memory used and intelligent memory controller with online memory disable function
 - Spare Policy
 - Each type (G3, G4, G5) has 1 fully equipped running spare in the CCR.
 - Spare Disk, Fans, Power Supplies also available in the CCR
 - MTTR
 - List of experts, best effort
 - In case of complete failure of one server, the hot spare will be renamed to the broken one, with automatic installation of the software packages needed and automatic restart of the services.
 - In addition, local private backups (in addition to the IT central one) allow to recover quickly from a major disk failure

MAJOR COMPONENTS

- Operator Consoles

- Inventory

- Standard PCs and 19" TFT screens
 - Running WinXP or Linux SLC4
 - 100 deployed in the CCC and 140 deployed in the CERN technical buildings
 - These consoles are NOT critical for operation

- MTTR

- CO has spare PCs and Screens
 - The re-installation of one console is automatic

- Specific Risks

- N/A

MAJOR COMPONENTS

- Interlock Systems

	LHC & Transfer Lines	Injector Complex
PIC	36 syst. protecting ~800 LHC electrical circuits	None
WIC	8 systems protecting ~150 magnets 5 systems protecting ~800 magnets	<u>LEIR</u> : 1 system & ~50 magnets
BIC	17 systems & ~200 User Permit connections 12 systems & ~100 User Permits connections	<u>SPS ring</u> : 6 systems & ~30 User Permits
FMCM	12 and 14 units	none

- Spare Policy
 - 10% of installed volume
- MTTR
 - List of Experts, best effort
- Specific Risks
 - N/A

MAJOR COMPONENTS

- On-Line Databases (Cf session 4 - T.Smith)
 - Inventory
 - Settings "LSA" database - for SPS, TLs, LEIR ... and LHC
 - Controls configuration database - controls system topology
 - Measurement database - short term read-back data
 - Logging database - long term archived data
 - Hosted and monitored by IT in Bldg 513
 - Major IT efforts towards better resilience (RAC, March 2008)
 - Spare Policy, MTTR and Support
 - IT-DES : see ATC-ABCO session 4 - T.Smith
 - IT can only propose best effort
 - Specific Risks
 - Unavailability of the LSA database makes it impossible for the operator to act on accelerator parameters
 - S.Myers -> Risk Analysis proposal

MAJOR COMPONENTS

- Application Software (Cf session 3, E.Hatziangeli)
 - Inventory
 - All generic X-Motif and Java application programs (knobs, working sets, Automatic Beam Steering, ...)
 - General services : LASER, Passerelle, ...
 - MTTR and Support
 - Operational problems fixed by list of CO/AP experts
 - Generic X-Motif applications: CO ensures ONLY corrective maintenance until the introduction of INCA by end 2009,10
 - Generic Java applications: many improvements ready for 2008 start-up. CO will introduce only high priority modification requests
 - Specific Risks
 - N/A

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CO FIRST-LINE SUPPORT

- Organization

- Team of 5 to 6 technicians
- Each member on service during one week
- Callable by CCC Operation 24/24 during accelerator run (~ 32 weeks)
- Applies to 'standard CO' controls (hardware/software), mostly Front-end
- Manages spare parts
- Tracing: E-logbook, Follow-ups

CO FIRST-LINE SUPPORT

- Scope
 - Piquet called by OP for:
 - PS Complex (Lin2, PSB, CPS, Lin3, LEIR, Isolde, AD)
 - CTF3
 - For SPS and North area, OP SPS team uses expert call list

