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1.0 INTRODUCTION

1.1 Purpose

The purpose of this document is to outline the Anacortes Refinery's approach to Layers of Protection Analysis (LOPA).

1.2 Scope

This procedure establishes minimum requirements for conducting Layers of Protection Analysis for all covered processes at the Anacortes Refinery, which meet the applicability standards.

1.3 Records Retention

Printed copies of this document should not be retained more than 12 months. Any revision to this document will be retained indefinitely.

2.0 REFERENCES

2.1 Marathon Standards, Policies & Procedures

- GEN-101, Marathon Petroleum Corporation Risk Calibration Standard
- PSM-1070, Process Safety Management
- PSM-1070 App E1, Layer of Protection Analysis
- PSM-95001, Guidance for Developing Layer of Protection Analysis (LOPA) Standards
- RSP-1315-000, Layer of Protection Analysis (LOPA)
- RSP-1129-030, HF Alky Protection and Mitigation Systems SIS
- RSP-1131-000, Pressure Protection and Disposal
- RSP-1135-LPG, LPG Storage Installations SIS
- RSP-1172-010, Atmospheric Storage Tank Instrumentation
- RSP-1172-020, Safety Instrumented System (SIS) General
- RSP-1172-021, Sulfur Recovery Unit (SRU) Application Standard
- RSP-1172-022, Fluid Catalytic Cracking Unit Application Standard
- RSP-1172-024, Heater SIS Application Standard
- RSP-1172-025, Boiler SIS Application Standard
- RSP-1172-026, Liquid Overfill Application Standard
- RSP-1172-027, Gas/Vapor Flow to Tank Application Standard
- RSP-1172-028, Reverse Flow to Vessel Application Standard
- RSP-1172-029, Blow Through to Vessel Application Standard
- RSP-1172-030, Pump Seals Application Standard

- RSP-1172-031, Minimum Protective Systems for Compressors Application Standard
- RSP-1172-032, SIS Application Standard for Delayed Coker Unit
- RSP-1172-023, SIS Application Standard for Loss of Cooling
- RSP-1172-024, SIS Application Standard for Hydrocracking Unit
- RSP-1172-025, Blocked Outlet Application Standard
- RSP-1173-010, DCS Alarm Management
- RSP-1303, PSM/RMP Process Hazard Analysis (PHA)
- RSP-1308, PSM/RMP Mechanical Integrity

2.2 Government Regulations

- OSHA Federal Regulation 29 CFR 1910.119, Process Safety Management of Highly Hazardous Chemicals
- EPA Federal Regulation 40 CFR 68, Chemical Accident Prevention Provisions

2.3 Industry Standards

- ISBN 978-0-470-76772-6, Guidelines for Engineering Design for Process Safety, Center for Chemical Process Safety, 2nd editions (CCPS), 2012
- ISBN 978-0-470-26140-8, Guidelines for Developing Quantitative Safety Risk Criteria, Center for Chemical Process Safety (CCPS), 2009
- ISBN 978-0-8169-0811-0, Layer of Protection Analysis: Simplified Risk Assessment, Center for Chemical Process Safety (CCPS), 2001
- ISBN 978-1-118-77793-0, Guidelines for Enabling Conditions and Conditional Modifiers in Layers of Protection Analysis, Center for Chemical Process Safety (CCPS), 2013
- ISBN 978-0-470-34385-2, Guidelines for Initiating Events and Independent Protection Layers in Layer of Protection Analysis, Center for Chemical Process Safety (CCPS), 2015

American Petroleum Institute (API)

- API RP 581, Risk-Based Inspection Technology

American Society of Mechanical Engineers (ASME)

- ASME BPVC Section VIII, Div. 1, Rules for Construction of Pressure Vessels

International Society of Automation (ISA)

- ISA 61511-1, Functional Safety: Safety Instrumented Systems for the Process Industry Sector - Part 1: Framework, Definitions, System, Hardware and Software Requirements
- ISA 61511-2, Functional Safety: Safety Instrumented Systems for the Process Industry Sector - Part 2: Guidelines for the Application of IEC 61511-1

- ISA 61511-3, Functional Safety: Safety Instrumented Systems for the Process Industry Sector - Part 3: Guidance for the Determination of the Required Safety Integrity Levels

3.0 DEFINITIONS

The following definitions are applicable to this procedure.

