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SHIFT PROTOCOLS PROCEDURES FOR ACCELERATOR-BASED EXPERIMENTS AT FERMILAB

This document describes agreed upon procedures and communication protocols for accelerator-based experiments at Fermilab.

The document has three sections that describe:

(1) How to certify a remote shift operation center and protocols for communications between remote shift personnel, the primary point of contact, and the MCR.

(2) The conditions which an experiment must meet to qualify and maintain qualification for "checklist shifts" and the basic requirements for communication with check list shifters.

(3) Expectations for communications between an experiment and the laboratory when the experiment is down for an extended period.

If modifications to the procedures and/or protocols become desirable, changes to the document can be proposed by contacting the Chief Research Officer (CRO).

1. REMOTE SHIFT PROTOCOL FOR FERMILAB EXPERIMENTS

This section describes agreed upon procedures for certifying remote operation centers for Fermilab experiments, and a protocol for communications between remote shift personnel, the primary point of contact, and the MCR.

1.1 INTRODUCTION

The viability of running some shifts from certified locations remote to Fermilab has been demonstrated for experiments using the Booster neutrino beam, and for experiments using the NuMI beam. These demonstrations exercised a procedure for establishing certified remote shift locations (Remote Operation Centers – ROCs), defined the preconditions that must be satisfied and a protocol for the communications of the remote shifters with the MCR. In the future it is anticipated that many Fermilab experiments will want to use remote shift locations for at least some of the time. It is desirable that, to the extent that is practical, the remote shift center certification procedures and MCR communication protocol are common to all the experiments on a particular beamline. This document describes the agreed upon procedures and protocols.

1.2 PRECONDITIONS FOR REMOTE OPERATION CENTER CERTIFICATION

There must be no ES&H functions provided by onsite shift personnel that might be compromised by remote shifts. The collaboration, in consultation with Program Planning and the relevant Laboratory Divisions, must provide a mechanism for on-call support for critical experiment infrastructure that requires on-site access.

1.3 REMOTE OPERATION CENTER CERTIFICATION

1. The experiment spokespeople are responsible for ROC certification procedures specific to the experiment. The institutional principal investigator(s) at the candidate ROC must verify with the experiment spokesperson(s) that the institution is ready to become a ROC, i.e. that all required monitoring, control and communication resources are up and running and that all shift functions can be carried out.

2. The experiment spokesperson(s) must communicate with the Head of the Operations Department of the Accelerator Division the name and the phone number of the new ROC ready to be certified. This must take place at 24 weekday-hours prior to the first time that the new site hosts a remote shift.

3. Before the first remote shift is taken, the Head of the Operations Department must (i) notify the MCR that the new ROC is being added to the list of recognized ROCs and (ii) verify the ROC contact information and ensure its availability to operators.

4. The experiment spokesperson(s) must make sure contact information for the new ROC is available to all experiment operations centers.

5. To complete certification, the new ROC must host 24 hours of "shadow shifts" in parallel with a `primary shift' hosted by the operations center located at Fermilab or another ROC which is qualified to host according to collaboration-defined procedures. This shadow shift is to make sure that all issues have been resolved and hand-off protocols understood. During these shadow shifts, the remote shifter(s) must remain in constant contact via video link with the primary shifter(s) and must perform all operations expected of the shift, including communication with the MCR. The shadow shifts must establish that the remote shifters can adequately fulfill all their responsibilities including, if applicable, DAQ operation and/or monitoring, data quality and/or beam quality monitoring, and logbook and/or checklist entries.

6. Once certified, experiment spokesperson(s) are responsible for defining conditions for a ROC to maintain its certification.

1.4 COMMUNICATION PROTOCOL

1. A ROC shifter will call MCR at the beginning of the shift to state the institution from where he or she is taking the shift. This location will also be added to the name entry in the MCR logbook. A list of ROC phone numbers will be accessible in the MCR so the operators can obtain the number readily.

2. For each beamline the "primary point of contact" for the shift will be the shifter for the experiment designated as the primary user of the beamline. In normal operations this is expected to be the NOvA experiment for NuMI and the ICARUS experiment for the BNB. The primary point of contact, whether they are at a ROC or otherwise, must be actively on shift, and when contacting the MCR at the beginning of the shift, must verify that the MCR has the correct phone number to contact them.

3. If the shifter is not the ``primary point of contact'' on the beamline, at the beginning of the shift they will make contact with the primary point of contact to state the institution from where he or she is taking the shift.

