Applicability of National Board Testing Data to Reliability for Industry

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Overview of National Board Capacity Certification Program

- 2 samples pressure relief devices (PRD’s) tested every six years
- Test requirements come from ASME Boiler and Pressure Vessel Code
- National Board Inspector witnesses manufacturing/assembly to assure samples are done to normal procedures
  - May include devices selected from stock
- Not intended to be statistical in nature
Overview of National Board Capacity Certification Program (cont.)

- “Penalty” test of 2 for 1 required upon test failure
- Corrective action is then required
- Tests performed at ASME/NB accepted test lab

- What does collected test data show for PRD Users?
Some Numbers...

Data on large number of tests was reviewed to look for trends, patterns etc.

Total number of tests included in the review: 21825
How Data was Analyzed

1. Included data from National Board and other accepted test labs
2. Started from the year 2000
   - Includes rupture disks as certified devices
3. Includes VR verification tests
4. Does not include “provisional”, R&D or informational tests
5. Does not include “investigation” tests (more on this later)
Limitations of the Review

Represents lower pressures/ smaller sizes

- Economic reality of testing

“Cleanliness” of the data
Some Numbers...

Breakdown by ASME Code Section

- Section I 13.6%
- Section III 12 tests
- Section IV 3.4%
- Section VIII 83.0%
Some Numbers...

Test medium used

- Steam 25.6%
- Air 48.6%
- Water 25.7%

Section VIII per medium

- Steam 10.6%
- Air 58.5%
- Water 31.0%
# Raw Results

<table>
<thead>
<tr>
<th>Test outcomes</th>
<th>%</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pass</td>
<td>84.9%</td>
<td>18538</td>
</tr>
<tr>
<td>Fail Set Pressure</td>
<td>7.1%</td>
<td>1541</td>
</tr>
<tr>
<td>Fail Blowdown</td>
<td>1.8%</td>
<td>383</td>
</tr>
<tr>
<td>Fail Capacity</td>
<td>5.4%</td>
<td>1186</td>
</tr>
<tr>
<td>Fail Operation</td>
<td>0.2%</td>
<td>43</td>
</tr>
<tr>
<td>Incorrect lift</td>
<td>0.1%</td>
<td>19</td>
</tr>
<tr>
<td>N/A</td>
<td>0.5%</td>
<td>113</td>
</tr>
</tbody>
</table>
Raw Results

- Pass: 100%
- Fail BD: 0%
- Fail set: 0%
- Fail Cap.: 0%
- Fail Op.: 0%
- Inc. Lift: 0%
- N/A: 0%
Analysis of Failures

Set pressure

- Failures represent valves out of Code tolerance
- What is “unsafe” level?
- 0.3% were above 116% of nameplate set pressure
Analysis of Failures (cont.)

Capacity

- Includes valve capacities less than rated
  - Common cause: Valve fails to achieve “secondary lift”
- Includes liquid valves failing to open by specified overpressure
- Includes rupture disk flow resistance($K_R$) / Minimum Net Flow Areas (MNFA) not to specification
Distribution Where Capacity was Measured

Valves, % Rated Capacity

Approx. 120 tests cap. < 50% = 0.54%
Analysis of Failures (cont.)

Other Capacity Issues

- 247 other failures where capacity was not measured (1.1%)
- Typical failure to open before 10% above set – mostly liquid valves
- Typical opening point in these cases is 12% to 15% above set
Rupture Disk $K_R$ Problems

Test $K_r$/Cert. $K_r$
Rupture Disk Capacity Problems

Data includes 128 Kr failures (0.7%)

Disk opened where Kr measurement is reported: 20 samples more than the 5X certified Kr (.09%)

Includes 18 failures to open (0.08%)

Some were reversal without opening

6 MNFA failures (insufficient disk opening)
Blowdown Problems

Represented 1.8% of test samples

Affect of blowdown on overpressure protection
- (More of an operational concern)
  - Section I short blowdown
  - Section VIII – adjustable design exceeding 7%
Other Problems...

Fail Operation  0.2%  (43 valves)
   Includes lift lever problems, valves “stuck open” etc.

Incorrect lift  0.1%  (19 valves)
   Restricted lift valves with lift not set properly (usually too high)
Summary

Estimates of PRD problems:

Set pressure problems: 0.3%
Valve Capacity problems: 0.54%
Rupture Disk Kr problems: .09%
Rupture Disk, failure to open: .08%
Total: 1.01%

Pressure Relief Device Availability Estimate: 98.99%
Investigation Testing

130 Investigation tests

37: Pass
70: N/A
11: Fail set
8: Fail capacity
4: Fail blowdown

Most problems noted were caused by lack of maintenance
Recommendations

- Recognize value of Code/NB Certification
  - Tight requirements provide extra margin for safety
  - Test issues cause suppliers to “tighten up”
  - NB Test capabilities to be expanded
Recommendations

- **Provide feedback**
  - PRD Suppliers
  - Regulatory Authorities
  - National Board when certification is suspect

- **Mandate In-Service Inspection at intervals supported by Inspection History**