EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
CERN — A&B DEPARTMENT

AB-Note-2004-043-OP

ACCELERATOR OPERATIONS FROM THE CCC

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Abstract

This note outlines how the AB/OP group sees the operation of all CERN's particle accelerators and experimental areas from the CCC. It covers; what is done now; what will have to be done from the CCC; who is needed to do the work and how accelerator operations should be organized in the CCC. The main body of the note only concerns shift workers. Non-shift worker accelerator operation is covered briefly in an annex. Also, it will not cover the aspects specific to the TCR and QCR Operators. This report is a synthesis of the views of the whole OP group and is an essential part of our preparation for operation from the CCC.

Geneva, Switzerland
10 May 2004

1 Introduction

This note outlines how the AB/OP group sees the operation of all CERN's particle accelerators and experimental areas from the CCC. It covers; what is done now; what will have to be done from the CCC; who is needed to do the work and how accelerator operations should be organized in the CCC. The main body of the note only concerns shift workers. Non-shift worker accelerator operation is covered briefly in an annex. Also, it will not cover the aspects specific to the TCR and QCR Operators. This report is a synthesis of the views of the whole OP group and is an essential part of our preparation for operation from the CCC.

2. What will Accelerator Operations do from the CCC?

Here I outline what Operations currently does from the MCR and the PCR and see how this will be extended to the CCC.

a. What do we operate?

Accelerator Operators are (or will be) responsible for the operation of:

- 2 LINACs
- PSB
- PS
- SPS
- AD
- All associated transfer lines
- AD experimental area
- ISOLDE (up to the target stations)
- North, East and West experimental Halls (West area operation stops at the end of 2004)
- nTOF experimental facility (up to the target station)
- CNGS facility (from 2006)
- LEIR (from 2006/7?)
- LHC (from 2007)

b. When do we operate it?

The MCR and the PCR are only manned during:-

- Hardware tests in preparation for Cold check-outs (2 - 3 weeks)
- Accelerator Cold check-outs (1 - 2 weeks)
- Periods of beam operation (several months)

In the CCC Accelerator Operators will only be present for the same periods. However, there will be Technical service Operators (presently in TCR and those planned for the LHC Cryogenic Plant Operation) present 365 days/year.

c. What does Operations actually do?

Hardware tests

During Hardware test the Accelerator Operators are not responsible for the hardware tests themselves, but they control access to the Accelerators and assist the equipment specialists with the tests. In the PCR the coordination of the hardware tests is done by OP this is not the case in the MCR.

The hardware tests will continue in a very similar way from the CCC. In addition in 2006/2007 Operations will be strongly involved in the LHC hardware commissioning with dedicated Operators on shift in the CCC, for each Octant being commissioned.

Cold check out

The machine cold check outs are performed by the Operators and coordinated by OP. The Operators have to prepare the Accelerator fully for beam operation and ensure that all the equipment functions as it should under beam conditions, but without beam. This involves a lot of liaison and coordination with all equipment specialists as well as a good knowledge of the various accelerator systems. During these periods the MCR Operators often join hardware specialists during interventions on the hardware or perform local interventions themselves, while this is rarely the case for PCR Operators. Since the CCC will be geographically distant from this equipment these interventions will be more time consuming and less frequent. In all other respects the cold check outs will be performed in the same way from the CCC. During cold check outs the accelerator operators are responsible for the application of all radiation and industrial safety rules concerning the accelerators

Beam Operation

During periods of beam operation the Operators have a number of distinct roles:

- to start all scheduled beam operations according to the priorities and schedule fixed by the ABOC,
- to maintain all accelerator beams at the optimum performance level (this includes beam parameters such as intensity emittance etc as well as beam availability)
- to operate the various experimental areas as well as the accelerators,
- to improve the performance of all beams, this includes testing and implementing ideas on existing beams and/or testing ideas for future implementation,
- to participate in the preparation and execution of schedule beam studies with other accelerator experts,
- to coordinate interventions and repairs on the accelerator hardware in case of breakdowns (Sometimes Accelerator Operators will intervene directly on accelerator hardware to try and make a first diagnosis of a problem and make repairs. This happens more often for MCR Operators due to their proximity to the accelerator equipment and will happen less from the CCC),
- responsible for the application of all radiation and industrial safety rules concerning the accelerator and its beams,
- to control the access into the accelerator tunnels and experimental areas,
- make certain patrols of controlled zones.

Here it should be emphasized that the Operator's role is far more than just intervening in cases of breakdowns. They are expected to set up, optimize the beams required by the various users and take whatever actions are necessary to maintain the best possible level of performance. The time that they spend working on breakdowns is only a small fraction of their total workload.

Apart from the reduction in the number of direct interventions on accelerator hardware for MCR Operators, these tasks will be the same in the CCC as they are now.

d. What about the LHC?

