REVIEW OF BUREAU VERITAS (BV)

MARCH 5 & MAY 15, 2014

FILM SAMPLE ASSESSMENT REPORTS

DRAFT

FOR INTERNAL USE ONLY

REPORT 413.61-14.67

Author: Lloyd Schaefer

Reviewed: Redacted

Index

Executive Summary

At request of the CPUC, Bureau VERITAS (BV), in January 2014, performed a Radiographic film assessment/audit from a sample of 800 weld radiographic inspections by TCI, a former PG&E NDT services contractor. This sample was broken down into two groups. The first group included 100 welds that PG&E had comprehensively reviewed. The second group included 700 welds that PG&E had reviewed, narrowly to this point in time, to identify the extent of condition (EOC) for issues of radiographic coverage. The March 5th 2014 report from BV was reviewed by PG&E, and was found to contain a wide variety of factual errors. These included; fundamental statistical mistakes, weld indication miss-typing & sizing errors, inconsistent, and in many cases incomprehensible nomenclature and descriptions of their concerns. The BV report concluded with a statistical summary which was thus erroneously derived and attempted to conclude that whether PG&E or its contractors performed radiography, that there was a 10% risk in PG&E's system for escaped defects. This report focuses on the BV allegations of 48 escaped defects by Radiography. It is being produced at request of the CPUC following a series of telecoms in which the CPUC agreed to consider the March 5 report (**Appendix I**) a "draft", pending review of PG&E communication of findings against the BV report methodology & conclusions. PG&E concurs and is acting on only one of the alleged TCI escapes, a separate weld repair radiograph from the group of 700 non-comprehensively reviewed welds. PG&E finds regarding the balance of 47 alleged escaped defects, with present weld imagery, that all are in compliance with the 20th edition of API 1104, and were improperly cited by BV as escaped defects.

Subsequent to the results of above described report on the BV draft of 5 March, 2014 being communicated to the CPUC, a final report was issued by Ruben Carranza of BV dated 15 May, 2014. This final report (**Appendix III**) contained nearly all of the same PG&E cited technical errors on the part of the BV reviewers in the draft version, as well as some new errors in interpretation, nomenclature & descriptive statistics. It was accompanied by a formal CPUC request to respond to the now 47 allegations of escaped defective welds in PG&E's system, termed also in API 1104 as imperfections, that the BV reviewers found not in compliance with API 1104 weld acceptance criteria. PG&E continues to maintain that no action is required for these 47, by the reasoning stated against the draft report on the same items, and based on the submitted analysis in section 2 and Appendix I of this report. Additionally the CPUC now formally requests from PG&E, documentation of its remaining extent of condition management activities inclusive film quality and coverage, and responses to BV recommendations. The detailed responses to these requests, as well as additional PG&E findings regards the BV review process in their final report, will be addressed in the discussion section of this report which has been added to complete PG&E's response to BV's Draft and Final assessments received from the CPUC.

1.0 Background & Qualifications

1.1 At request of the CPUC, Bureau VERITAS (BV), in January 2014, performed a Radiographic film assessment/audit from a sample of 800 weld radiographic inspections by TCI, a former PG&E NDT services contractor. This sample was broken down into two groups. The first group included 100 welds that PG&E had comprehensively reviewed. The second group included 700 welds that PG&E had reviewed, narrowly to this point in time, to identify the extent of condition (EOC) for issues of radiographic coverage.

1.2 This report documents the PG&E review and technical fact finding regards the subject March 5th 2014 draft (**Appendix I**) as well as the final (**Appendix III**), May 14th 2014 BV, reports. In these reports, BV attempts to show that there are film quality issues, as also previously self-reported by PG&E. Further, BV propounds that a systemic escaped defect rate of 10% exists in PG&E's pipeline system. Because the Pipeline Safety Act requires specific and prompt actions upon the revelation of weld defects, PG&E took immediate action to review the report's allegations of 48 escaped defects. It was noted that this assessment was launched with an opening meeting. However no interim reports on potential findings, or a closing meeting were offered by BV. BV informed on departure that a courtesy brief on the findings of the report, in advance of the issuance, would be provided. This did not occur. PG&E at several points during the 2 week assessment conducted at its ATS facility, volunteered to hear and address any concerns, but were not engaged by BV reviewers.