Table 1 Acronyms

Term	Description
BPCS	Basic Process Control System
CM	Conditional Modifier
CPV	Critical Process Variable
HAZOP	Hazard and Operability (Study)
IE	Initiating Event (Cause)
IPL	Independent Protection Layer
LOPA	Layer of Protection Analysis
MAWP	Maximum Allowable Working Pressure
NTE	Not to Exceed
PFD	Probability of Failure on Demand
PHA	Process Hazard Analysis
PRD	Pressure Relief Device
PST	Process Safety Time
PSV	Pressure Safety Valve
QRA	Quantitative Risk Analysis
RAGAGEP	Recognized and Generally Accepted Good Engineering Practice
RRF	Risk Reduction Factor
SIF	Safety Instrumented Function
SIL	Safety Integrity Level
SIS	Safety Instrument System
SME	Subject Matter Expert
SRS	Safety Requirement Specification

Other terms associated with this document:

Operator Response Time

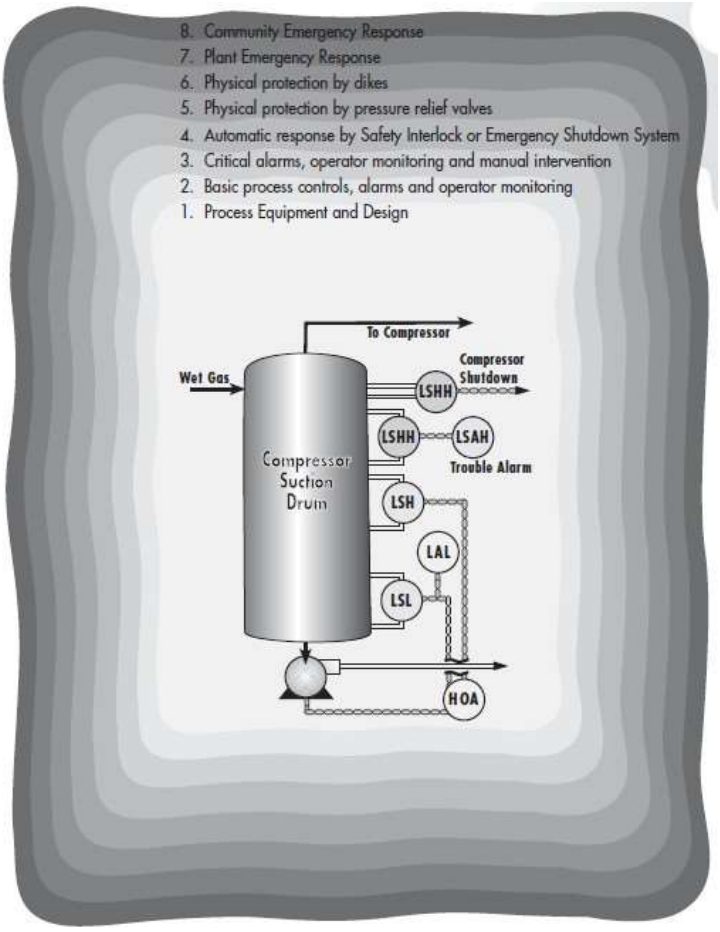
Risk

Safeguard

4.0 LOPA OVERVIEW

4.1 Overview

In any refining process multiple layers of protection are employed to ensure safe and reliable operation. These layers start at the most basic level with proper equipment selection and design which are targeted at prevention and ultimately escalate to those layers intended to mitigate an incident once it occurs, such as emergency response.



