Joint Industry Project
PRV Stability – Round II
Project Charter

PRV Stability

Research Program

Revision	Description	Date
A	Strawman draft	7/19/12
B	Draft to potential Sponsors	8/6/12
C	Participant feedback	8/22/12
D	Aldeep and Darby Comments	12/31/12
E	Draft to potential participants	

Project Charter

September, 2012 (Draft E)

Table of Contents

Table of Tables

1 EXECUTIVE SUMMARY

The first joint industry project (PERF 99-05) on PRV stability was initiated to develop the relationships between stability and the PRV installation, cast those relationships into a model that will allow for prediction of PRV stability through the development of practical model. The results at the completion of the project indicate that while the model has promise, there are limitations on its practical use, including the following:

- The model shows strong dependence upon parameters that are not available from the valve manufacturer, such as the damping factor, which can depend upon local conditions (e.g. lubrication, contamination, alignment, history, etc.) as well as the geometry of the flow path around the disc (which varies with valve size and with manufacturer).
- No framework for the extrapolation of the parameters beyond the sample tests

The goals for the next step for the PRV Stability Research Program are three-fold:

- Develop guidance on whether PRV installations may be subject to instability
- Develop guidance on predicting consequences (e.g. damage to the valve) in the event of instability
- Develop guidance for implementing mitigating or corrective actions

The research will be sponsored by operating companies, PRV manufacturers, and consulting companies (Participants) who will supply funds, equipment, and/or resources under an agreement similar to that used for the PERF-99-05 (Attachment) to allow leveraged research while being protected from anti-trust concerns. Indirect stakeholders will be identified and engaged during this project. Requests for proposals will be developed for various technical aspects of the project and submitted to researchers, and the responses from the RFP will be used to establish the budget for the project. For estimation purposes, a preliminary budget of $40,000 to 50,000 per participant per year for two (2) to three (3) years is provided. The cost will vary depending on project scope and number of Participants. Researchers will then be selected to provide proposals that outline the project scope and costs.

2 PROJECT CHARTER

2.1 Introduction

2.1.1 Background

Pressure relief valves (PRVs) are used throughout the hydrocarbon processing industry to minimize the risk of equipment failures from high pressures. PRVs are reclosable devices that are intended to reseat once the pressure has dropped, thereby maintaining inventory and minimizing emissions. Several industry documents are available that specify details of design, sizing, installation, etc. of PRVs. One of these documents, API Recommended Practice 520 "Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries" Part II "Installation" states "Excessive pressure loss due to friction at the inlet of a pressure relief valve will cause rapid opening of the valve. Chattering may result in lowered capacity and damage to the seating surfaces." It also specifies that "The inlet piping between the protected equipment and the inlet flange of the pressure relief valve should be designed so that the total pressure loss does not exceed 3% of the set pressure of the valve."

Similar limits can be found in ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Non-Mandatory Appendix M, Paragraph M-7 "Inlet Pressure Drop for High Lift, Top Guided Safety, Safety Relief, and Pilot Operated Pressure Relief Valves in Compressible Fluid Service," which states "The nominal pipe size of all piping, valves and fittings, and vessel components between a pressure vessel and its safety, safety relief or pilot operated pressure relief valves shall be at least as large as the nominal size of the device inlet and the flow characteristics of the upstream system shall be such that the cumulative total of all nonrecoverable inlet losses shall not exceed 3% of the valve set pressure."

2.1.2 PERF-99-05 Project (Round I)

The first joint industry project (PERF 99-05) for the PRV Stability Research Program was initiated to develop the relationships in the PRV installation that may affect the PRV stability, cast those relationships into a model that may allow for a prediction of PRV stability, and perform tests on a sample of installations to determine the feasibility of practical use of the model.

The API, and the a consortium of API member companies, commissioned a seven-phase joint industry project (PERF 99-05) to identify, from a more fundamental perspective, those factors that are important in influencing the unstable cycling or chatter of relief valves and to arrive at a more scientifically based criterion for selection and installation of valves which will ensure stable operation.