1.3 The author of this report has over 30 years of experience in NDE. He is currently ASNT certified Level III in 5 methods, including the Radiographic Test Method. He has also been certified as Level III across a diverse array of industries, including; Saudi Aramco, Siemens, Rolls Royce, Boeing, Rockwell, Northrop, Honeywell, Aerojet, and SpaceX, in addition to his present certification as Level III for PG&E. He is an active member of the Scientific Advisory Board of the German Federal Institute for Materials Research and Testing (BAM) sponsored NDE reliability working group since 1998. He has served as a member of the Iowa State University, Center for Non-Destructive Evaluation Industrial Advisory Board since 1995. He has authored the ASNT Handbook on Non-Destructive Testing 2nd edition and first or co-authored over 50 peer reviewed publications and symposia presentations. He is presently an active and voting member of the ASTM E-07 standards committee for Non-Destructive Testing. A key area of his scientific studies is the modeling & measurement of NDE methods reliability, and germane to this report, focuses include human factors influences on probability of detection and false call causes and controls. He teaches courses in basic and advanced NDE reliability and Risk Based Life Management internationally. He is also a registered Six Sigma Black belt by the American Society for Quality, a Certified Quality Engineer, and holds memberships with ASNT, DgZFP, ASM, AWS, ASQ and PMI.

1.4 This report describes the PG&E approach, assessment, and conclusions regarding the BV assessment claim of 48 API 1104 code discrepancies in our pipeline welds. Additionally, in the appendix, PG&E provides quantitative substantiation for its interpretative claims that 47 of the 48 BV identified welds, are acceptable to the 20th edition of API 1104. We do also note substantial errors in BVs assessment of film quality issues, but that is outside this scope of this report.

2.0 Approach & Results

2.1 Upon receipt of the now nominated draft BV assessment report, PG&E reviewed the conclusions and attempted to link to and identify the individual findings. On page 9 of the BV report a conclusion, shown below in Figure 1, indicates that there is a 10% escaped defect rate from the combined sample of 800 radiographic inspections sampled.

COMBINED RESULTS

Collectively, the 800 samples yielded a 58 % Non-Compliance Rate and a 10% Defect Escape Rate.

Figure 1 – BV Combined results statement on Defect Escape Rate

2.2 BV offers a summary (ref. pages 7 and 9 of the BV report) from each sample in support of the 10% Defect Escape Rate conclusion shown below in Figures 2 & 3. What becomes immediately clear is that neither individually, nor in summation, is BV entitled to a conclusion of an escaped defect rate of 10%.

- DEFECT ESCAPE RATE - 6 of 100 (6%) samples contained API 1104 unacceptable discontinuities that went undetected during the primary TCI Radiographic inspection.

The discontinuities detected are:

ITEM #	DEFECT DETECTED	WELD SAMPLES REJECTED
1	Internal Undercut (IU)	2
2	Incomplete Fusion (IF)	1
3	Inadequate Penetration due to Hi-Lo (IPD)	1
4	Inadequate Penetration (IP)	1
5	Elongated Slag Inclusion (ESI)	1

Figure 2 – BV calculated Defect Escape Rate for the sample of 100 weld inspections

- DEFECT ESCAPE RATE - 42 of 700 (6%) samples contained API 1104 unacceptable discontinuities that went undetected during the primary TCI Radiographic inspection.