LOPA is a tool that can be used for the relative comparison of process risks, especially for the high severity/low frequency events where past experience is not a good basis for determining frequency. It is also used to assess the effectiveness of protection layers in reducing the frequency at which potential consequences associated with process hazards might occur. LOPA provides specific criteria and restrictions for evaluation of hazard causes and protection layers reducing the subjectivity of qualitative methods. LOPA is a semi-quantitative analysis tool that bridges the gap between a qualitative risk assessment such as a HAZOP and more detailed quantitative methods such as QRA.

4.2 Relationship Between LOPA and the Risk Calibration Standard

The Corporate Risk Calibration Standard (GEN-1010) establishes a risk matrix and defines response criteria (A though D) based on risk. The event severity (severity of the consequence) and the mitigated event likelihood (frequency) determined during LOPA is then used to determine the risk ranking, based on the risk matrix from GEN-1010.

4.3 Relationship Between LOPA and HAZOP

LOPA should be done in conjunction with the 5-year PHA and with project PHAs, after the HAZOP is completed. For projects, timing of the HAZOP within the project lifecycle is specified in Section 9.2 of RSP-1303. The practices for identifying and evaluating hazards, developing recommendations, and documenting the recurring and new unit HAZOPs will continue per RSP-1303. HAZOP studies are the Refining means for complying with the PHA requirement in the OSHA PSM and EPA RMP Standard. LOPA then goes above and beyond the regulatory requirement for PHA.

4.4 LOPA Relationship to SIS Review

The SIS Review per Section 1.2.4 of RSP-1172-020 for existing SIS is completed every 5 years to update the Safety Requirements Specifications (SRS). The SIS Review covers the entire Safety Requirement Specifications for an SIS, which contains many aspects in addition to the risk assessment and LOPA. It should be done within 6 months after the completion of the LOPA. The LOPA information (risk assessment) is one of the inputs to an SRS.

5.0 LOPA TEAM

5.1 LOPA Team

The personnel assigned to the LOPA Team should be qualified (i.e., have sufficient knowledge of the process and the unit) to evaluate the following:

A. Progression of the initiating event to the consequence,

B. Likelihood of initiating events,

C. Applicability of Conditional Modifiers, and

D. Applicability and reliability of Independent Protection Layers (IPLs).

The LOPA Team shall consist of core members who participate full time during the study. Full-time members shall be assigned to the LOPA team to fill the following roles:

A. LOPA Facilitator,

B. Scribe,

C. Technical Service Engineer,

D. MPC Engineering Department representative,

E. Operations representative with board operations experience on the process, and

F. Control Systems Engineer.

NOTE: For the LOPA, the facilitator (or another team member) may act as the scribe if desired.

5.2 Team Member Selection

A team of knowledgeable, multi-disciplinary members shall be selected so that a balanced approach to evaluating process hazards and safeguards is achieved. The experience of the LOPA Team should be such that they have knowledge in each area that is represented. For LOPAs done in conjunction with regular unit HAZOPs, it is preferable to use the same personnel that participated in the HAZOP study, supplemented with the additional disciplines required for LOPA.

Refer to the corporate LOPA standard RSP-1315-000 for detailed requirements for team members.

The PSM Coordinator shall propose a LOPA team for Refinery Management review and Technical Service Manager approval prior to the start of the LOPA . The minimum knowledge and/or experience for the full time LOPA team are listed in the table below.

NOTES:

1. Additional MPC employees or outside consultant(s) shall be used to provide for any deficiency in the required team member set of competencies.
2. The Operations Representative shall always be an MPC employee unless the LOPA covers a unit being operated by contractors.

5.3 Study Approval

The Study Approval Form for a LOPA study provides a documented basis for the LOPA study, defining the scope and the team membership. A Study Approval Form shall be developed and signed by the Technical Service Manager prior to the start of the LOPA study. Signature documents the approval of the LOPA team

The Study Approval Form shall contain at minimum:

A. The scope of the study,

B. The reason for the study,

C. The intended start and end dates for the study,

D. The core team members, and

E. Technical Service Manager Approval.

NOTE: A sample template for the Study Approval Form can be found in Appendix E of the corporate LOPA standard.