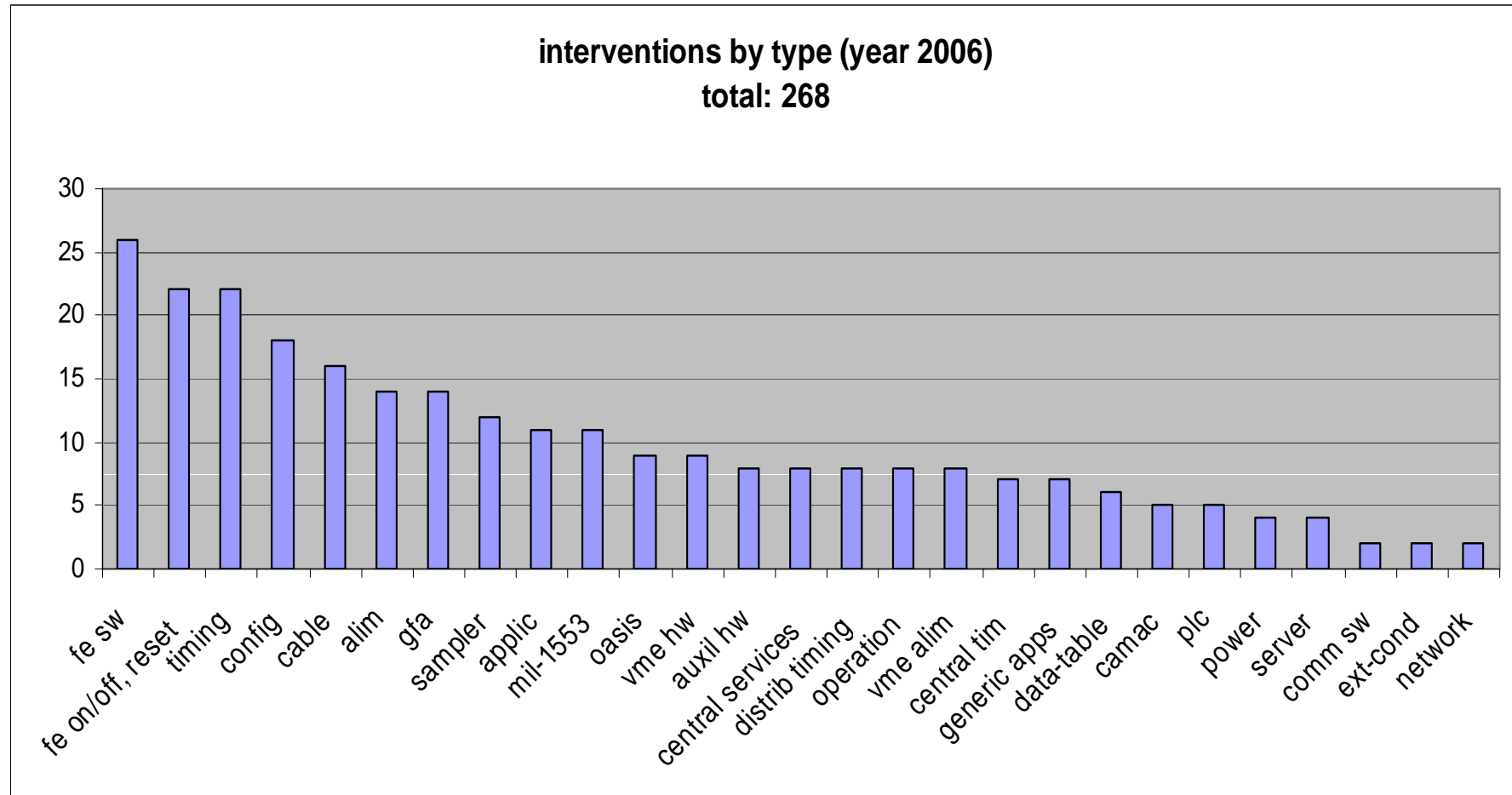
CO FIRST-LINE SUPPORT

- Proper Functioning
 - Training: Basic skills, knowledge of geographical, technical details
 - Regular information from CO sections (SW or HW updates, new installations, planned interruptions)
 - Weekly Contact with Operations team (planned changes, follow-ups)

CO FIRST-LINE SUPPORT

- Domain of Intervention
 - Quality assurance: ensure new systems put in exploitation are correctly delivered (files, startup) configured and documented.
 - Diagnostic: identify causes of failure within the different layers of control system
 - Procedures: non-destructive resets, setting-ups
 - Hardware interventions: identify and replace failing components, re-initialize systems (front-ends, HW modules, timing distribution, MIL-1553, etc)
 - Software: Restoring operational data, correct configuration of front-end equipments or generic applications, FE startup sequences

CO FIRST-LINE SUPPORT



CO FIRST-LINE SUPPORT

(2007 not yet detailed, has similar figures)

- Yearly total (registered): 268
 - HW 111
 - SW 133
 - External 15
- Outside working hours*: 35
 - Total Duration (h) 53
 - Mean duration (h) 1h30
- Requiring follow-up: 67

* not counting issues solved by phone/rlogin

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CONCLUSIONS

- **Spare Policy**
 - available today for all CO hardware components, with sufficient margins
 - CERN wide spare policy for PLCs due for Q1 2008
- **Hardware Obsolescence**
 - On-going program for the re-engineering of obsolete hardware modules
 - New contracts for AB (Q2 2008) for the medium term procurement of new Front-end platforms (VME, Industrial PCs)
- **Front-End (GM) and Application (X-Motif) Software**
 - Will remain as is, with CO corrective actions when required, no new developments

CONCLUSIONS

- **First Line Support**

- We still inherit from the situation prior to the AB restructuring
 - PS complex : CO piquet (guaranteed response time) maintained in 2008
 - SPS : list of experts, best effort
 - LHC : list of experts, best effort
- CO piquet act as first line for the PS complex
- CO piquet can diagnose problems BUT **has real intervention "competence" on the front-end layer ONLY**
- For other systems, the "expert" intervention is mandatory to fix the problem (back-ends, timing, AP software, DBs, ...)
- As proposed by CO3 : the question of first-line support should be agreed at the ABMB level, in particular the **expected guaranteed response time in case of blocking problem for the overall LHC injection chain?**

CONCLUSIONS

- 2009 and beyond
 - Injector renovation project will align the injector controls infrastructure and limits of responsibility to the ones used for the LHC machine (CO3 proposal)
 - CO is actively developing the core building blocks in 2008 (New Front-end platforms, FESA 3.0, INCA)