4. If there is a problem found with the detector such that the data will not be useful for more than an hour of beam time, MCR must be notified and MCR will determine whether or not to stop delivering beam. The guideline for the MCR is that if at least one experiment can take useful data, the beam should be delivered to it unless there are other reasons for shutting it off.

5. MCR will not respond to requests to go to the experimental area to reset or monitor anything at the experiment or its local control rooms.

6. There will always be experiment experts locally available that can be called to respond to problems. A list of these experts will be maintained locally at each ROC for quick access.

7. The ROC shifter must also be able to communicate with the active shifters on the other experiments using the beamline. The spokespeople will ensure that all their ROC's have lists of the possible locations where these other shifters may be, so that in the event that other experiments are running remote shifts, contacts can be established as needed.

8. MCR will normally only contact the ``primary point of contact'' on the beamline, regardless of whether that point of contact is on site or is remote. It will be the responsibility of the primary point of contact to communicate messages from MCR to other users of the beamline. The locations of the other users will be in the MCR E-Log since the protocol for notifying MCR of a remote shift is the same for all experiments, regardless of whether they are the primary point of contact.

9. Experiments which have multiple ROCs in use are encouraged to use services which enable a single phone number to ring in multiple ROCs and to register this

single phone number with the MCR in addition to all the local phone numbers for the ROCs. Google Voice is an example of one technology option which has been deployed for this purpose.

2. CHECKLIST SHIFT PROTOCOL

Experiments with sufficiently automated data acquisition and monitoring systems that are capable of detecting and in cases correcting error conditions may, subject to the requirements below, run their shifts as "checklist shifts". These are shifts whereby an assigned shifter uses non-interactive monitoring tools to check the performance and state of the experiment's detectors, data-taking, and use of beam, and alerts the experiment's experts and other support personnel as needed when problems arise.

These protocols establish the conditions which an experiment must meet in order to qualify and maintain qualification for checklist shifts and outlines the basic requirements for communication with check list shifters in order to ensure the highest standards for experimental operations at Fermilab.

2.1 QUALIFYING FOR CHECKLIST SHIFTS

2.1.1 General Conditions

Experiments may operate with checklist shifts during beam-on conditions only with approval of the CRO. With the exception of qualifying contingencies outlined below, experiments that are primary beam users are expected to operate shifts from their Remote Operations Centers (ROCs) during normal beam-on operations, and will not be qualified for checklist shifts.

2.1.2 Qualifying Contingencies

Qualifying contingencies are conditions of widespread disruption in which normal shift operations are prevented due to widespread access restrictions to ROCs, such as during the Covid-19 pandemic. During such contingencies, the CRO may permit experiments that are primary beam users to conduct checklist shifts, subject to meeting the requirements listed in the remainder of Section 2.

2.1.3 Application for Approval to take Checklist Shifts

An experiment wishing to incorporate checklist shifts into its operations should submit an application to the CRO that:

1. Demonstrates that the experiment meets the required preconditions for Remote Shifts described in Sec. 1.2.

2. For primary users, demonstrates a need for checklist shifts on the basis of a qualifying contingency.

3. Demonstrates minimal incremental impact of checklist shifts on detector performance, detector uptime, and timely communication with MCR. A guideline is that an experiment is ready to propose checklist shifts if, during a testing period of not less 80 hours of shift operation in 8-hour or longer segments, the evaluation of the experiment is that less than four hours of additional downtime (5%) or reduced data quality would have been incurred by checklist shifts, and that there would have been no incidents of downtimes exceeding 2 hours that would not have been reported to the Main Control room within 30 minutes of crossing the 2 hour threshold.

4. Documents the experiment's procedures and protocols for running checklist shifts including documentation of the communication protocols between the checklist shifter and the Main Control room and the checklist shifters and the primary beam users.

5. For secondary beam users, documents the experiment's plans and procedures for assuming primary user status on the beamline during a checklist shift.

The CRO will review the application and approve the experiment for checklist shifting if the above items are addressed satisfactorily.

2.2 MAINTAINING QUALIFICATION

To maintain its qualification to run checklist shifts an experiment must maintain a high monthly-averaged uptime performance and continue to demonstrate that the communication protocols with the Main Control Room and other users of the beamline function smoothly. A guideline for acceptable detector uptime is outlined in Sec. 2.1.3 above. If in a monthly average, the differential downtime from running checklist shifts exceeds 5%, or if there are multiple events in one month where 2 hour downtimes are not reported according to the timeline described above, the experiment spokesperson(s) will report on this situation to the CRO. The CRO will then work with the experiment to understand the risk of similar incidents in the future. If necessary, the CRO may suspend the qualification until identified issues are addressed and/or call for a review of the situation.