ITEM #	DEFECT DETECTED	WELD SAMPLES REJECTED
1	Internal Undercut (IU)	20
2	External Undercut (EU)	1
3	Incomplete Fusion (IF)	6
4	Inadequate Penetration due to Hi-Lo (IPD)	3
5	Inadequate Penetration(IP)	5
6	Elongated Slag Inclusion (ESI)	1
7	Porosity (P)	1
8	Burn Through (BT)	3
9	Internal Concavity	2

Figure 3 - BV calculated Defect Escape Rate for the sample of 700 weld inspections

2.3 PG&E then attempted to identify the specific references to these alleged defects. Owing to pervasive unclear writing and nomenclature errors, a telecom was held with the CPUC and BV to clarify which welds contained their specific findings

2.4 PG&E notes here that the proper form of such a rejection/finding must contain actionable information including a specific code reference and a quantified declaration in the structure of "Should be" and "Is".

2.5 With the BV further confirmations of the involved welds in hand, PG&E reviewed each defect escape allegation, and summarized its own findings in Figure 4 below.

Cat.	Defect Type & API 1104 Code Section	BV declared defects in 100 sample	BV declared defects in 700 sample	Number & ID of those agreed by PG&E as rejectable to the applicable API-1104 code
1	Burn-Through 9.3.7	0	3	None
2	Int. Concavity 9.3.6	0	2	None
3	Int./Ext. UC 9.3.11	2	21	None
4	IP/IPD 9.3.1, 9.3.2	2	8	One TCI escape on non-reviewed repair shot (W22R of BV item 625, TCI Env. 80-3)
5	Slag 9.3.8	1	1	None
6	Porosity 9.3.9	0	1	None
7	Inc. Fusion 9.3.4	1	6	None

Figure 4 – Summary of PG&E findings regards Escaped Defects

2.6 PG&E finds only one escaped defect, identified in Category 4 in Figure 4 above and is in the process of addressing the condition.

2.7 PG&E is concerned that specific items within BV's list of 48 defects were characterized in recollection by the BV reviewers as "extreme", "severe", and "critical" during telecom communication. PG&E found some of the widest degrees of interpretative errors in these items which were in fact acceptable to the 20th edition of API 1104.

2.8 To validate PG&E's technical expert assessments of these 48 identified issues, additional supporting quantitative analyses were performed and are contained, for BV's consumption, in Appendix I.

2.9 An update regards the single instance of IPD that PG&E agrees with from the draft and final BV report. PG&E has determined that the weld in question, BV sample 625, item 80-3, weld 22 was in fact initially identified improperly as a code weld, but was, after the repair cycle determined not to be an API-1104 code weld. Hence the NDT crew was misinformed regards the requirements. The NDT crew should have documented this information on the reader sheet for clarity, but the information is resident in the as built package.

3.0 Discussion

3.1 As was indicated in the executive summary, PG&E has already responded in the approach and results section of this report that BV has committed factual errors in its interpretations which led to the incorrect conclusion of "escaped defects" (as titled in the draft version), or "non-compliant imperfections" as these same indications were titled in the final version submitted to PG&E.

3.2 In addition to the errors cited in Section 2 of this report, the communicated wide array of BV errors in film quality disagreements remain, e.g. Item 16-3 Weld 13, BV item 371 cites PG&E for

missing a two shot event on the weld. Despite the clearly documented reader sheet, as well as PG&E telephonic and e-mail communication pointing out that this is a seam weld, and not a girth weld to which the 3 shot rule is applied per code, BV includes it and all the other invalid film quality calls, despite direct evidence to the contrary. PG&E also notes that now in the final report, the number of total undercut calls has inexplicably grown from 23 to 24. The number of Internal Undercuts (IU) has decreased by 1 from 22 to 21, but the number of External Undercuts (EU) has grown by 2 to 3 (three). No explanation is given for this discrepancy, and nowhere in the text of their report is the new External Undercut cited. The identified sample number of the de-correlation is identified by PG&E as sample 5, and no claim of external undercut is made for this weld. Similarly the BV errors in its burn through assessment, where they executed a substantial forensic miss, either applying themselves, black sharpie magic marker residue (see appendix I), or failing to note it, resulting in inaccurate more dense measurements in an area of dispute.