The seven phases of the PERF 99-05 Project were as following:

Phase I: Literature Search and Critical Review

Phase II: Industry Survey

Phase III: Engineering Model Design Planning

Phase IV: Experimental Program

Phase V: Mathematical Modeling

Phase VI: Engineering Tool Development

Phase VII: Comprehensive Final Report

In Phase I, approximately 65 references were identified which include material related directly or indirectly to the cyclic operation or stability of relief valves. There are additional sources cited within these references that were also pertinent and many of them were reviewed. The literature search and critical review phase has helped identify critical valve performance parameters that eventually were taken into account in developing an understanding of design and operation parameters that impact PRV instability.

In Phase II of the project, the industry was surveyed for incident that may be related to PRV instability problems.

At the end of Phase III, a mathematical model was developed to predict the opening disk lift versus time response of a pressure relief valve in vapor or gas service. The model predicts stability through simulating the time response of the disk, which can be monotonically stable, oscillatory stable, or oscillatory unstable. The model accounts for the influence of the input parameters representing process conditions, valve physical parameters, and installation parameters, which were found to have a highly non-linear effect on the dynamics. Most of these parameters are readily available to the pressure relief valve designer, such as the process conditions and installation parameters; however, there are two parameters that are not considered to be readily available.

An experimental program was executed in Phase IV of the PERF 99-05 Project. The primary objective of the experimental program was to utilize the testing results to validate the mathematical Gas Valve Stability Model that has been developed in Phase III of the Project.

The experimental program was conducted using 18 conventional relief valves, representing three manufacturers, three valve sizes, and two set pressures. An initial valve characterization testing, with replication, was performed to obtain valve characteristics such as set pressure, blowdown, discharge coefficients, flowing capacity, and opening times, following the requirements of ASME Boiler and Pressure Vessel Code Section VIII and API Standard 526. The definition of opening time was not as straightforward as one may think at first glance, and further thought was given to the appropriate definition. After establishing the valve characteristics, several tests were run with varying inlet and outlet piping lengths as well as varying operational conditions, within the limitations of the testing facility. In the event a pressure relief valve failed to meet the fitness for service tests, it was removed from the testing scheme. Both the limitations of the testing facility and the failure of some relief valves led to gaps in the experimentation space; nonetheless, some duplication of the tests was performed for reproducibility.

It has been demonstrated that disk lift and other system transients that occur during PRV opening can be measured with excellent repeatability of results. Test procedures, instrumentation, and data reduction knowledge obtained from this test program will be applicable to future test projects that investigate dynamic response of PRVs and related systems.

In addition to the impact of valve installation parameter impact on stability, the experimental program has provided critical data on the impact of various operation parameters, such as depressuring rates, flow rate, pressurization rates on PRV stability.

The Phase V of the PRV Stability Project was aimed to validate the applicability of the mathematical model for predicting the valve initial disk lift as a function of time based on the completed testing program results.

The results at the completion of the project indicate that while the model has promise, there are limitations on the practical use, including the following:

- The model shows strong dependence upon parameters that are not available from the valve manufacturer, such as the damping factor, which can depend upon local conditions (e.g. lubrication, contamination, alignment, history, etc.) as well as the geometry of the flow path around the disk (which varies with valve size and with manufacturer).

- There is no framework for the extrapolation of the parameters beyond the sample tests (in which the parameters were determined by fitting the experimental data).
- Some experimental runs found instability on closing as the equipment was being depressured, and the model was not designed to apply to relief valve performance at closing.

In addition, other models have been developed independently of that created during the PERF 99-05 Project. These models may provide additional insight into the prediction of PRV Stability.

