# Failure Mode and Effect Analysis at AMTF about Non-Confomities

## European XFEL GmbH, Hamburg

## Strategies‘ and Factory Development

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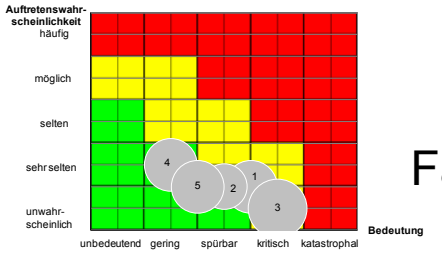
# Agenda

- Motivation
- Analysis of the existing data
- Failure and Effect Evaluation
- Measures and possible effects
- Analysis of the Non-Conformities

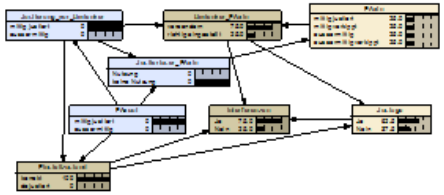
## Motivation

# Motivation



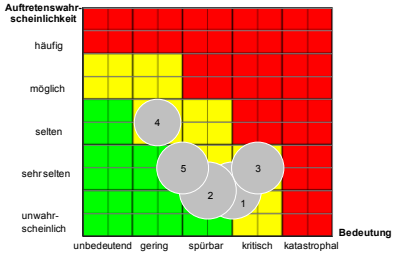

Failure and Risk Analysis

Detection of failures

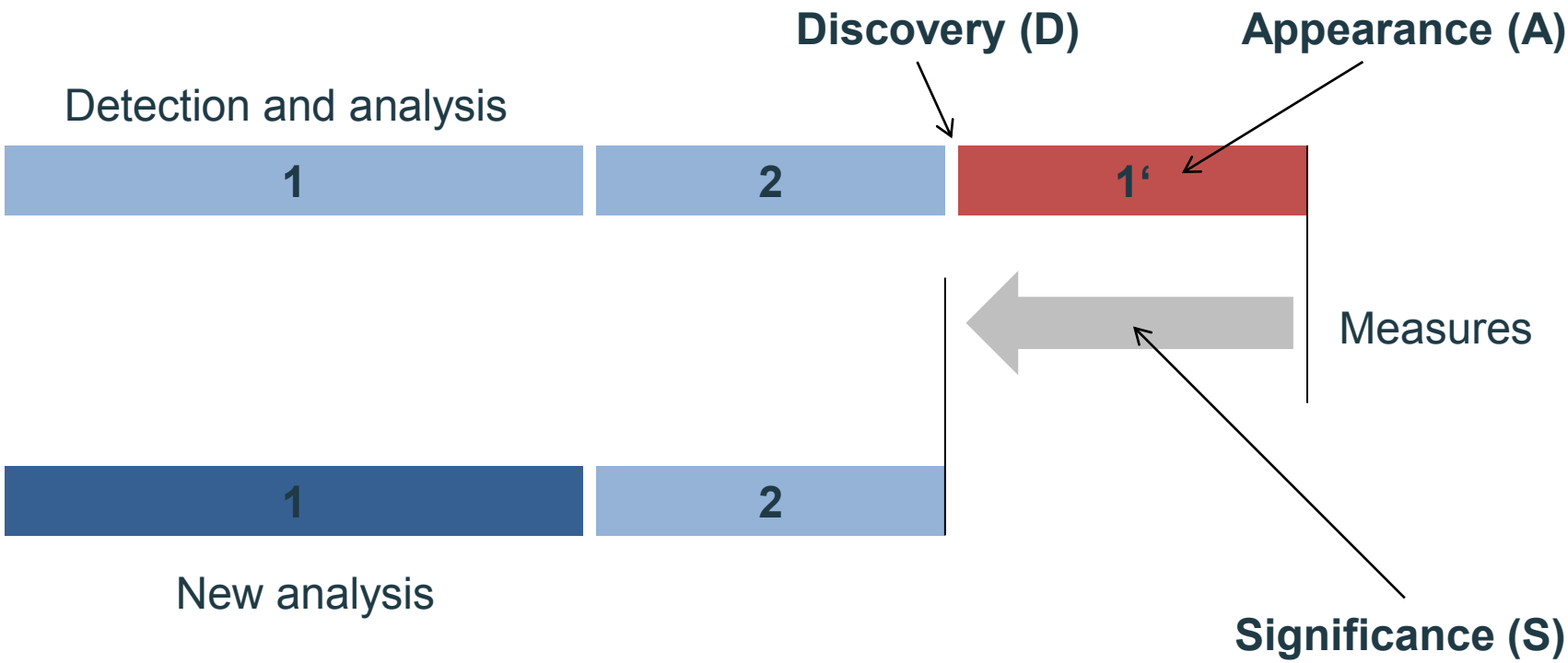


Definition of measures

Failure and Risk Analysis



# Motivation




**Risk Priority Count = A * S * D**

## Analysis of the existing data

# Analysis of the existing data

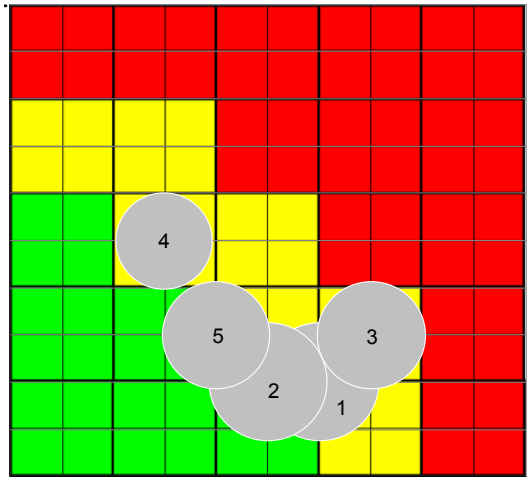
| Risk detection and Analysis at the current situation | | | | | Max. tolerable Value | 5 | 5 | 5 | 125 |
|---|---|---|---|---|---|---|---|---|---|
| Nr. | Area / Process / Characteristic / Part / Function | Potential Risk / Danger | Potential Aftermath / Effects of the Risk | Potential Reasons | Actual Control Mechanisms | Appearance | Significance | Discovery | RPC |
| 1 | Example | Example | Example | Example | Example | 1 | 1 | 1 | 1 |
| 2 | Example 2 | Example 2 | Example 2 | Example 2 | Example 2 | 2 | 9 | 10 | 180 |
| 3 | | | | | | | | | |
| 4 | | | | | | | | | |

## Failure and effect evaluation

# Analysis of the existing data

| Risk detection and Analysis at the current situation | | | | | Max. tolerable Value | 5 | 5 | 5 | 125 |
|---|---|---|---|---|---|---|---|---|---|
| Nr. | Area / Process / Characteristic / Part / Function | Potential Risk / Danger | Potential Aftermath / Effects of the Risk | Potential Reasons | Actual Control Mechanisms | Appearance | Significance | Discovery | RPC |
| 1 | Example | Example | Example | Example | Example | 1 | 1 | 1 | 1 |
| 2 | Example 2 | Example 2 | Example 2 | Example 2 | Example 2 | 2 | 9 | 10 | 180 |
| 3 | | | | | | | | | |
| 4 | | | | | | | | | |

Likelyhood of appearance