6.0 LOPA PROCESS

6.1 LOPA Process

The Layer of Protection Analysis (LOPA) process has several steps which must be completed to achieve reliable results. These steps are listed below, and more fully described in subsequent sections of this document.

1. Select the LOPA Scenario,
2. Evaluate Application Standard applicability,
3. Determine Initiating Event Frequency,
4. Apply appropriate Conditional Modifiers,
5. Identify independent protection layers, assign risk reduction factors,
6. Calculate the Total Risk Reduction Factor,
7. Risk rank scenario with existing IPLs,
8. Develop recommendations if required, and
9. Determine post mitigation risk ranking.

NOTE: LOPA Calculations can be performed using either frequencies/probabilities (likelihood) or Risk Reduction Factors. Risk Reduction Factors (RRF's) are the inverse of frequencies and probabilities. When frequencies and probabilities are used, the numerical values are decimals less than one (such as 0.001) and are often expressed in exponent form (such as 10^{-3}). Risk Reduction Factors are numbers greater than one (such as 1,000). While the calculations are equivalent, using the Risk Reduction factors allow the use of whole numbers rather than decimals, thus Risk Reduction Factors are used in this practice. The tables in the following sections are given using the Risk Reduction Factor. Where desired, Risk Reduction Factors can be converted to the likelihood (likelihood = 1 / RRF).

6.2 Scenario Selection

LOPA is performed for individual cause/consequence pairs ("scenarios") identified in the PHA. Multiple causes leading to the same consequence may be grouped together for analysis but shall be evaluated individually. Event likelihoods for multiple initiating events with the same consequence will not be summed (no cumulative likelihood calculations).

LOPA may not be appropriate for all hazard scenarios identified. Refer to the corporate LOPA standard RSP-1315.

6.3 Application Standard Applicability

Application Standards are documents that outline a consistent approach across all refineries for managing risk for certain common hazards. These standards combine on LOPA risk assessment with expertise, engineering judgment, and industry standards and practices for determining when additional layers of protection are required, and what those layers are. Application Standards embody MPC's approach to managing associated risks.

For the purposes of LOPA, the Approved Application Standards are as follows:

A. RSP-1172-010, Atmospheric Storage Tank Instrumentation

B. RSP-1172-020, Safety Instrumented Systems (SIS) General

C. RSP-1172-021, Sulfur Recovery Unit (SRU) Application Standard

D. RSP-1172-022, Fluid Catalytic Cracking Unit Application Standard

E. RSP-1172-024, Heater SIS Application Standard

F. RSP-1172-025, Boiler SIS Application Standard

G. RSP-1172-026, Liquid Overfill Application Standard

H. RSP-1172-027, Gas/Vapor to Tank Application Standard

I. RSP-1172-028, Reverse Flow Application Standard

J. RSP-1172-029, Blow Through to Vessel Application Standard

K. RSP-1172-030, Pump Seals Application Standard

L. RSP-1172-031, Minimum Protective Systems for Compressors Application Standard

M. RSP-1172-032, SIS Application Standard for Delayed Coker Unit

N. RSP-1172-033, Loss of Cooling Application Standard

O. RSP-1172-034, SIS Application Standard for Hydrocracking Unit

P. RSP-1172-035, Blocked Outlet Application Standard

Q. RSP-1129-030, HF Alky Unit Protection & Mitigation Systems

R. RSP-1135-LPG, Liquefied Petroleum Gas (LPG) Storage Installations

As part of the LOPA, each scenario should be reviewed to determine if one of the Application Standards applies to the scenario under review. Identifying the appropriate application standard prior to selecting the Conditional Modifiers and IPLs for the LOPA scenario allows the team to use the guidance in the standard for the LOPA.

NOTE: When the LOPA team determines that an application standard exists for a LOPA scenario, they must document this for each scenario, in the LOPA tables, in the PHA Pro software. Documentation will include the application standard applicable, as well as the specific section of the application standard which applies to the scenario.