3.3 In attempt to understand the reasons for the unusually wide discrepancies in the interpretation of these sample TCI radiographs, PG&E reviewed its notes regards the observed conduct of the review by BV. Most notable was that in stark contrast to industry requirements from ASTM and quantified best practices, over the course of the 2 week stay it was observed that the film review took place with the room lighting in the on condition. Measuring the ambient light levels at the viewer surfaces used by the reviewers, PG&E recorded values which are as high as 4-5 times the ASTM limits of 3 foot candles maximum. This was brought to the reviewer's attention, but they dismissed the need for reduced lighting as they interpreted the TCI radiographs.

3.4 During the course of our investigation for this report, PG&E has learned that the principal BV reviewer, observed as responsible for ~60-70% of the on-site physical film review at PG&E, is not at present an ASNT level III certificate holder in Radiography as advertised in the report of qualifications, and by his signature, and as required for this activity. The ID number sequence as well as certification dates for his ASNT methods where he is a level III certificate holder, dye penetrant and ultrasonic, indicate that he has been so certified a maximum of 5 years. This is in stark contrast to the 23 years represented in his bio. A discussion with the technical staff at ASNT has revealed that he has been only certified for 1 cycle (5 years), and for Radiography this expired in 2013 and was not renewed. ASNT prohibits the signing of documents representing ASNT level III certification when that method is not held.

3.5 Neither reviewer claimed in writing, or in oral interview, any substantive experience in working with the API 1104 code. This was recognized by our external level III consultant in early communications of their findings, where BV was found to have applied ASME code requirements for acceptance criteria, which are not applicable to the product in this review. The principal reviewers resume was reviewed on-line (www.climbwithsummit.com/images/charlescv.pdf), and cited technical experience as an individual contributor acquiring experience and executing film reading responsibilities, pre-dates 1957, as all of the experience since that date has been in management roles and training. This

experience, as well as the limited technical experience on the part of the second reviewer are cited by Fücsök, Müller et al (http://www.ndt.net/article/ecndt02/429/429.htm) as being critical gaps for the maximized interpretation, termed Receiver Operating Characteristic (ROC) of radiographs.

3.6 Despite PG&E's concerns about the preparedness, experience and credentials of the reviewers for this assessment, as well as the noted impacts to its potential reliability in its observed conduct, it is noted in a book with Title author claim from the principal BV reviewer; "Handbook of Nondestructive Testing" 2nd Edition, a direct acknowledgement that the PG&E chosen methodology for validation of the initial interpretation is correct. While Mr. Hellier is not the author of the majority of the book's chapters, the published chapter/section 11.3.1, while quite dated, demonstrates 2 key points regards our technical argument for acceptance, especially in the categories of; Burn through, concavity and internal/external undercut. 1. The practice of using digital radiography to measure change in thicknesses, which all of these indications are, is a decades old practice with copious academic and cross industry validation. 2. It is advocated by Mr. Hellier as increasingly a code required and in all cases "an essential" means of interpreting radiographs. Despite these material facts, and a preponderance of industry and academic practice which validates the PG&E approach to the radiographs in question, Mr Hellier, the other BV report writers and signatories are unwilling to acknowledge that the BV final report (**Appendix III**, page 7)mention of the PG&E December 5, 2013 report had little to do with mechanical measurements of undercut conditions, but in fact was an explicit validation of the radiographic method of interpretation that PG&E applied. Finally on the topic of "Non-Compliant Imperfections Detected", BV cites lack of access to the welds themselves, or mechanical means to inspect them. This again improperly frames the problem, which is one of interpretation, and the quantitative results documented by PG&E clearly demonstrate that no code violations exist for these classes of cited "defects" or as now declared in the final report, "Non-Compliant Imperfections". PG&E did communicate in detail the various types of indications that are germane to pipeline welds also their radiographic characteristics. In addition PG&E directly offered to perform measurements or train the reviewers in the appropriate digital radiographic measurement methods for the evaluation, but were refused in each case by the BV reviewers.