2.1.3 Incentives

Program Incentives

- Improved process safety
- Cost avoidance
- Improved industry reputation
- Improved engineering practices
- Improved PRV system design
- Improved PRV system reliability – Decreased downtime

Participant Incentives:

- Reputation – Addressing a safety issue for the industry
- Recognition for supporting high-profile study
- Influence research direction
- Faster implementation of the research results while testing is completed

2.2 Project Scope

2.2.1 Primary Technical Goals

The primary goals for this project in the PRV Stability Research Program are three-fold:

- Develop guidance on whether PRV installations may be subject to instability
- Develop guidance on predicting consequences (e.g. damage to the valve) in the event of instability
- Develop guidance for implementing mitigating or corrective actions that address potentially instable PRV installations

2.2.2 Scope of Work

For specific information pertaining to the scope of work, please refer to the PRV Stability Research Program – Round II – Request for Proposal (RFP). It is important to note that proposals may be submitted for any partial aspect of the scope of work; therefore, multiple proposals may need to be selected for execution of the desired scope of work.

2.3 Project Organization and Funding

2.3.1 General

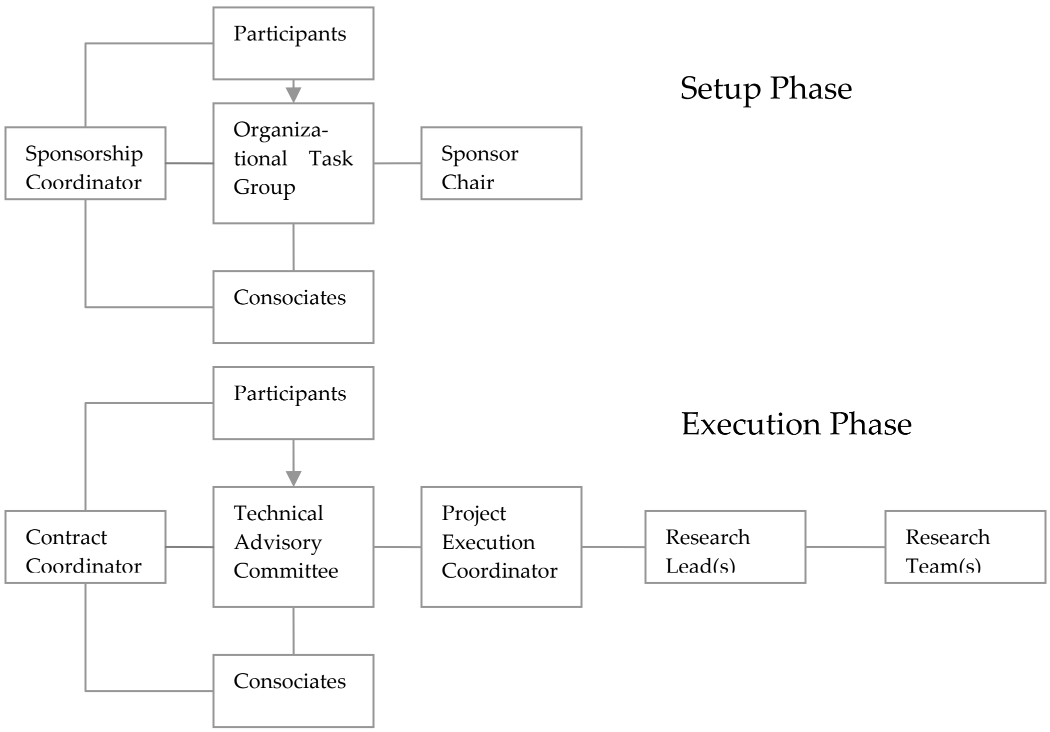
The research will be sponsored by direct stakeholders (Participants) who may supply funds, equipment, and/or resources under an agreement similar to that used for the PERF-99-05. Participants may include operating companies, PRV manufacturers, and consulting companies. In addition, indirect stakeholders (Consociates) may be identified and engaged during this project, and may include non-governmental or governmental organizations and associations that are able to participate in pre-defined capacity. Finally, interested parties that are unable to participate directly, but wish to be informed regarding the status and progress of the project and to offer their comments (Informed Parties) will also be identified.

The project is divided into two phases – a setup phase and an execution phase. During the setup phase, three parallel tracks will be worked: project charter development, drafting of the partnership agreement, and the RFP process. As part of the project charter development, participants will be recruited and this project charter, intended to cover some of the organizational aspects, has been developed to serve as a 'memorandum of understanding' among the potential participants prior to actually entering into a Participation Agreement.