Clearly the major challenge for Operations of the coming years will be the commissioning and the initial operation of the LHC. This will not only involve running the machine itself (the most complex particle accelerator ever built), but also supplying the particle beams to commission and fill it. It should be remembered that the performance of the LHC will depend critically on the quality of the beam(s) delivered by the injectors. The PSB will determine the transverse emittance of the beam in the LHC; The PS will determine the longitudinal bunch parameters; The SPS will determine the overall filling pattern.

Therefore the CCC is an essential element in the operation of the LHC as it puts the whole LHC Operations team under a single roof working together towards the goal of running the machine. This team will include all injector operations, the LHC cryogenics and the CERN Technical Services upon which the LHC depends. The performance of the LHC will be directly related to the performance of the Operations team in the CCC.

Running-in the LHC is already a huge task, but we will have to accomplish this at the same time as maintaining all the present operations as well as supplying the high intensity beam for the CNGS facility and commissioning the future Heavy Ion beams for the LHC.

3. How should Accelerator operation be organized in the CCC?

a. How are we organized today?

Currently the accelerator Operators work in two separate control rooms. They are divided into three teams, covering PSB, PS and SPS.

PSB Operators are responsible for operation of:

- 2 LINACs & transfer lines
- PSB
- ISOLDE (up to the target stations)
- PSB to PS transfer lines.

PS Operators are responsible for operation of:

- PS
- EAST HALL & transfer lines
- nTOF (up to the target station)
- transfer line towards SPS (TT2)
- Transfer lines to AD
- AD and AD experimental area, (when AD specialist is not present see annex).

SPS Operators are responsible for operation of:

- SPS
- NORTH and WEST Halls & transfer lines (WEST operation stops at the end of 2004)
- part of SPS injection line (TT10)
- TI8 – LHC injection line (from September 2004)
- CNGS from 2006

The following Operators are present for one shift in the MCR:

- one PSB Operator
- one PS Operator
- one Shift Leader, who works most of his time on the PS (see section **3.f**).

The following Operators are present for one shift in the PCR:

- one SPS Operator
- one SPS Shift Leader (see section **3.f**).

This number of 5 Operators for the current complex of machines is considered as the minimum that is workable in view of the wide range of responsibilities that the OP crews have (**see section 2**). It is essential to maintain distinct separate roles for the present Accelerator Operators as they need to maintain a high level of understanding of a wide range of very specialized hardware and the different processes that make up an accelerator. Experience from the MCR and the PCR (during SPS/LEP operation) shows that one Operator can be considered as an expert on one machine and have a good knowledge of another but not more. In a few exceptional cases Operators can be considered as experts on two machines, but this is the exception and not the rule.

b. How will we be organized in the CCC?

In the CCC there will be distinct specialized teams of Operators for the different machines and during periods of accelerator operation there will be 7 persons on shift for the accelerators:

- 1 PSB Operator
- 2 PS Operators
- 2 SPS Operators
- 1 LHC Operator
- 1 LHC EIC (the Engineer in Charge is an engineer/accelerator physicist who will be dedicated with the LHC Operator to LHC operation)

It is envisaged that after some years of LHC operation the EIC will no longer be working on shift. Then the number of Accelerator Operators on shift in the CCC will be 6.

We must maintain 7 Operators for each of these 6 posts in the CCC, this is vital to allow Operators time to work on other tasks (SW development etc). Without this commitment to other tasks it would not be possible to move Operators into other groups

after a number of years in the control room. This flow of experienced Operators into equipment and other service groups is very useful for the Department and must be maintained. (see section **3.c**)

Also the majority of the applications that are used to control the accelerators are written by the OP members. These normal days give them also time to spend dedicated time on machine specific issues for which they will not have time during shifts. Some Operators are responsible for entire or part of systems around the accelerators like CBCM, CATV, BSM, TOMOSCOPE hardware, etc.. They need normal days for development and maintenance of these systems

c. What type of Operators do we need?

It should be noted that the Operators are the people who start-up, optimize, maintain and improve all the beams in all CERN's Accelerators. This deliberate decision to move more responsibility to Accelerator Operators has led to a considerable increase in the level and competence of Accelerator Operators and has reduced considerably the number of engineers and accelerator physicists dedicated to Operations. This approach must be maintained and encouraged in the CCC

It is globally far more efficient to have a team of high-level, competent Operators supported by a small team of Accelerator Physicists, rather than a large team of Accelerator Physicists supporting a lower level team of Operators.