Significance

# Analysis of the existing data

| Appearance | | | Significance | | | Probability of Discovery | |
|---|---|---|---|---|---|---|---|
| Description | Times | Eval-uation | Description | Time [h] | Eval-uation | Description | Eval-uation |
| very unlikely. | 1% | 1 | Very low functional impairment, recognizable only by qualified personnel 2 hours | 2 | 1 | Any mistakes that cause is discovered safe | 1 |
| Unlikely failure cause | 3% | 2 | Low functional impairment of the product / process 4hrs | 4 | 2 | Discovery of errors search, eg several independent tests | 2 |
| Low likelyhood of appearence | 5% | 3 | Low functional impairment of the product / process 1 shift | 8 | 3 | Discovery of errors search, eg several independent tests | 3 |
| Occasional appearance of the failure cause | 8% | 4 | Functional impairment of the product / process 1day | 16 | 4 | Discovery of errors cause is likely tests are relatively safe | 4 |
| Occasional appearance of the failure cause | 10% | 5 | Functional impairment of the product / process | 32 | 5 | Discovery of errors cause is likely tests are relatively safe | 5 |
| Occasional appearance of the failure cause | 18% | 6 | Functional impairment of the product / process 4 days | 64 | 6 | Discovery of errors cause is likely tests are relatively safe | 6 |
| Failure cause appears repeatedly | 35% | 7 | Severely limited functionality of the product / process | 90 | 7 | Discovery of errors is less likely | 7 |
| Failure cause appears repeatedly | 30% | 8 | Severely limited functionality of the product / process 7days | 112 | 8 | Discovery of errors is less likely | 8 |
| Likely cause of Failures | 35% | 9 | Failure of the process / product | 160 | 9 | Discovery of errors cause is unlikely error cause is or can not be detected | 9 |
| Very likely cause of failures | 40% | 10 | Failure of the process / product threat to human life 14 days | 224 | 10 | Discovery of the cause of the error has occurred requested is unlikely error cause is or can not be detected | 10 |