Where the Application Standard contains a LOPA, the application standard LOPA should be used as the starting point for the LOPA review. The LOPA team shall validate the initiating event frequency and the conditional modifiers used in the application standard and adjust where necessary to represent the specific installation. The required protections in the application standard shall be listed as IPLs in the LOPA if they are present.

6.4 Initiating Event

An initiating event (cause) is the original failure or error that initiates the scenario. Initiating event(s) that could lead to the process deviation shall be identified and documented. The team shall list each identified initiating event and its associated Risk Reduction Factor (RRF). The initiating event RRF will be used in determining the overall risk reduction factor as outlined in RSP-1315, Section 4.7.

Every identified cause that can lead to the consequence of interest shall be evaluated.

NOTE: It is important not to confuse process deviations with initiating events. An initiating event should be a specific failure leading to the consequence of

interest. Initiating events should be attributable to a specific instrument or piece of equipment.

6.5 Conditional Modifiers

Conditional Modifiers are risk reduction factors that may be justifiably applied to an event likelihood when certain conditions are met.

Refining recognizes the following Conditional Modifiers:

- Time at Risk / Enabling Condition,
- Probability of Personnel Presence,
- Probability of Ignition,
- Probability of Vessel Failure due to Overpressure,
- Probability of Process Specific Failures,
- Probability of Pump Seal Failure,
- Probability of Compressor Failure, and
- Probability of Harm to the Environment.

NOTE: The LOPA team will determine which Conditional Modifiers are appropriate for each scenario being evaluated. Refer to RSP-1315 for detailed guidance on conditional modifiers.

6.6 Independent Protection Layers

Independent Protection Layers (IPL) may be credited for reducing the likelihood of an event when applying LOPA. Independent Protection Layers are safeguards that are designed and implemented to prevent the propagation initiating events to the consequence of interest. IPLs are both independent of the initiating event AND other IPLs. IPLs must be effective, independent, and auditable. Further instruction and clarification regarding independent protection layers can be found RSP-1315

Safeguards can be either preventative or mitigative. Preventative safeguards prevent the propagation of failure and thus can prevent the consequence from occurring (if they work). They reduce the frequency of the event. Alarms, trips, relief valves, etc. are generally considered preventative safeguards.

- Mitigative safeguards take effect after the consequence has occurred. They are designed to stop escalation, and thus reduce event severity, but not the frequency of the event. Fireproofing, fire monitors, emergency response, etc. are generally considered mitigative safeguards.

Whether a safeguard is considered preventative or mitigative depends on how the consequence is defined. Mitigative safeguards should be considered when defining the severity of the consequence. Only preventative safeguards can be considered in the LOPA as IPLs. Refer to the corporate LOPA standard RSP-1315-000 for detailed requirements and comprehensive tables describing the Independent Protection Layers

6.7 Current LOPA Risk Rank

The existing risk rank (A through D) for the scenario is determined from the severity assigned to the scenario by the team and the frequency category determined in RSP-1315 tables from the Total Risk Reduction Factor in accordance with the Risk Matrix in Table 4 of GEN-1010. The existing risk rank will be based on the equipment and IPLs as they currently exist in the plant, and referred to as the Current Risk Rank. This risk ranking does not consider any potential future IPLs that may be proposed by the LOPA team.

The current risk ranking shall be documented in the LOPA worksheets for each cause/consequence pair.

NOTE: This risk ranking is separate from the HAZOP risk ranking. The LOPA risk rank and HAZOP risk rank may not be the same because the Frequency Category determined in the HAZOP may be different from the Frequency Category determined by the LOPA.

6.8 Application Standard Compliance Review

Where an applicable standard exists, the team should determine if it has been properly implemented for the installation under review. The term Properly Implemented means that the required minimum protections have been implemented as described in the Application Standard. The Application Standard, the applicable section of the standard, and compliance (yes or no) should be recorded in the LOPA worksheets.

If the required minimum protections specified in the application standard are not present, a recommendation shall be developed for implementing them.

6.9 Development of Recommendations

Once the initial risk ranking has been determined and the associated application standard identified and reviewed, The LOPA team shall determine if IPLs are adequate or if additional layers of protection are needed to mitigate the risk. The flowchart in Section 7.0 should be used as a guide for developing recommendations.

