

¹ **Shift overview for the Quality Assurance of the 3”**
² **OD PMTs**

³ **Technical Note**

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¹⁴ **1 Introduction**

¹⁵ Each Hyper-Kamiokande Outer Detector (OD) photomultiplier tube (PMT) will undergo quality assurance (QA) to assess performance and ensure reliable long-term operation. The OD
¹⁶ PMT QA program consists of a series of electrical and optical tests performed on PMTs after
¹⁷ delivery and prior to their integration into PMT+WLS units and installation.

¹⁹ This technical note describes the shift work associated with the OD PMT QA, with a particular focus on personnel roles, shift organisation, training requirements, and safety considerations. It is intended to support safety review and shift planning for the QA task.

²² A detailed description of the QA setup, procedures, performance metrics, timeline, and acceptance criteria is outside the scope of this document and will be covered in dedicated OD
²³ PMT QA documentation. Interfaces with other OD activities, including PMT delivery, storage,
²⁴ and assembly, are described in the corresponding OD installation procedures, logistics, and
²⁵ instructions technical note [1].

27 2 Shift work

28 The OD PMT QA work will take place in a ground-floor room at the University of Toyama.
29 PMTs will be stored before and after QA in a separate ground-floor storage area at the same
30 site. QA will be carried out in the same room as the PMT+WLS unit assembly, within a clearly
31 marked and optically separated area equipped with two dark boxes and the required readout
32 and control equipment.

33 PMTs will be transported between the storage and QA areas at ground level, typically using
34 a trolley to reduce manual handling. As the QA space is shared with other OD activities,
35 including PMT assembly, coordination is required to maintain clear access paths and to separate
36 tasks where needed. Further details of room layout, storage, transportation, and assembly are
37 provided in the OD installation technical note [1].

38 2.1 Tasks and responsibilities

39 During QA shifts, shifters will handle PMTs and operate the QA test setup. This includes
40 transporting PMTs between storage and the QA workspace, loading and unloading them into
41 dark boxes, and connecting and disconnecting high-voltage (HV) and signal cables. PMTs will
42 be moved in boxes of six, each weighing up to ~ 15 kg, while individual PMTs are lightweight.
43 Transport will be assisted by carts or trolleys. Handling of PMT transport boxes during delivery
44 may also be required, depending on final logistics.

45 Shifter tasks include opening and closing dark boxes, retrieving and positioning PMTs on
46 PMT stands, performing basic visual inspections, scanning and logging PMTs with a barcode
47 scanner, and operating HV and data acquisition systems. These activities involve repetitive
48 handling and working in bent positions. A photo of a PMT on a PMT stand inside a dark box
49 is shown in Fig. 1.

50 Shifters will also handle optical fibres, LEDs, and data acquisition hardware such as ADCs,
51 high-voltage power supplies, low-voltage function generator, and a control computer.

52 The QA shifts may also involve external workers, such as students from the University of
53 Toyama. These workers could perform routine tasks such as transporting PMTs, loading and
54 unloading of PMTs into dark boxes, and basic visual inspections, under the supervision of
55 trained shifters and/or the shift leader.

56 2.2 Training and supervision

57 Shifters will receive training in manual handling of PMTs, working with fragile equipment,
58 and basic awareness of high- and low-voltage equipment. Training will also cover scanning
59 and logging PMTs, handling optical fibres and LEDs, operating data acquisition hardware and
60 software, and using carts or trolleys for transport.

61 Routine QA tasks, such as loading and unloading PMTs, visual inspections, and data ac-
62 quisition, can be performed independently by trained shifters. An expert will be available for
63 guidance during initial setup, troubleshooting, final data analysis and approval, or any non-
64 routine adjustments to the QA equipment.

65 All shifters must be aware of potential hazards, including repetitive handling, bent postures,
66 and interaction with HV equipment, and must follow established safety procedures.



Figure 1: A single PMT mounted on a PMT stand inside one of the QA dark boxes. The orange cable is an optical fibre used to deliver light from an LED pulser (not connected here) to the PMT photocathode and is connected to a cap that is covering and protecting the PMT face.

67 External workers, if hired, will receive the same training as regular shifters, including man-
68 ual handling, awareness of fragile equipment, and basic high-voltage safety. They will perform
69 tasks only under supervision and will not carry out non-routine adjustments to the QA setup.

70 **2.3 Schedule and workload**

71 QA shifts are planned to last up to 8 hours per working day. Shifters will work in pairs to
72 safely handle PMTs, including loading, unloading, transporting between storage and the QA
73 workspace, and performing QA measurements. At least one experienced shift leader will be
74 present near or in Toyama at all times. The total QA campaign is expected to span several
75 weeks, depending on the PMT delivery schedule and testing rate.

76 **3 Safety considerations**

77 The QA work involves working with PMTs and associated equipment, and includes potential
78 hazards related to manual handling, electrical connections, and workspace coordination. Key
79 safety considerations for shifters are summarized below:

- 80 • **Manual handling:** PMTs will be handled in boxes of six, weighing up to ~ 15 kg. Individual
81 PMTs are lightweight. Shifters must use proper lifting techniques and, where
82 possible, use trolleys or carts to transport PMT boxes between storage and the QA
83 workspace. Training in manual handling will be provided.
- 84 • **Working postures:** Loading and unloading PMTs into dark boxes will require bent pos-
85 tures. Shifters should take regular breaks and limit the work in a bent position as much
86 as possible.
- 87 • **Fragile equipment:** PMTs are fragile and must be handled with care to avoid dam-
88 age. Shifters should follow established procedures for handling, loading, and unloading
89 PMTs, and report any damage or issues immediately. Shifters will wear gloves and safety
90 goggles when handling PMTs to protect against accidental breakage.
- 91 • **Electrical safety:** The QA setup includes high-voltage power supplies and low-voltage
92 function generators. Shifters must be trained in basic electrical safety, avoid contact
93 with live circuits, and follow established procedures for connecting and disconnecting
94 HV cables. The HV power supplies will be automatically turned off when not in use
95 and the QA area will be clearly marked with appropriate signage. The splitters for PMT
96 signal and HV will be enclosed in a protective casing to prevent accidental contact with
97 high-voltage parts and located outside easy reach of shifters.
- 98 • **Workspace coordination:** The QA area is shared with other OD activities, including
99 PMT assembly. Clear access paths must be maintained, and tasks should be coordinated
100 to avoid interference or hazards.
- 101 • **Emergency procedures:** Shifters must be familiar with emergency procedures, includ-
102 ing evacuation routes, first aid locations, and contact information for emergency services.

¹⁰³ **References**

- ¹⁰⁴ [1] Sammy Valder for the FD3 Working Group. Outer-detector installation procedures, logistics,
¹⁰⁵ and instructions. HK Technical note 0115. URL: [https://wiki.hyperk.org/do/
view/HyperK/TechNote0115](https://wiki.hyperk.org/do/view/HyperK/TechNote0115).