## Measures and possible effects

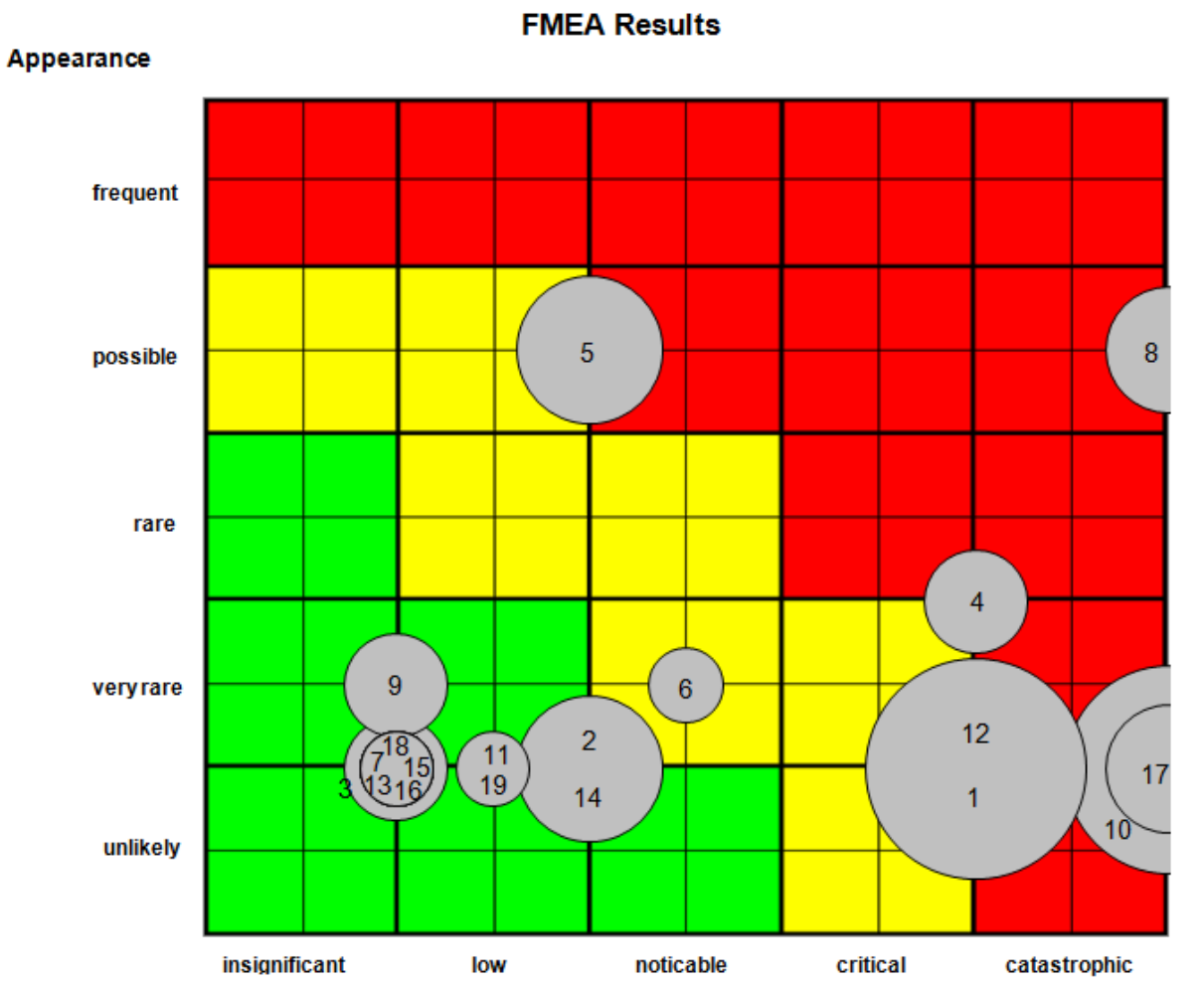
# Measures and possible effects

| Risk detection and Analysis at the current situation | | | | | Max. tolerable Value | 5 | 5 | 5 | 125 |
|---|---|---|---|---|---|---|---|---|---|
| Nr. | Area / Process / Characteristic / Part / Function | Potential Risk / Danger | Potential Aftermath / Effects of the Risk | Potential Reasons | Actual Control Mechanisms | Appearance | Significance | Discovery | RPC |
| 1 | Example | Example | Example | Example | Example | 1 | 1 | 1 | 1 |
| 2 | Example 2 | Example 2 | Example 2 | Example 2 | Example 2 | 2 | 9 | 10 | 180 |

| Proposal Measures Reason-/Effect oriented | Responsible | Date | Take Measure | Appearance | Significance | Discovery | RPC |
|---|---|---|---|---|---|---|---|
| Example | Example | Example | Example | 1 | 1 | 1 | 1 |
| Example 2 | Example 2 | Example 2 | Example 2 | 2 | 5 | 6 | 60 |

