Meeting Minutes
API RP 520 Task Force
Spring 2004 Meeting
Atlanta, Georgia

Date: Tuesday, May 18, 2004
Time: 8:00 am – 12:00 pm

Introduction and Approval of Minutes

1) Task Force Chairman Phil Henry called the meeting to order at 8 AM, asked for introductions and passed the meeting sign-in sheet. There were 24 attendees (all members) present as the meeting convened. Tom Bevilacqua was appointed to record the minutes of the meeting.

2) The minutes of the Fall 2003 meeting held in Denver were approved by general consent, with the notation to item 4 of the minutes that as yet none of the Task Force members had received from API a copy of the recently-published RP 520 Part II.

Technical Inquiries

3) The agenda included seven Technical Inquiries to be addressed. The first (TI 520-I-02/02), from Technip-Coflexip, asked for a clarification of the impact of back pressure on the capacity of a pilot operated pressure relief valve (POPRV). The membership concurred with the response drafted by Chairman Phil Henry and included with the agenda. This response noted that, as the lift of a POPRV is not affected by the back pressure on the valve, the capacity for compressible fluids is not reduced until the ratio of the total back pressure to the inlet pressure exceeds the critical flow pressure ratio (examples of which are to be found in Table 7 of RP 520 Part I. The response noted further that for incompressible fluids, equations 3.9 indicate that flow capacity will be reduced by increasing total back pressure, but that as the lift of a POPRV is unaffected by back pressure, its back pressure correction factor k_W is always equal to 1.0.

4) Discussion of the inquiries listed as numbers 2 and 4 on the agenda – both of which involved determination of “k” (Cp/Cv) for use in sizing calculations – was deferred to the planned general discussion of this topic later in the meeting.

5) The inquiry listed third in the agenda (TI 520-I-01/03) from Costain Oil, Gas & Process Ltd., concerned Section 3.3.3.1.3 of RP 520 Part I and differing maximum permissible built-up back pressure for differing overpressures (e.g., for “process” and fire scenarios). The membership concurred with Phil Henry’s draft response stating that the intention of the seventh edition of RP 520 Part I is to permit the back pressure on a conventional PRV in compressible fluid service to be as high as, but not exceed, the allowable overpressure. In response to the Inquiry’s question of the need for

capacity re-certification at a higher back pressure, the response notes that capacity certification is a matter for ASME, not the API PRS Subcommittee.

6) Inquiry 520-I-06/03 from Samsung Engineering Ltd. concerns the applicability of the 3% limitation on PRV inlet pressure drop to liquid-service PRVs and the use of rated versus design flow capacity in calculating the pressure drop. Phil Henry's draft response stated that the 3% inlet loss rule applies to both vapor and liquid services, that the current recommendation is to use the rated capacity in calculating the pressure drop – except for modulating relief valves (such as some POPRVs), and that the API PRS Subcommittee is currently sponsoring a Joint Industry Project to study the applicability of the 3% rule.

While there was general agreement with most of the draft response, a lively discussion ensued regarding the PRV flow rate used in calculating the inlet pressure drop for liquid service. Several attendees noted that while they use the rated capacity for calculating vapor inlet losses, they use the design capacity for calculation of liquid flow losses. Representatives of the relief valve manufacturers generally agreed with the use of design capacity in liquid pressure drop calculations; some argued for using the design capacity even for compressible fluid pressure drop calculation. Phil Henry was surprised by these comments, noting that the Task Force had specifically addressed this issue in discussions prior to the publication of the current edition of RP 520 Part II, and that there had been membership consent to the language in this edition. Ed Zamejc noted that the 3% rule does not appear in the 1st edition of RP 520. Clark Shepard pointed out that the use of the rated capacity in the design of inlet piping provided some conservatism in the sizing which has often proved helpful as plants are debottlenecked and relief flow rates increase. A question was raised concerning the relevance of the current PRV Stability Study to this issue. While Dr. Ron Darby has been working on a version of his model applicable to liquids, the emphasis has been on gas phase applications, because they are generally more prevalent in the petroleum and petrochemical industries. The current experimental phase of the study includes no tests in liquid service. While there was some discussion of possibly issuing an early revision to RP 520 Part II, it was decided not to do so, but rather to continue the discussion of both sides of the issue at the fall meeting; **this topic will be added to the agenda under "Old Business."**

7) Technical Inquiry 520-I-07/03 from Samsung Engineering is in regard to a perceived inconsistency between the default value (0.9) of the rupture disk combination capacity factor (k_c) and the limitation of the inlet pressure loss to 3% of the set pressure. The attendees agreed that the Inquirer is "mixing apples and oranges" in that he mistakenly associates the k_c value of 0.9 with an inlet pressure loss of 10% of the set pressure. **Phil Henry said that he would draft a response to this Inquiry. Steve Palmer, Tom Bevilacqua, Denis DeMichael, and Kyle Roth volunteered to review the draft response.**

8) Inquiry 520-I-08/03, from AIChE member Luigi Raimondi makes note of the inconsistency of fluid composition and fluid properties stated in the example in

Section 3.6.2.2 of the current edition of RP 520 Part I. Phil Henry noted that a similar Inquiry had been addressed recently. The attendees agreed that no new response need be drafted.

Review of Current Action Item List

9) Phil Henry presented a cumulative list of 35 action items concerning both Parts I and II of RP 520. Only 7 of these items are considered resolved; several items were to be discussed later during the meeting. Phil asked for volunteers to accept responsibility for several items not yet assigned to anyone, and that **those members to whom items have been assigned please bring them to resolution**.