Accelerator Operators are currently recruited in either career path C or D, depending on their technical qualification. New recruits are usually young; it is often their first job after college. They are recruited on 3+3 LD contracts. After 6 years, they have the possibility to move onto FT posts. In order to obtain an FT post the Operator must be seen to have a clear future career evolution either inside Accelerator Operations as a shift leader or in another technical area at CERN (Controls, beam diagnostics etc.). It is important to maintain a strong continuity inside Operations, by keeping staff in Operations for > 6 years, as it takes a relatively long time to fully learn the job (1 - 2 years) and a minimum of 4 -5 years to become a shift leader. Without this continuity it would not be possible to maintain the required level of competence in the team.

d. How is accelerator operation supervised?

Presently the work of the Operators is supervised by a number (usually 4 or 5 per accelerator) of Accelerator Supervisors (previously known as Coordinators for SPS and LEP). These Supervisors oversee the work in the control room, fix beam priorities and assist the Operators when necessary. They are on duty for a week, and during that week they are available both during and outside normal working hours to assist Operators with any problems that they cannot resolve. The Supervisors also deal with operations related problems that require longer term follow-up (several days). However, this is NOT a piquet service as the number of times Supervisor intervention is necessary outside working hours is very small. This is again due to the high level of the Operators who can deal with almost all problems on the accelerators independently. There are dedicated Supervisor teams for the LINAC, PSB, PS, SPS and ISOLDE.

It takes several years to train a good Accelerator Supervisor. The ideal Supervisor needs a solid knowledge of the Accelerator, a sound understanding of Accelerator Physics and good communication skills. They are usually Engineering or Physics Honours level degree graduates. About 60% of the Accelerator Supervisors are in the OP group (except for the LINAC where they are all in the ABP group). The remainder are in the ABP, RF and CO groups. The use of Supervisors from these other groups improves contact with the groups concerned and will be maintained in the CCC, but the majority of the Supervisors will still be from the OP group.

It is not envisaged to change the role of the Supervisor with the move to the CCC and the supervision of Accelerator Operators will be done in the same way. Therefore it is again very important to maintain the present level of Supervisor and Operator competence and expertise in the future.

e. Contact with specialists/experts

For an Accelerator Operator in the control room, contact with the equipment experts is a vital part of his/her job. Operators have to run the equipment, they have to optimize it's use and diagnose problems, often remotely. Therefore a close contact with all equipment specialists is essential, to maintain knowledge and understanding of the accelerator hardware. An Operator's sound knowledge of how to use the accelerator hardware reduces the number of times he/she will need specialist help to run the accelerator. This knowledge can only come from close personal contact with the experts concerned. This close contact is very important in both the MCR and the PCR, it will be even more important in the CCC, where the present MCR teams will be further away from the hardware itself.

The Operators also need to have very close contact with various beam studies that are performed on the machines. They can make very active contributions to such studies and many of the operations that are tested in these studies soon become standard operation practice so it is vital to have Operators participating from the beginning. This means that all beam studies etc should be done from the CCC and not from other local control rooms. This is presently the case in the MCR and the PCR, except for a number of RF studies, where certain facilities are only available locally. However, in both MCR and PCR the RF experts make a particular effort to maintain excellent contact with the Accelerator Operators. This close contact must continue in the CCC.

f. How will the hierarchy in the CCC be organized?

In both PCR and MCR, there is always a Shift Leader on duty. A Shift Leader is an experienced Operator, who takes overall responsibility for activities in the Control room during one shift of duty. The Shift Leader role requires a good understanding of the accelerators and the experience to take on the spot decisions on priorities, particularly when action is needed in several areas at once. This system works very well in the MCR and the PCR and there will have to be a similar role defined for the CCC. However, it is not clear that a single person will be capable of taking such on the spot decisions for all the accelerators (Can one person decide how many pulses ISOLDE should get at the

same time as dealing with LHC cryogenics experts?). Therefore it may be necessary to define more than one shift leader post for the various areas of work. However Accelerator Operations will need to maintain the idea of a shift leader and, with 12 people present the CCC will need someone to take decisions in case of conflicting requests etc.

Annex: Non-shift operation

For AD and ISOLDE the mode of operation is rather different. Here there are no dedicated Operators on shift. In both cases there is a small team (5 people) of Operation Supervisors, who are responsible for the operation of the facility for one week each. During normal working hours the Supervisor runs facility and makes whatever interventions are necessary. The overnight operation of the facility is done by the MCR Operators for the AD and the Users themselves for the ISOLDE facility. The AD and ISOLDE supervisors are considered as piquet teams as they get called relatively frequently outside working hours. This is a direct consequence of the decision not to have specialized teams of Operators for these facilities.

These AD and ISOLDE Supervisor teams spend a lot of time running their facilities directly from small local control rooms, which are located close to the facility itself. This is because AD and ISOLDE were conceived with this style of operation in mind and still need a physical “local presence” on a regular basis. The Operations teams also have a lot of close contact with the end users in both cases.

This style of operation will be more complicated from the CCC in Prevessin. However, work is in progress at both AD and ISOLDE to minimize these complications.