## Analysis of the Non-Conformities

# Analysis of the Non-Conformities




**Probability of Discovery** - Bubble Size

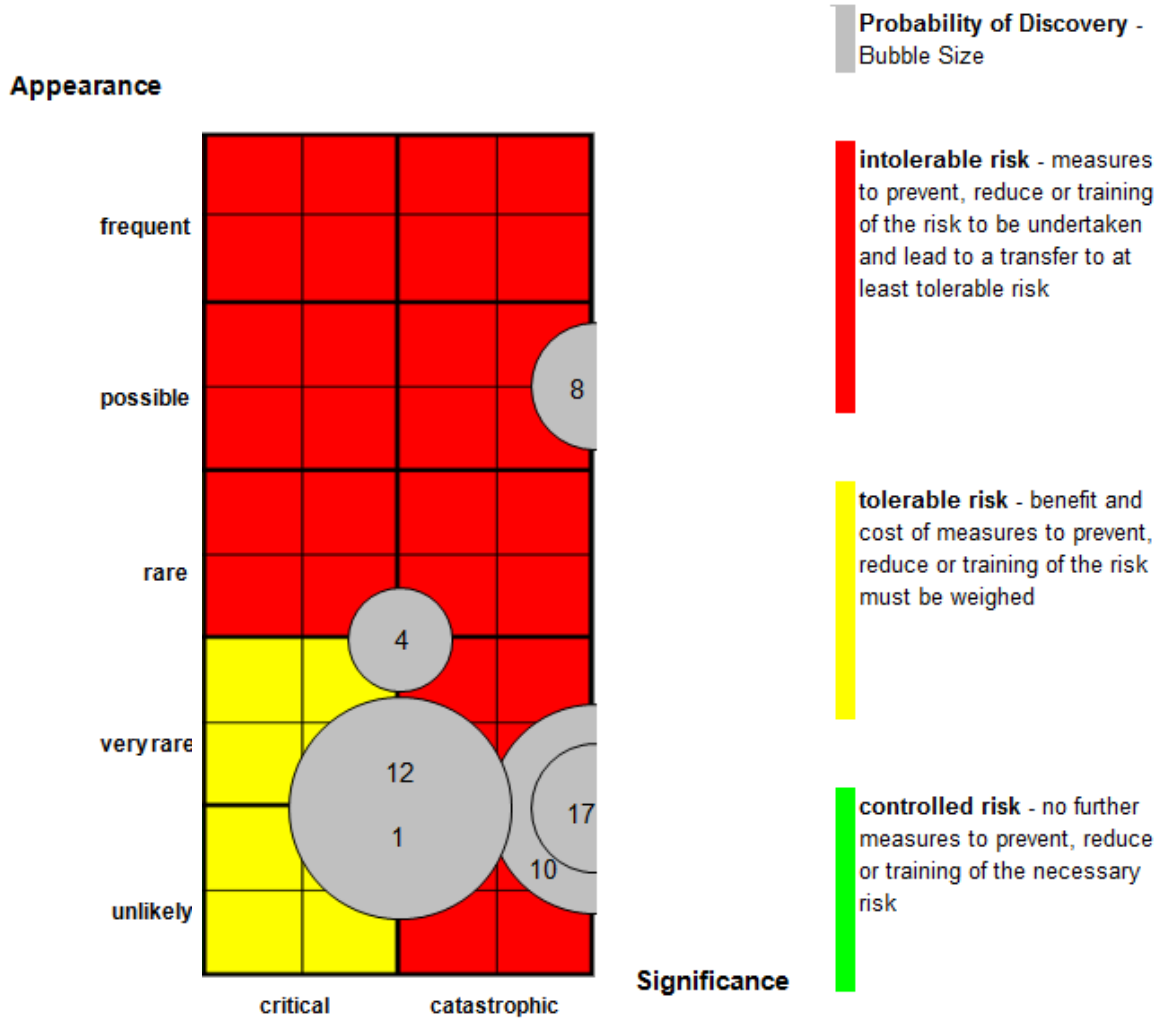
**intolerable risk** - measures to prevent, reduce or training of the risk to be undertaken and lead to a transfer to at least tolerable risk

**tolerable risk** - benefit and cost of measures to prevent, reduce or training of the risk must be weighed

**controlled risk** - no further measures to prevent, reduce or training of the necessary risk

# Analysis of the Non-Conformities

| Nr. | Area / Process / Characteristic / Part / Function | Appearance | Significance | Discovery | RPC |
|---|---|---|---|---|---|
| 8 | Problem with cool down process (cold leak) | 7 | 10 | 3 | 210 |
| 10 | Rising of the helium backgrund at T = 2 K | 2 | 10 | 8 | 160 |
| 12 | Heat load problems (defects in module) | 2 | 8 | 9 | 144 |
| 5 | Leak at coupler - Flange A (warm) | 7 | 4 | 4 | 112 |
| 4 | Leak at coupler - Flange A (cold) | 4 | 8 | 2 | 64 |
| 17 | Leak in 2K Area | 2 | 10 | 3 | 60 |
| 1 | Leak at couplers vacuum line (cold) | 2 | 8 | 2 | 32 |