2.3 BASIC PROTOCOLS FOR CHECKLIST SHIFTS

2.3.1 Shifters running checklist shifts must be reachable via phone during their shifts and should inform both the Main Control Room and primary beam user of their location and phone number at the start of the shift.

2.3.2 For each beamline a prioritized list of secondary users who are qualified to become primary users should be established. Should a primary beam user go offline for an

extended period, the secondary users should be consulted to see if they are willing to accept the role and responsibilities of the primary user for the beamline. Experiments running checklist shifts should have procedures in place for promptly deciding if they wish to assume the role of primary user and switching into the primary user role. If no primary user can be identified on a beam line, the Main Control Room may choose to stop sending beam down the line.

3. EXPERIMENT DOWNTIME PROTOCOL

Experiments using beam provided by the Fermilab accelerator complex are, with the exception of test-beam experiments, expected to take data 24 hours per day, seven days a week during normal accelerator operations. If data taking is unexpectedly interrupted for an extended period, it is important that appropriate actions are taken to keep the relevant laboratory departments, divisions, and directorate informed of the status. This section describes those actions and when they should be taken.

3.1 DEFINITIONS

The downtime protocols formalize expectations for communications among several actors:

Experiment operators include the collaboration shift workers and collaboration on-call experts that support the shifters.

Support groups are a set of Fermilab personnel within one of the Fermilab divisions who have technical expertise in a specific facet of experiment operations.

Designated Responsible Person (DRP)
An experimental collaboration should have a Designated Responsible Person (DRP), for example the experiment Run Coordinator, who is available on a 24 hour, 7 days per week basis in the event of unanticipated interruptions to normal data taking. The DRP shall be sufficiently knowledgeable to determine which, if any Support Groups are needed to diagnose the problem, and have access to the list of support groups that may be needed, and associated contact information.

Collaboration Management Responsible Person or Persons (CMRP)
The Collaboration Management Responsible Persons are the collaboration spokespeople or their designees who have final responsibility for the collaboration's operation of the experiment.

Laboratory Heads include laboratory leaders with responsibility for experiment operations and oversight of the Support Groups. These are

- the heads of the Accelerator, Particle Physics, Core Computing, and Neutrino Divisions,
- the Head of the Office of Program Planning,
- the Associate Laboratory Director for Particle Physics.

3.2 PROTOCOL

During unplanned downtimes, notification of relevant experiment and laboratory stakeholders should proceed according to the following timeline. In each case, the times given are to be understood as the actual accrued downtime or the anticipated downtime. For example, if an experiment has been down for 30 minutes and recovery is anticipated

to incur 60 minutes of additional downtime, the experiment operators immediately proceed with the protocols required for a 90-minute downtime.

The following protocol is a template; each experiment should follow this template to produce a protocol specific to their experiment DRPs, CMRPs, and Support Groups. To facilitate execution during detector downtimes, the experiment protocols should outline the hours and expectations for Support Group coverage as specified in the experiment's TSWs and SOWs with the relevant divisions, and contact phone numbers and/or procedures to contact responsible persons in those divisions should be specified.

Stage 1	<1 hour	**Experiment operators** follow experiment procedures to attempt to restore the detector to an operating state.
Stage 2	1 hour	If the downtime has lasted one hour or is anticipated to last one hour or more, **Experiment Operators** contact the experiment **DRP**. The **DRP** ensures that the **Main Control Room** has been contacted and ensures that any relevant **Support Groups** have been contacted.
Stage 3	2 hours	If **Support Groups** have been contacted but have not acknowledged contact, and the requested support falls within the coverage prescribed by the Experiment Operations Plan and/or Memorandum of Understanding between the collaboration and the division, the **DRP** should escalate to email and phone contact with **Laboratory Heads** with direct oversight responsibility for the **Support Group** that has not acknowledged contact.
Stage 4	12 hours	If downtimes extend to 12 hours, the **DRP** contacts the experiment **CMRP** by phone and by email. The **CMRP** reports the downtime incident to **Laboratory Heads** via email.
Stage 5	24 hours	The **CMRP** reports the detector status to **Laboratory Heads** via email every 24 hours while the downtime incident continues.
Stage 6	End of incident	The **DRP** notifies the **Main Control Room** of the resumption of data taking following any Stage 2 or greater incident. The **CMRP** provides a summary report of any Stage 4 or greater incident to **Laboratory Heads** via email.