AB / RF GROUP

C. Rossi on behalf of the AB/RF Group

MTTR, SPARE PARTS AND STAND-BY POLICY FOR RF EQUIPMENTS

AB / RF GROUP

Many thanks to all colleagues in the AB/RF Group who have provided material for this presentation and some of their time for discussions and explanations.

MTTR, spare parts and stand-by policy for RF equipments

Mean Time to Recovery = average time to recover from a failure → average beam downtime due to a specific failure

Mean Time to Repair = total of corrective maintenance time divided by the total of corrective maintenance actions during a given period

In this presentation I will consider the

Mean Time To Recovery

as it is directly related to the beam availability

MTTR, spare parts and stand-by policy for RF equipments

The contribution of the RF systems to the beam downtime has been very small in 2007 and during the past years in general.

Machine	RF Availability In 2007	RF Quota on Fault
Linac2	99.4 %	46.5 %
Linac3	100* (89 – 98)%	0* (40 – 50) %
PSB	99.2 %	24.4 %
PS	99.6 %	5.8 %
AD	99.1 %	3.8 %
SPS	98.8 %	5.4 %
LEIR	Data not available	

*Limited operation during 2007.

The general strategy relies on the availability of hot spares, whenever possible, or at least on a reasonable stock of spare parts.

The RF Group contributes to the AB Risk and Impact Register → effective machine consolidation strategy.

MTTR, spare parts and stand-by policy for RF equipments

RF Vacuum Tubes

We maintain a stock of spare tubes according to the following rule:
1 spare tube / socket, when many sockets are concerned by the same tube model;
Multiple spare tubes in the case of single sockets.

Long term contract with RF tube manufacturers, agreement on our policy for spare stock management;
Alternative suppliers for tubes whose production is discontinued by the traditional manufacturer.

Few critical areas:

1. SPS TWC200 Siemens amplifiers – the tube RS2004 could be soon out of production, spare tubes partly not new → diacrodes;
2. SPS TWC800 – minimum stock of old klystrons → IOTs;
3. Linac2 – tube TH170R limited production still possible, stock sufficient until 2015;
4. Rex – tube TH391 limited set of spares available.

For all events requiring the replacement of a vacuum tube a MTTR going from few hours to max 1 day can be estimated.

MTTR, spare parts and stand-by policy for RF equipments

Linac2 and Linac3

Spare parts available, in general; complete amplifier assembly for the 200 MHz 2.5 MW systems (common to Linac2 and Linac3);
HV power supplies under AB/PO responsibility.

Complete renovation of the control and interlock systems, under the Simatic standard.

Critical areas:

1. Linac3 100 MHz amplifiers (2 x 350 kW) – no spares for the HV anode capacitor → production of few spares;
2. Linac3 ramping cavity 100 MHz amplifier – partial stock of spare parts (controls and electronics).

MTTR going from 2 days (event 1) to 2 days (temporary repairing) – 3 weeks (proper fixing) (event 2).

Rex

Spare parts are partially available, in general; weak point in the 200 MHz tetrode amplifier (TH391);
Low priority, limited set of spares → implement spare policy.

MTTR could be relatively long, depending on spare availability

MTTR, spare parts and stand-by policy for RF equipments

PS Booster – HLRF (C02, C04, C16)

Complete spare cavities available, ready for installation. Complete set of spare RF amplifiers, ancillaries and discrete components.

Critical areas:

1. The C04 limited air cooling capability could affect the system reliability in the case of new operation schemes;
2. One spare HV anode power supply for 12 operational power supplies.

MTTR going from 2 days for one complete cavity replacement to 1 week for patching to a different HV anode power supply → degraded operation possible.

PS Booster – LLRF

Complete spare modules are available for Ring and surface equipment. Hot spares available for pick-ups

Critical areas:

1. No hot spares for the PSB damper pick-ups and kickers.

MTTR 1 week in case of PSB damper pick-up and kicker failure.

MTTR, spare parts and stand-by policy for RF equipments

LEIR

Complete hot spare RF system available in the ring (RF cavity + amplifier). Complete set of spares for all the RF components.