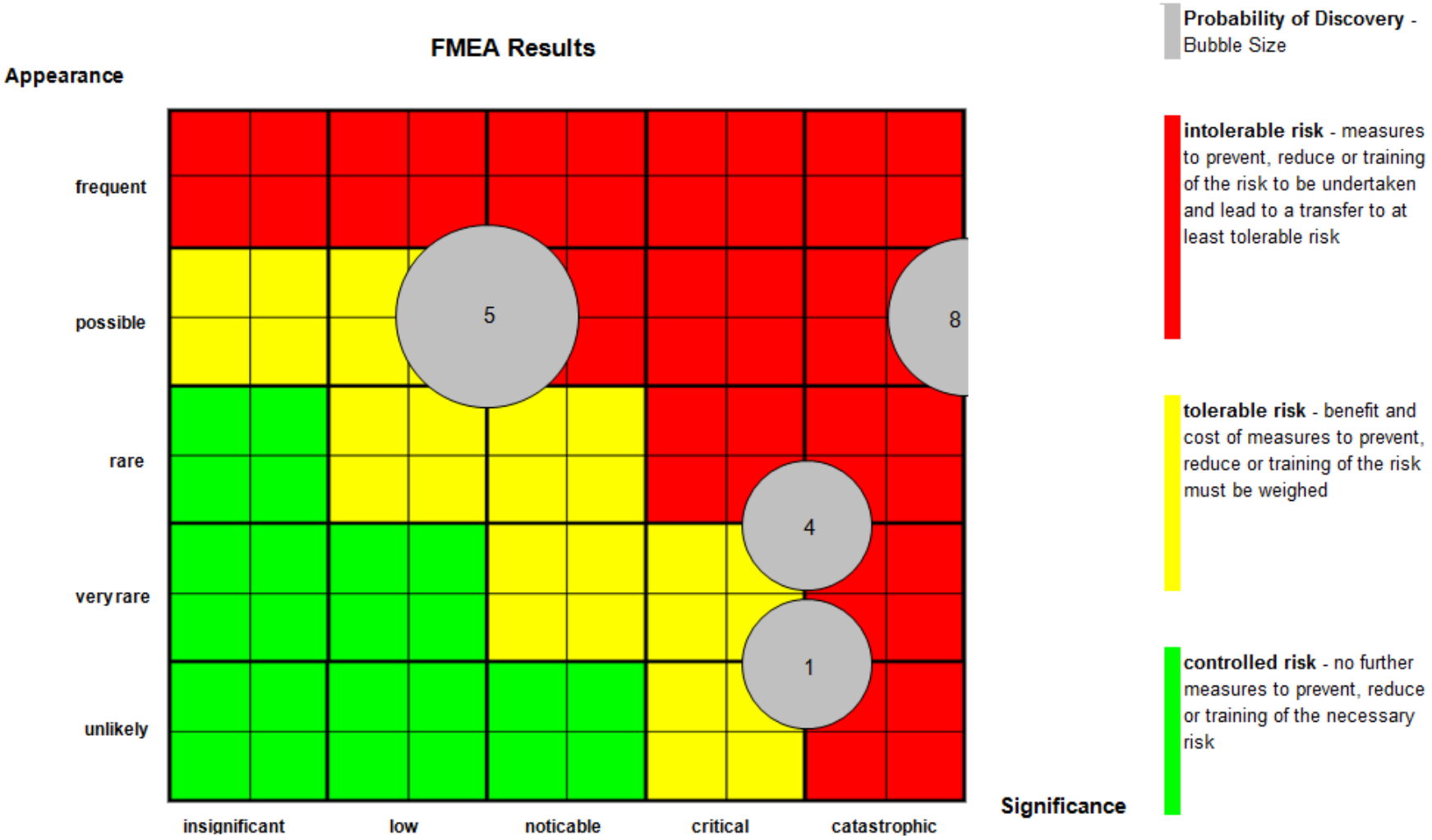
# Analysis of the Non-Conformities

| Nr. | Area / Process / Characteristic / Part / Function | Potential Risk / Danger | Potential Aftermath / Effects of the Risk | Potential Reasons | Actual Control Mechanisms | Appearance | Significance | Discovery | RPC |
|---|---|---|---|---|---|---|---|---|---|
| 8 | Problem with cool down process (cold leak) | Wasted time due to deviations in the test | Risk of one or two additional weeks due to another pumpdown | Indium sealing, copper gasket, flange not sharp enough, human error module error | Leaktest at 2K (happens earlier – integral Leaktest) | 7 | 10 | 3 | 210 |
| 10 | Rising of the helium backgrund at T = 2 K | Leak in the tunnel | Risk of one or two additional weeks due to complex leak search | complexity of the system | Leaktest at 2K | 2 | 10 | 8 | 160 |
| 12 | Heat load problems (defects in module) | unknown | Complex investigations | unknown | Visual check, … | 2 | 8 | 9 | 144 |
| 5 | Leak at coupler - Flange A (warm) | Leak in the tunnel/ Waste time due to deviations in the test | Risk of one additional two days due to leak search and solving | component problem (assembly) | Leaktest at warm | 7 | 4 | 4 | 112 |
| 4 | Leak at coupler - Flange A (cold) | Leak in the tunnel/ Waste time due to deviations in the test | Risk of one additional week due to leak search and solving | component problem (assembly), human error (damage flange by cables during connection) | Leaktest at warm Leaktest at 2K | 4 | 8 | 2 | 64 |
| 17 | Leak in 2K Area | Leak in the tunnel | Risk of two additional weeks due to another pumpdown | complexity of the system (product and test assembly) | Leaktest at warm | 2 | 10 | 3 | 60 |
| 1 | Leak at couplers vacuum line (cold) | Leak in the tunnel | Risk of one additional week due to reparation works (warm parts involved) | Leak from the bellow (material problem), bad assembly of the coupler | Leaktest at warm / Leaktest at 2K | 2 | 8 | 2 | 32 |