The Participation Agreement will be the actual 'contract' between the various parties for the execution of the work; however, a lesson learned from the PERF 99-05 project is that this will likely be a critical path to begin the project's execution phase. The intent is to draft the Participation Agreement form that will include the structure of the document with important legal aspects, but exclude the project details to give potential participants enough information to being their internal vetting processes for participation. In order to execute the Participation Agreement, several pieces of information will need to be collected: the technical researcher(s) and their proposal(s) for execution of the work are selected, the budget is developed, the project is proposed to an appropriate overseeing organization, and all parties who want to participate are identified.

The RFP process will consist of the development of the RFP which will be reviewed and agreed upon by the potential participants. Interested researchers will be contacted and a Request for Information will be issued where a request is made for basic qualification information as well as comments on the RFP (to identify the need for clarification). The potential participants will have an opportunity to review the qualification information as well as an opportunity to review and comment on any update to the RFP in the event of significant revision. The RFP will then be issued to the interested researchers, who may submit proposals to execute all or part of the requested scope of work. These proposals should include details on the costs, resources, and timelines involved in the execution. The potential participants will then deliberate on the proposals and select the one(s) to proceed with. Once selected, the proposal(s) will provide the basis for the scope of work and the budget, which are elements of the Participation Agreement. The execution phase commences when the participation agreements are in place.

As part of the project, the roles of Sponsorship Coordinator and Sponsor Chair will be identified to facilitate progress. During the setup phase, the Sponsorship Coordinators will be ExxonMobil Research and Engineering Company, and Smith & Burgess, and the Sponsor Chair will be **TBD**. Similar roles will exist during the execution phase of the project; however, they will be defined in the Participation Agreement as the Contract Coordinator and the Project Execution Coordinator. During the execution phase, ExxonMobil Research and Engineering Company will be the Contract Coordinator. The Project Execution Coordinator for the execution phase will be selected by the Organizational Task Group.



2.3.2 Project Proposal to PERF(SM)

One of the responsibilities of the Contract Coordinator is to sponsor the project to the Petroleum Environmental Research Forum (PERF)SM, a "non-profit organization created in 1986 to provide a stimulus to and a forum for the collection, exchange, and analysis of research information relating to the development of technology for health, environment & safety, waste reduction and system security in the petroleum industry" (for more information regarding PERF, please refer to its website – www.perf.org). Note that PERF is not associated with the American Petroleum Institute (API). This sponsorship involves submitting a project proposal to the PERF board during a scheduled meeting. When and if the project is accepted, a project number is assigned and the sponsoring organization files, on behalf of the Participants, disclosure notifications with the Attorney General of the United States and the Federal Trade Commission under the provisions of the National Cooperative Research and Production Act of 1993 (15 U.S. Code Sections 4301-4305) and particularly Section 6 of that Act (15 U.S. Code Section 4305). Potential participants may be required to authorize EMRE to file this on their behalf.

This process is the same as that undertaken for the PERF 99-05 Project, which was sponsored to PERF by BP Amoco Chemical Company.

2.3.3 Desired Setup Phase Timing

For the setup phase of the project, the following milestones have been targeted, with an eye towards the desire to have a better budgetary estimate in hand by November and to start the execution phase of the project in 2013:

- Draft participation agreements to Organizational Task Group – January 2013
- Submit strawman RFP(s) to Organizational Task Group for review – February 2013
- Issue RFP to potential researchers – March 15 (due April 1)
- Compile technical research proposals and submit to Organizational Task Group – April 15
- Deliberate on selection of potential researchers and preparation of budget – May 1
- Contract Coordinator to propose project to PERF – April 1
- Execute participation agreements – starting May 15

Table 1: Current Gantt Chart Illustrating Setup Phase Desired Timing

To Be Developed

2.3.4 Roles and Responsibilities

2.3.4.1 Organizational Task Group

An Organizational Task Group will be formed during the setup phase with a representative from each potential Participant and/or Consociate, and is open to any interested party. The Organizational Task Group will be required to provide feedback on the Project Charter and each representative will be required to accept the Project Charter as a memorandum of understanding among the Organizational Task Group. The Organizational Task Group will be required to provide feedback on the RFP, assist in the pre-qualification of the potential researchers, review the proposals submitted, and select the desired proposal(s). In addition, the Organizational Task Group will be responsible for electing the Project Execution Coordinator for the execution phase.