3.7 Finally, the CPUC on May 19, 2014, e-mail requested responses to the following:

1. Review the 47 imperfections noted and provide a response on how PG&E plans to mitigate the safety risk associated with each imperfection.

2. Submit a plan to comprehensively review the entire 3755 weld population unless PG&E can provide substantial evidence that such a review will not decrease the risk associated with the welds.

3. Provide a response to each of the 3 recommendations noted.

4. PG&E has noted that 488 of the 3755 welds either are missing coverage, shot using 2-shot technique, or have improper 120 degree exposure. Provide a response to each weld BV identified to be either missing coverage, shot using 2-shot technique, or improper 120 degree exposure that PG&E has not included in its population of 488 welds.

3.8 Regards these May 19 CPUC requests: In order to have any level of efficiency and effectiveness in this TCI recovery process, PG&E needs to as first priority, close on issues of weld soundness and thus safety regards the BV cited weld defects (draft) or non-compliant imperfections (final). The widespread and pervasive nature of errors in the final BV report causes us great concern. That said, the current in work status of the items is as follows:

Responses:

1: The facts are clear that none of the 47 cited welds has non-compliant to code imperfections. Evaluations for each cited weld, demonstrating its acceptability are detailed within Appendix I.

2: As agreed to by the CPUC and PG&E, the comprehensive plan to review and address the entire 3755 weld population in addition to the overall Extent of Condition resulting from the TCI discovery by PG&E, is in execution via the Lawrence Livermore National Labs headed TCI EOC analysis task.

3: As to sub 1 of the BV final report recommendations, PG&E's NDE program, inclusive vendor surveillance, has been submitted and approved by the CPUC. As to sub 2 of the BV recommendations, The LLNL TCI EOC analysis effort includes assessment of other involved NDT companies going back to 1961, and in the submitted and approved PG&E NDE program, currently all NDE vendors and their processes have been audited and all project allowed technicians have been proficiency tested & endorsed. As to sub 3 of the BV recommendations, random field observations are in place and executed to a rule based statistical sampling plan inclusive of closed loop corrective action and maintained performance dashboard.

4: All agreed 2-shot or short/missing coverage welds are being addressed by the LLNL TCI EOC reliability impact study task. All additional false call 2-shot event misses require correction by BV in their final report, as requested by PG&E in previous telephone and e-mail communication, in addition to being discussed in section 2 and 3 of this report.

4.0 Conclusions & Recommendation

4.1 PG&E is not in agreement with the findings, statistical methodology, or conclusions of either the draft or final versions of the BV report: "Sample Review of TCI Radiographs". PG&E has substantial concerns regards the BV reviewers, their approach and methodology, as detailed in this report, which must be addressed by the CPUC with its BV assessment team.

4.2 PG&E recommends that CPUC and BV again review the technical and quantitative fact finding contained in this report and reconcile the results followed by the issuance of an accurate and

complete report. As desired PG&E again extends the offer to host BV if they wish to further evaluate their positions. We further recommend that the CPUC work to achieve interpretative clarity among its team by using only fully oriented, properly credentialed individuals who are experienced specifically to the requirements of API 1104.

4.3 PG&E will await a corrected report prior to discussing the other requests and recommendations, except to re-iterate that the overall issues of film quality, limited exposure (2-shot or coverage gaps), and resultant impacts to detection reliability are being worked under contract with Lawrence Livermore National Labs (LLNL), as CPUC is already informed and aware.

Appendix I

PG&E Quantitative Analysis of BV findings for "escaped defects" in TCI weld radiographs

Appendix II

March 5, 2014 BV Draft Report "Sample review of TCI Radiographs"

Appendix III

May 15, 2014 BV Final Report "Sample review of TCI Radiographs"