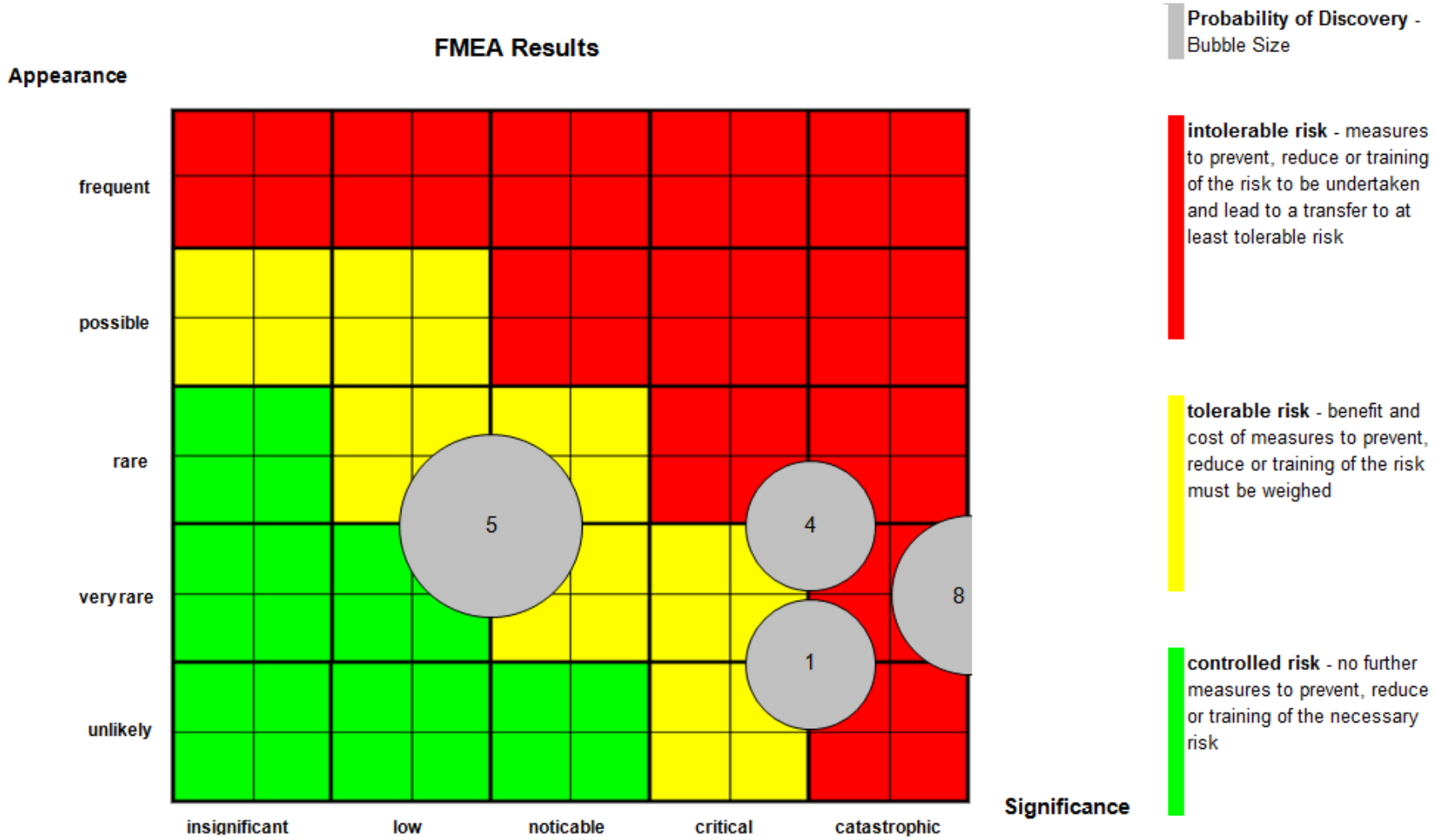
# Analysis of the Non-Conformities

| Nr. | Area / Process / Characteristic / Part / Function | Potential Risk / Danger | Potential Aftermath / Effects of the Risk | Potential Reasons | Actual Control Mechanisms | Appearance | Significance | Discovery | RPC | Proposal Measures Reason-/Effect oriented | Responsible | Appearance Measure | Significance Measure | Discovery Measure | RPC Measure |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | Problem with cool down process (cold leak) | Wasted time due to deviations in the test | Risk of one or two additional weeks due to another pumpdown | Indium sealing, copper gasket, flange not sharp enough, human error module error | Leaktest at 2K (happens earlier – integral Leaktest) | 7 | 10 | 3 | 210 | Solving the issues with the indium sealing (thickness of the sealing) | Michal, Jacek | 3 | 10 | 3 | 90 |
| 5 | Leak at coupler - Flange A (warm) | Leak in the tunnel/ Waste time due to deviations in the test | Risk of one additional two days due to leak search and solving | component problem (assembly) | Leaktest at warm | 7 | 4 | 4 | 112 | restructurinng of the procedure (testing at desy, assembly in france) | Mr. Vogel | 4 | 4 | 4 | 64 |