Critical areas:

1. Weakness of the transformer of the HV anode power supply for the RF amplifier → new transformer delivered by the manufacturer.
   HV anode power supply under AB/PO responsibility.

MTTR expected shorter than 1 day in all cases.

MTTR, spare parts and stand-by policy for RF equipments

AD

When AD was built its operational horizon was 2005 and components from previous systems were used (LEAR, EPA).

Critical areas:

1. Some spares available for the high level RF, but general weakness due to component aging.
2. LLRF Schottky pick-ups have no spare.

MTTR 1 week due to pick-up failure → degraded operation possible.

AD Stochastic cooling

50 microwave amplifiers are maintained, but old.

Critical areas:

1. No drawings for the pick-up and kicker movement electronics and motors.
2. Control system still based on old, modified CAMAC controller.

MTTR 1 to several weeks depending on fault.

MTTR, spare parts and stand-by policy for RF equipments

PS HLRF (C10, C20, C40, C80, C02)

All high level RF systems have at least one hot spare installed in the ring; complete set of RF amplifiers, ancillaries and discrete components available.
4 out of 6 C02 HLRF systems have been recently renovated.
Periodic maintenance and consolidation strategy in place.

Critical areas:

1. Some components in the C10 system are old and becoming obsolete, including cavity servos → general consolidation in progress.

Reduced MTTR due to hot spare system → degraded operation for AD beam.

MTTR, spare parts and stand-by policy for RF equipments

PS LLRF

The system is very complex, with a majority of dedicated equipment for specific beams and some equipment required by all beams.
Spare modules and components are generally available.

Critical areas:

1. 40 / 550 modules have no working spare → repair / production of working spares in progress;
2. The one-turn delay feedback is not installed on cavity C10 11 (spare system) → degraded operation for AD beam;
3. Obsolete electronics in the Hereward damping system;
4. 10 MHz matrix (special chassis, modules but no complete spare available);
5. The whole system availability relies on the operation of the room air conditioning system (system monitoring);
6. Extremely old electrical power distribution from the switchboard to the racks.

Variable MTTR related to diagnostic time (could take more than a day in rare cases) and spare availability.

MTTR, spare parts and stand-by policy for RF equipments

SPS HLRF (TWC200, TWC800)

Complete set of spare RF amplifiers, ancillaries and discrete components is available, apart from the RF tubes already mentioned.
Periodic maintenance and consolidation strategy in place.

Critical areas:

1. Spare couplers (TWC200) and RF windows (TWC800) could not be tested because of lack of manpower;
2. 2 out of 3 transformers broken during 2007 on TWC800 → new transformers ordered.

Variable MTTR related to spare availability → degraded operation possible for TWC800 system.

The progressive slow replacement of old Siemens amplifiers with new, probably diacrode, amplifiers will reduce the impact of possible failures.

MTTR, spare parts and stand-by policy for RF equipments

SPS RF Controls

Spare modules and components are partially available.

Critical areas:

1. The TWC200 cavity controller is equipped with Simatic PLC dating from 1982, with limited amount of spares;
2. The programming machine for that system is obsolete and only few remain (probably) at CERN.
3. No hot spares available for the transverse dampers.

Variable MTTR depending on the controller component affected.

MTTR between 2 and 4 days for replacing one kicker in the machine.

MTTR, spare parts and stand-by policy for RF equipments

PIQUET

HLRF is providing a piquet service for SPS equipments and PS C02.
LLRF is providing a piquet service for PSB, PS and SPS.
The HLRF intervention in the PS area (Linacs, LEIR, AD, Rex, PSB, PS) and the LLRF intervention in some of the machines of the PS area (LEIR, AD) is guaranteed by means of a list of specialists available on call.

In the PS area the HLRF piquet is not possible due to lack of manpower; however the on-call list has assured an effective intervention until now. The presence of hot spares helps.

Critical areas:

1. Small number of specialists available for many different systems in the PS area;
2. Limited standardization of modules and equipments (basically due to their different age and to limited renovation).

Variable MTTR depending on specialist availability when the “piquet” is not provided or cannot solve the problem.