Ten (10) members of the Organizational Task Group constitute a quorum for a meeting of the Organizational Task Group. The prequalification of potential researchers, the selection of the desired research proposal(s), and the election of the Project Execution Coordinator will occur by a majority vote of the Organizational Task Group, and previous notice will be given.

The Researcher prequalification process involves receipt of specific information from interested Researcher(s) as defined in the RFP, and is anticipated to include curricula vitae of principal researchers, description of similar types of research projects executed, and details of familiarity with the subject matter. The members of the Organizational Task Group will be asked to review the information and vote on whether or not a Researcher(s) should be able to submit a proposal. The 'prequalification' will be determined by the Organizational Task Group in their sole discretion.

The Organizational Task Group will cease to exist at the end of the setup phase, when the Participation Agreement has been executed.

2.3.4.2 Technical Advisory Committee

A Technical Advisory Committee comprised of representatives of each Participant will act as the steering group during the execution phase of the project. Specific aspects of the Technical Advisory Committee will be established as part of the Participation Agreement; nonetheless, the responsibilities of the Technical Advisory Committee during the execution phase are anticipated to be participation in the decision gate meetings to review the completion of a stage, to authorize the next steps as well as funding after the decision gate, approve the experimental plans proposed by the researchers, and participate in the stewardship meetings. The stewardship meetings are anticipated quarterly, and the Technical Advisory Committee will meet twice per year during the API Committee on Refining Equipment meetings. Any Participant may witness tests or review data generated during the execution phase with prior notification and protocols to be established.

2.3.4.3 Sponsorship Coordinator

During the setup phase, the Sponsorship Coordinator will be responsible for recruiting direct stakeholders for the project and identifying indirect stakeholders. As part of the recruiting effort, the Sponsorship Coordinator will develop this project charter, containing the scope and objectives, and outlining the commitments from the direct stakeholders, and will submit the project proposal to PERF. The Sponsorship Coordinator will assist the Sponsor Chair in obtaining the information needed to release the RFP. After receipt of the technical proposals, the Sponsorship Coordinator will work with the Sponsor Chair and the participants to develop the program budget. The Sponsorship Coordinator will then use the program budget for the resource definition/project cost that is needed to execute the participation agreements. It is anticipated that the formal awarding of the technical research programs will occur simultaneously with the execution of the participation agreements. The

Sponsorship Coordinator will be accountable for the execution of the participation agreements.

During the execution phase, the Sponsorship Coordinator (as the representative for the Contract Coordinator) is responsible for maintaining any aspects of the participation agreements (e.g. retaining documentation on file). In addition, the Sponsorship Coordinator is accountable for maintaining and disbursing funding for the project.

2.3.4.4 Sponsor Chair

Prior to the selection of the research teams, the Sponsor Chair will be responsible for developing the RFP and coordinating the RFP process, with consultation from the participants. After receipt of the technical proposals, the Sponsor Chair will coordinate with the Sponsorship Coordinator and the participants to select proposals and develop the program budget. This step feeds the information for resource definition/project cost that is needed to execute the participation agreements. It is anticipated that the awarding of the technical research programs will occur simultaneously with the execution of the participation agreements.

After the research program is established, the Sponsor Chair (as the representative of the Project Execution Coordinator) will be the primary liaison between the participants and the research teams. Prior to actual execution of a research program, the Sponsor Chair will be accountable for reviewing the experimental plans submitted by the research teams and getting approval to proceed from the participants. During the execution of the research program, the primary responsibility will be to track and report the research program progress to the participants. In addition, the Sponsor Chair may witness tests or review data generated during the execution phase. The Sponsor Chair will conduct quarterly stewardship meetings and periodic project decision gate meetings where the participants will have the opportunity to modify the path forward for the project, and will present the overall progress semi-annually to all stakeholders.