| 4 | Leak at coupler - Flange A (cold) | Leak in the tunnel/ Waste time due to deviations in the test | Risk of one additional week due to leak search and solving | component problem (assembly)<br><br>human error (damage flange by cables during connection) | Leaktest at warm<br>Leaktest at 2K | 4 | 8 | 2 | 64 | restructurinng of the procedure (testing at desy, assembly in france)<br><br>poka yoke | Mr. Vogel (supported with weekly reports)<br><br>Mateusz | 2 | 8 | 2 | 32 |
| 1 | Leak at couplers vacuum line (cold) | Leak in the tunnel | Risk of one additional week due to reparation works (warm parts involved) | Leak from the bellow (material problem),<br>bad assembly of the coupler | Leaktest at warm / Leaktest at 2K | 2 | 8 | 2 | 32 | Investigation about bellow material<br><br>restructuring the procedure of the coupler assembly | Mr. Müller<br><br>Mr. Müller | 4 | 8 | 2 | 64 |

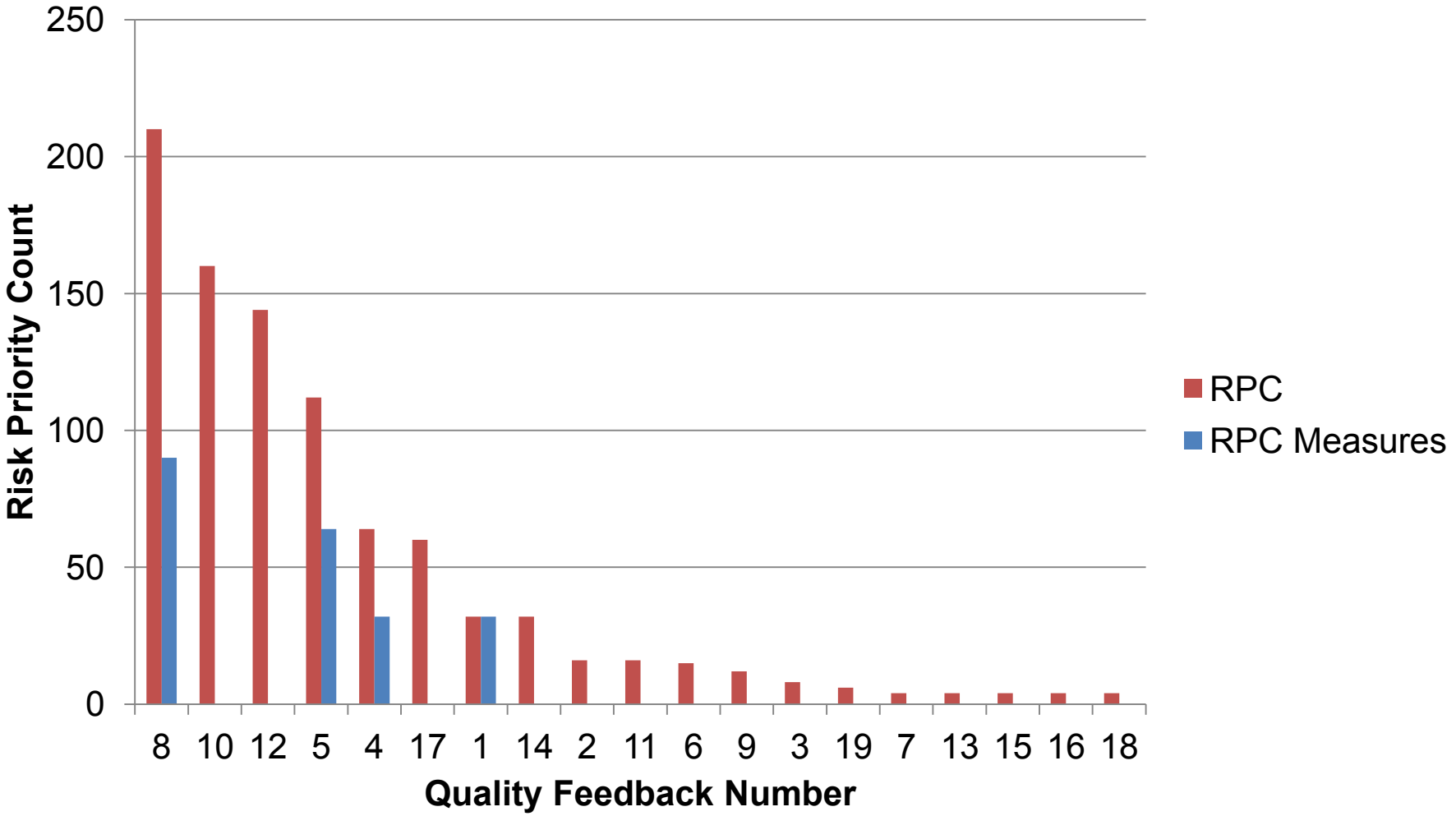
# Analysis of the Non-Conformities actual condition



