Daya Bay Near Experiment Hall

RPC Gas System

Procedure for the gas system routine leak check

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Procedure for the RPC gas system routine leak check

1. Purpose:

During the installation of the Daya Bay RPC gas system the entire gas system has been leak checked up to the points where four gases enter the gas mixing panel. The gas mixing panel itself has also been thoroughly leak checked up to the starting point of the main gas pipe, which is extended to the experimental hall and finally connected to the flexible gas pipe. The gas pipe system is a static structure, as long as all the fittings are fastened, it shouldn't develop new leak spot. Because the gas cylinders will be replaced routinely, the pipe system might be disturbed and could develop leak at certain weak spots, we set this procedure to prevent it from happening unnoticeably.

2. Scope:

This document covers the routine procedure for checking the gas tightness in the RPC gas system.

3. Policy:

Princeton University has provided the RPC gas system, is responsible for the safely running this system, however the Daya Bay experiment needs a team to operate and maintain the normal operation of this system. The procedure mentioned in this document should be the routine tasks for this team.

4. References

The RPC gas system user's manual (DocDB #5441

http://dayabay.ihep.ac.cn/DocDB/0054/005441/001/DayaBayGasSystemUserManual.pdf) is the most comprehensive resource for those who want to know the details of the RPC gas system. It also includes detailed description of the gas distribution system. If there is any question about the gas pipe system this manual should be the first place to be consulted.

ResTek leak detector user's manual, see Appendix (A).

5. Definitions

6. Precautions and Limitations

The most likely leak spot will be at the Swagelok fittings. Fastening the Swagelok fitting has to follow certain rules, you should inform the gas expert immediately and leave the repair work to them if you find the loose fitting.

7. Parts and Equipment:

ResTek leak detector, see figure 1.



Figure 1. ResTek leak detector.

8. Procedures:

The leak check can be divided into two divisions of the entire gas system: (1) From gas cylinders to the outlet port of the mixing panel, division #1; (2) From the mixing panel outlet port to the digital bubbler, division #2. We have separate procedures for two divisions.

- 1) Leak check procedure for division #1
 - Check the gas consumption rate

Under normal operation mode the gas consumption rate should be stable and consistent with our calculation. The expecting gas cylinder replacement time intervals are summarized in table 1 provided the total flow rate is 2 vol./day.

Gas	Cyl. #	Initial (psig kg)	Final (psig kg)	Time interval (day)
Argon	5	2300	100	17
R134A	1	50	1	10
Isobutane	1	9	1	22
SF6	1	9	1	70

Table 1	. Gas	cylinder	replacement	time	interval.
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The numbers listed in the table 1 are the tentative estimation, the final cylinder size/weight may be different so does the estimation of the time interval. The final numbers will be established based on the running experience.

If we find the time replacement interval for any of four gases is shorter than normal, it is a indication of gas leak for that gas, we'll pursue the next step.

• Check the suspected gas channel with ResTek leak detector

To use the leak detector follow the steps below:



Figure 2. Leak detector schematic.

(1) Powering Up

Depress and hold the power button (Figure 2) until the unit responds with the wake-up mode. The leak detector will run through a self-calibration sequence for approximately 15 seconds. During this time **DO NOT** attempt to zero the unit.

(2) Zeroing the Unit

After the LED lights stop flashing, the unit is ready for use. The instrument may need to be zeroed periodically between uses, especially if it is moved from room to room, or between areas of differing temperature or humidity. Do not attempt to zero the unit while the probe is stored in the holder. The probe **MUST** be removed from the storage container before zeroing the unit. To re-zero, press the Zero switch. The unit will run a self-calibration sequence for approximately 4 seconds. When all LED lights stop flashing and the green LED light is lit, the unit is ready for use.

(3) Detecting Leaks

Slowly move the probe tip around fittings and other suspected leak sources. If the Leak Detector senses a gas other than air, the LED bar graph will begin to light, and an alarm will sound when the last LED light illuminates. For five gases used in Daya Bay RPC gas system the red LED lights indicate helium leak, the yellow LED lights indicate argon, isobutane, R134A or SF6 leak. Remove the probe from the vicinity of the leak and allow the unit to return to zero. If a large

amount of gas has entered the probe, it may take a few seconds for the instrument to clear itself. Please do not attempt to zero the unit while it is clearing out the gas from the probe. This may cause the unit to malfunction. Place the probe near the leak again to confirm its location. The reference gas inlet (Figure 2) must not be restricted or the unit will not operate correctly. Similarly, the exhaust port allows the gas being tested to exit the Leak Detector and must remain unobstructed. The exhaust port is located in the probe docking station.

Gas	Minimum detectable	Indicating LED light	
	leak rate (atm cc/sec.)	color	
Helium	1.0×10^{-5}	red	
Hydrogen	1.0×10^{-5}	red	
Nitrogen	1.0×10^{-3}	yellow	
Argon	1.0×10^{-4}	yellow	
Carbon dioxide	1.0×10^{-4}	yellow	

The sensitivity of this leak detector is listed in Table 2. Table 2. Sensitivity of ResTek leak detector.

(4) Repair the leak spot

Mark the leak spots, report to gas expert for repair. If there is some serious leaking Swagelok fittings need to be repaired immediately, call the gas expert to get advice. Under the guidance of the gas expert you should repair them with caution. The right size fixed wrench should be used to fasten the loose fitting (for the ¹/₄" Swagelok fittings 9/16" wrench should be used). After the repair use ResTek leak detector to check again. Appendix (B) briefly describes the steps for assemble and reassemble Swagelok fitting.

2) Leak check procedure for division #2

The division #2 of the RPC gas system includes the entire gas distribution system and RPC modules after the outlet port on the gas mixing panel. The main tool to check the gas leak for this division is the digital bubbler system. This system is recording the gas bubbling rates from each gas channels, near hall has 108 channels and far hall has 162 channels. Under normal circumstance the bubbling rate should be constant for each channel from time to time, if there is leak developed in the course of experiment, some channels will show lower bubbling rates, which is a good indication of the leak. Check the MySQL database for such abnormal channels. The details of the database for digital bubbler can be found in the "RPC gas system user's manual". Also the Detector Control System monitoring screen will show such abnormal channels in the histograms: the corresponding channel's histogram bar will be shorter than usual, or even drop to zero.

9. Appendix (A)

ResTek leak detector user's manual see the link below:

http://www.restek.com/pdfs/204-07-006.pdf

Appendix (B)

Swagelok Fitting Installation Instructions

1. Insert tubing into the Swagelok tube fitting. Make sure that the tubing rests firmly on the shoulder of the tube fitting body and that the nut is finger-tight.

2. Scribe the nut at the 6 o'clock position.

3. While holding fitting body steady with a back-up wrench, tighten the nut 1 1/4 turns to the 9 o'clock position for 1/4 in tube fitting.



Note: For 1/16 and 3/16 in.; 2, 3, and 4 mm tube fittings, tighten the nut 3/4 turn to the 3 o'clock position.

Reassembly Instructions

After you disassembled a Swagelok fitting and need to reassemble it, follow the instruction below:

1. Insert tubing with pre-swaged ferrules into the fitting body until the front ferrule seats.

2. Rotate the nut with a wrench to the previously pulled-up position, at this point a significant increase in resistance will be encountered.

3. Tighten slightly with a wrench (approximately a quarter turn).