10) There was some discussion of item number 22 on the list. Denis DeMichael noted that he had performed some example calculations of built-up back pressures for several valve overpressures and sent these to the Task Force membership following the Spring 2003 meeting. Denis noted that his calculation results indicated that there may be reason not to permit larger allowable built-up back pressure at allowable overpressures larger than 10%. **It was agreed this topic should be discussed at the fall meeting.**

Next Revision of RP 520 Part I

Appendix D Simplification

11) Phil Henry noted that a revised Appendix D drafted by Rob Kreder and Aubry Shackelford was presented at the Fall 2003 meeting. This draft, with comments by Dr. Ron Darby and replies by Kreder and Shackelford, was included in the handouts distributed by Phil for the Spring 2004 meeting. The key features of the revised Appendix D are 1) presentation of the "homogeneous direct integration" (HDI) method as the first option for two-phase sizing and 2) removal of the "one-point" method for calculation of the omega parameter.

12) The discussion of the revised Appendix concerned several issues: whether to advocate the HDI method for *all* relief device capacity calculations in the main text, the need for one or more flow charts to provide guidance on when and how to employ various calculation methods, and the role of relief device vendors in verifying sizing calculations performed with the HDI or Omega methods.

13) There was general agreement that the HDI method is superior to others due to its lack of need for assumptions of fluid behavior and approximations (e.g., the questions concerning calculation of "C," via the ratio of specific heats or the isentropic expansion coefficient – see below). While some members expressed concern about the "universality" of the availability of fluid property simulation packages capable of reliably performing isentropic flashes, it was conceded that such packages were required to perform Omega method calculations, so no extra burden would be presented by the HDI. However, concerning the possibility of presenting the HDI method in the main text of RP 520 Part I, it was generally agreed that the next edition

should present HDI as an option in Appendix D, noting its applicability beyond two-phase flow applications.

14) Concerning the general practice of relief device vendors performing sizing calculations, and the difficulty presented to this practice by the need for fluid property packages for both the Omega and HDI methods, it was suggested, and generally accepted, that probably the best resolution would be for the purchaser/user of the device to specify a value for the mass flux in addition to the fluid properties typically specified in the past.

15) It was agreed that flowcharts should be introduced in the main text of RP 520 to provide guidance on the use of the various relief device sizing methods presented throughout the document. **Roger Danzy noted that he has some draft flowcharts. He will refine them and present them at the next meeting.**

Additional Items for Appendix D Revisions

16) Concerning two-phase flow sizing of non-capacity-certified liquid relief valves, Roger Danzy noted that the valve manufacturers want such sizing guidance removed from RP 520. Roger stated that if liquid were to flash in a non-certified valve, it would pop open (due to the expansion of the vapor), achieve full lift, and therefore be oversized (since the non-certified sizing equations would have been used). He noted that whereas the currently recommended value of k_d for two-phase service is 0.85, the effective value for a non-certified valve would be 0.62 (liquid k_d) * 0.6 (non-certified F_p) = 0.36. Other Task Force members noted that some method of evaluating the two-phase flow capacity of existing non-certified installations is required. It was suggested that for non-flashing service, the current non-certified equations should be used, while for flashing service, the Omega sizing equations could be used. Dr. Lai asked the group how much flashing would constitute the transition point between methods. The high subcooling transition was suggested, but there was no general agreement on this issue.

17) Concerning appropriate values for the viscosity correction factor in two-phase service, it was noted that the studies carried out by Dr. Darby of Texas A&M and Dr. K. Molavi of Dresser in the mid 1990s (*Process Safety Progress* **16** (2), 80 – 82 (1997)) supported use of the values in the current RP 520, with the viscosity of the two-phase fluid evaluated as the volume-weighted average viscosity of the two phases. It was agreed that this method for determining the two-phase viscosity correction factor should be added to Appendix D, in the contexts of both the HDI method and the Omega method.

18) Roger Danzy raised a question concerning capacity certification and stamping for two-phase applications. There was some discussion concerning a suggestion to add a section to RP 520 Part I addressing specification and/or certification of relief devices for two-phase service. It was noted that the current edition provides guidance on the selection of relief valves for two-phase flow services. It was acknowledged that two-phase flow capacity certification remains a very difficult topic. It was also noted that

ASME is considering a Code Case concerning "dual stamping" of relief devices (i.e. for both liquid and vapor services).

Ratio of Specific Heats, k

19) Phil Henry noted that the handouts contained correspondence from Ron Darby concerning the use of and determination of values for the ratio of specific heats, "k," in relief device sizing. The essence of Dr. Darby's argument is that the entire question of "k' is best avoided by employing the homogeneous direct integration method rather than methods that involve the use of "k" as an approximation to the isentropic expansion exponent. It was recognized that this issue is tied directly to the previous discussion of Appendix D revisions.

Two-Phase Discharge Coefficient, k_d

20) It was noted that the meeting handouts also contained discussions by Dr. Darby and by Dr. Joe Leung of the evaluation of discharge coefficients. Dr. Darby's thesis is that if the flow is choked in the relief valve nozzle, the deviation from ideal nozzle behavior will be small, so the vapor value for k_d should be used. If the choke point comes downstream of the nozzle, the liquid value of k_d should be used. Dr. Leung's analysis leads to the conclusion that non-ideality in the nozzle behavior is tied primarily to the fluid compressibility, so that even with very limited mole fractions of vapor in the two-phase mixture, the fluid behaves essentially as a vapor, such that the vapor value for k_d becomes appropriate. No clear resolution of this matter was reached.

Task Force Chairman Phil Henry adjourned the meeting at approximately 12:00 pm.