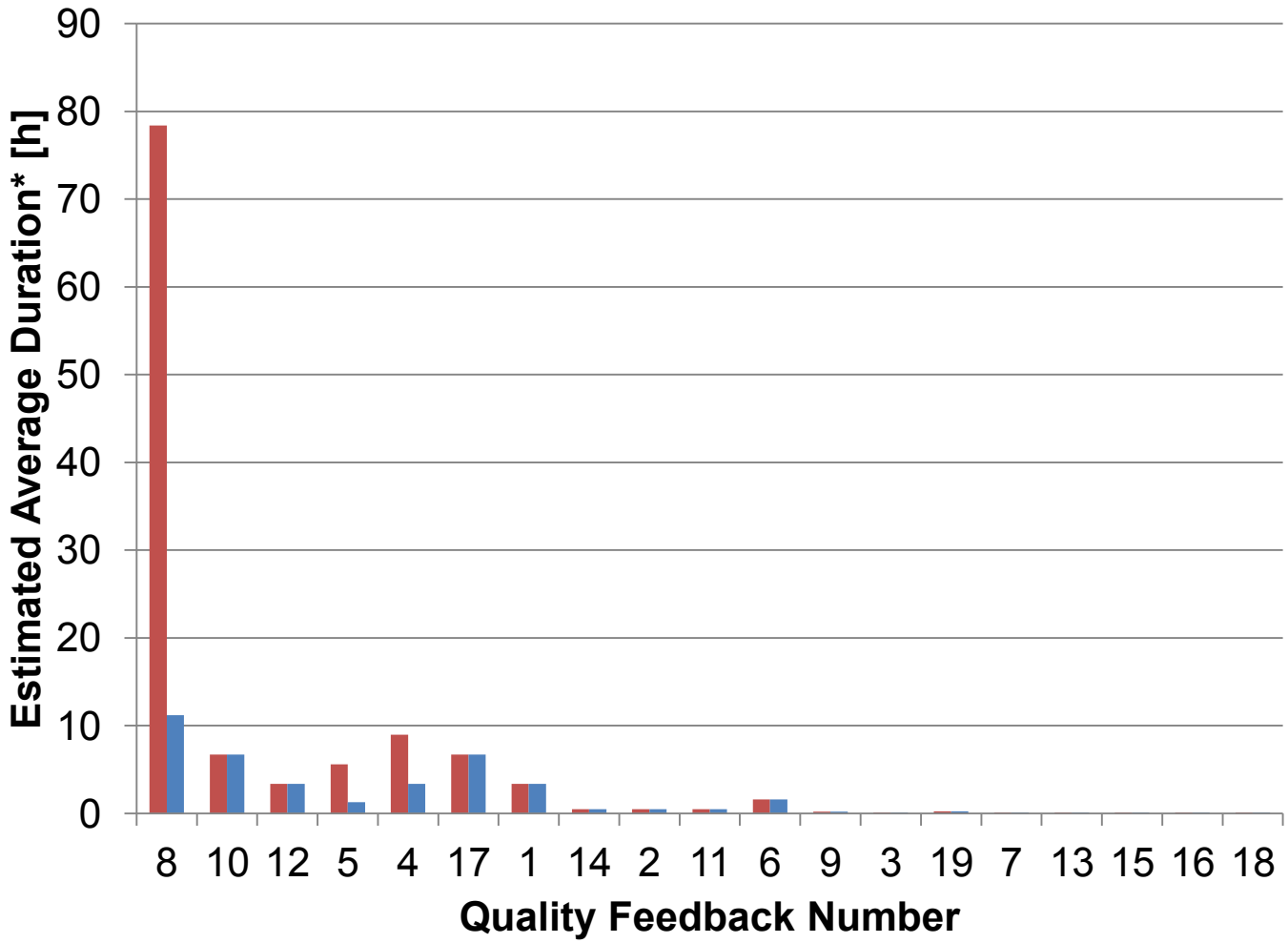
# Analysis of the Non-Conformities estimated future condition



# Analysis of the Non-Conformities



# Analysis of the Non-Conformities




| | Shifts |
|---|---|
| **Present:** | 15 |
| **Future:** | 5 |
| **Delta:** | -10 |

* The estimated average duration is calculate by summing up the total time spend on the search, reparation of a failure in all modules it occurred and dividing it through the total number of modules.

## Defined Measures

# Defined Measures

| Non-Conformity | Measure | Responsible |
|---|---|---|
| Problem with cool down process (cold leak) | Solving the issues with the indium sealing (thickness of the sealing) | Michal, Jacek |
| Leak at coupler - Flange A (warm) | Restructuring of the procedure (testing at desy, assembly in france) | Mr. Vogel |
| Leak at coupler - Flange A (cold) | restructuring of the procedure (assembly in france) | Mr. Vogel (supported with the weekly reports) |
| | Restructuring of the procedure | Mateusz |
| Leak at couplers vacuum line (cold) | Investigation about bellow material and the procedure of the coupler assembly | Mr. Müller |

## Thank you for your attention!

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