The high-level tasks envisioned at this point are outlined in the table below, along with anticipated responsibilities, accountabilities, consulting, and informing assignments. The assignments recognize that the participants are a collection of direct stakeholders; therefore, anytime the participants are identified with a responsibility, a single person is assigned the accountability for accomplishing the task. For the high-level tasks where the Sponsor Chair has accountability, the task is presumed to be accomplished with a simple majority vote of a quorum of participants.

2.3.4.5 Summary

The charts below outline the responsibilities, accountabilities, consultation, and information actions for various roles and tasks.

Table 2: RACI Chart – Setup Phase

Task	Sponsor Chair	Sponsorship Coordinator	Participants	Consociates	Informed Parties	Research Tech Lead	Research Team
Develop charter with scope and objectives	C	R	C	C	C		
Recruit participants and define commitments	C	R	C	C	C		
Write Request for Proposal (RFP)	R	C	C	C	C	C	
Prequalify potential researchers	A	C	R	R		I	
Publish and coordinate RFP	R	C	C	C	I	C	
Select proposals	A	C	R	R		C	
Develop program budget	A	C	R	R		C	
Execute sponsorship agreements	I	A	R	R			
Propose project to PERF	I	R	I	I		I	
File with Attorney General and FTC	I	R	I	I		I	

Table 3: RACI Chart – Execution Phase

Task	Sponsor Chair	Sponsorship Coordinator	Participants	Consociates	Informed Parties	Research Tech Lead	Research Team
Maintain participation agreements	I	R	I	I		C	
Track and report project metrics / budget	R	I	C	C		C	
Conduct decision gates	A	I	R	R	C	I	
Maintain and disburse funding	I	A	R	R			
Develop experimental plans	I					A	R
Approve experimental plans	A	I	R	R	C	C	
Oversee testing, data analysis, conclusions	I					A	R
Submit research progress report (weekly)	I					A	R
Submit progress report (monthly)	R	I	I	I		C	
Conduct stewardship meeting (quarterly)	A	I	R	R	I	I	
Present state of the project (semi-annual)	R	I	I	I	I	I	

2.3.5 Preliminary Budget

To develop the preliminary budget, the following information was used:

- Research Team comprised of Technical Lead for 8 months full-time equivalent per year and Experimental Team for 3 months full-time equivalent per year, average rate of $150/hr
- Testing comprised of 100 tests per year, $1,000/test
- Sponsor Chair, 35 half day meetings plus 80 manhours per year, $225/hr

- Technical Advisory Committee participation, 19 days per year, $225/hr (academic only)
- PRVs are donated to offset participation fee
- 10 Participants providing funding

Table 4: Preliminary budget

Role	Basis (per year)	Annual Cost
Research Team	1,760 manhours	$264,000
Testing Cost	100 tests	$100,000
Sponsor Chair	220 manhours	$49,500
Task Group	152 manhours	$34,200

Based on these assumptions, a preliminary cost of $40,000 to $50,000 per year for each Participant is estimated.

2.4 Organizations Expressing Interest

2.4.1 Participation List

The following organizations have expressed an interest in participation in this Joint Industry Project.

Table 5: Organizations expressing interest

American Petroleum Institute	Akzo Nobel	BASF
Bayer	BP	Chevron
ChevronPhillips Chemicals	Chiyoda	ConocoPhillips
Curtiss Wright	DIERS	Dow
Equity Engineering	ExxonMobil	Fauske & Associates
FHR / Koch Industries	GE Oil & Gas	Holly/Frontier
Huntsman	INEOS	Inglenook Engineering
ioMosaic	Leser	Lyondell Basell
Marathon	PBF Energy	Phillips 66
Praxair	Shell	Siemens
Smith & Burgess	Tyco International	Valero
Western Refining		

2.4.2 Questions

For more information regarding participation in the program, please contact the Sponsorship Coordinators, Dustin Smith (dustin.smith@smithburgess.com, 713.802.2647) or Clark Shepard (clark.d.shepard@exxonmobil.com, 703.846.3327).