Case Study 3

Outlier due to excessive ingress of water in IP test.

History: The lab is a longstanding CTF3 laboratory.

Laboratory participated in 8 programs in the last 3 years, 4 during 2018.

In addition to IP test, they received outliers (causes/root causes in brackets), in other programs as follows:

- Ball Pressure test, (equipment used was not compliant, due to deficient method of implementing test procedure)
- Heating in switches (Laboratory's procedure did not prevent the use of tape to fix the thermocouples)
- Plug discharge test (2 different methods were in use yielding different results)

Analysis of IP Test outlier

"Tests affected: None, this concerns a proficiency test from IFM only". "Containment actions are not applicable, as the report has already been released."

After first analysis the following possible root causes were identified:
1) Test procedure not followed: in case the test object was placed in the flow too early, during the stabilization period, the flow was still higher than required.
2) The measurement set-up is incorrect: the flow is higher than calculated/expected.
3) Test equipment failure: significant ingress of water via the side and top hole of the test object caused by a failure of the test equipment.

In order to rule out the first root cause, the test was repeated twice under supervision of lab manager. Both tests resulted in significantly higher ingress of water (delta weight: 324gr and 142gr). During the test execution no deviations from the work instruction were noted while the results still were not within the expected range. This leads to the conclusion that the IFM test has been executed according to the test procedure.

A second step was to re-validate the measurement set-up: a big container was placed underneath the drip plate, catching the entire output. The measurement was conducted over a 10 minutes period of time with a flow of 0.2 l/min. The measured mass increase of the container was between 3.5 and 7%, higher that the calculated mass. The deviation is caused by slight variations in the the height of the water level in the drip box, the level is measured visually and slight differences can go overlooked, but will not lead to major deviations in the output. This leads to the conclusion that the measurement set-up is within acceptable parameters.

During the two re-tests it was again observed that a substantial amount of water collects on top of the sample and that during the rotation of the platform this water enters the test object via a hole in the side and via the holes in the top. This required additional investigation.

To further investigate the root cause of this phenomenon the following variables were identified:
a) The rotation of the turn table might influence the flow of the water
b) The usage of demi water and possible difference in surface tension
c) Variations in the flow, we currently test with a relatively high flow (0.2 l/min)

The turn table speed was decreased to 1 rotation/ 60 sec (was 1 rotation/ 46 sec), the test was repeated, resulting in a delta weight of 224 gram, so the ingress was still too high. A higher rotation speed has been accepted in the past as it was considered a more severe test.

In our test set-up demi-water is used to prevent the drip-outlets from getting calcified. Since the physical properties of demi-water are different from regular tap water an additional test is performed with tap water. The difference in surface tension resulted in slightly less build up of water on the top, but after some time the water again entered the test object via the various holes. This resulted in a delta weight of 129 gram. The usage of demi water does have some influence but not sufficient to be marked as root cause.

As last test we decreased the input flow. The calculated value for the input flowmeter of 0.20 is chosen as it is right in the middle of the allowable range (0.16 l/min corresponds to 1 mm/min, 0.24 l/min corresponds with 1.5 mm/min). We tested again with a flow rate of 0.165 and this had a huge impact on the ingress. There is much less water building up on the top of the sample and the water runs off via the side, missing the pre-drilled holes on the top. This results in a delta weight of 18 gram.

Originally submitted root cause

Conclusion: the outlier of the IFM IPX1 outlier is caused by the margin the quality department built into the input flow setting of the IPX test set-up. In this test the additional water caused a build up of water on the test object which in its turn caused an excessive amount of water ingress.
The adapted input flow corresponds with 1.125 mm/min and is within specification of the flow rate in IEC 60529.

Other contributing factors were the usage of demi water and the rotation speed of the turn table, but their contribution to the difference in weight is limited.

Proposed corrective actions

The applicable Test template shall be updated with the new input flow settings.
The test equipment shall be adapted so that the turn table speed is decreased to 1 rotation/ 60 sec.

IFM staff reply

See below database entries:

Program Follow Up Actions		
	Action	Comment
3	Response Rec'd	The laboratory has stated that results varied when the equipment was set to the minimum and maximum settings allowed by the standard. The laboratory has been requested to explain how they will make this uncertainty clear to customers.
3	Closed	If sample fails IPX1 at flow rate of 0.18 or higher, the minimum flow rate will be used. Initial failure and uncertainty will be discussed with customer.

Questions for workshop:

1. The provided information was the third version of root cause analysis and corrective action submitted to IFM, including a GNCR referral and extension granted by the secretariat. The secretariat allowed this matter to be closed because the ingress was too high and the lab has since developed a contingency to deal with it. (Too high ingress also provides a safety margin for products.) However, the lab identified an equipment issue by stating that the "middle range" adjustment of water flow yielded results that were too high. This would be unusual in normal circumstances and is suggestive that more could be done towards improving consistency.

a) What other types of things within the area of equipment set up or verification could the laboratory look at to try to bring their equipment performance into line with other laboratories?

b) Look at other reasons identified for PTP outliers in past 3 years (mentioned on top of page 1) and suggest some higher level quality system changes that might need to be considered by the laboratory.