Generally, a recommendation is not required when the installation follows the Application Standard and the risk is no higher than "C-ALARP", though the team may choose to make a recommendation. If the installation is not in compliance with the Application standard, a recommendation shall be made to comply with the Application Standard, unless there is already an existing recommendation from the Application Standards Gap Assessment that can be referenced.

If the LOPA scenario is not covered by an existing Application Standard, follow the flowchart in RSP-1315 to determine whether a recommendation is required. If the initial risk rank is "A" or "B", the response criteria and approval levels specified in GEN-1010 (Table 5) apply.

Where the LOPA team determines additional layers of protection are necessary, a recommendation shall be developed and documented in the LOPA report. The recommendation should include the Risk Reduction Factor provided by the proposed IPL. Recommendations shall be reviewed with the appropriate subject matter expert (generally the Refining Technologist or Specialist) before they are finalized to ensure

quality and consistency across the Refining sites. Recommendation approval levels and timelines will be managed in accordance with GEN-1010.

NOTE: Refer to IG-43 for guidance on the compliance dates for the following LOPA recommendation scenarios target dates;

- When due dates for LOPA recommendations related to gap assessment implementation can be deferred beyond the next turnaround.
- When the same recommendation is identified during a LOPA, as an existing recommendation from application standard gap, what to do with the LOPA recommendation
- When recommendations identified in a LOPA related to the implementation of an approved application standard can be deferred past the first turnaround, if necessary, to match the Application Standard gap project schedule and how to document this in LOPA.

6.10 Future Risk Ranking

The Final Risk Rank for the scenario will be determined in the same way as the Initial Risk Rank, with the exception that proposed IPLs will be considered to be implemented for the purposes of risk ranking. The Final Risk Rank will be based on the equipment and IPLs as they would exist if the LOPA team's recommendations were implemented. This risk rank is a measure of the effectiveness of the team's recommendations.

The Final Risk Ranking shall be completed and documented as follows:

A. Use the event consequences as determined by the team to select the consequence category from Table 1 of GEN-1010.

B. Calculate the Final Risk Reduction Factor with credit for existing AND proposed IPLs and use tables found in RSP-1315 to determine the quantitative frequency category.

C. Use the consequence category and quantitative frequency category from tables found in RSP-1315 with the Risk Matrix in Table 4 of GEN-1010 to determine the Final LOPA Risk Rank of A through D.

NOTES:

1. If the HAZOP recommendation differs from the LOPA recommendation, or if LOPA determines that a recommendation is not required, the HAZOP recommendation shall be considered on its own merit and retain the risk rank and source from the HAZOP.
2. Where a LOPA confirms a HAZOP recommendation, the HAZOP recommendation shall be kept and the LOPA team may reference the HAZOP recommendation instead of creating a LOPA recommendation.

7.0 LOPA DOCUMENTATION AND MANAGEMENT SYSTEM

7.1 Documentation

The LOPA facilitator is responsible for documenting the LOPA with a list of findings and recommendations. A LOPA report shall be completed for each LOPA performed.

NOTE: The LOPA report described in this section is a separate report from the HAZOP report in order to allow for different timing, facilitators, etc. Keeping the HAZOP and LOPA reports separate allows for better separation of regulatory and non-regulatory requirements. However, where desired, a joint HAZOP/LOPA report may be issued. The joint report shall then include all the required sections for the HAZOP (per RSP-1303) and the LOPA (see list below).

The following information shall be included in the LOPA report.

A. Executive Summary,

B. LOPA Scope (e.g., unit under review),

C. LOPA Facilitator,

D. LOPA Team Members,

E. LOPA session dates,

F. Team attendance for each date,

G. The signed Study Approval Form,

H. A copy of the risk matrix used for the study,

I. A list of all HAZOP scenarios considered for the LOPA study and the reason for excluding any potentially applicable scenarios from LOPA,

J. LOPA Worksheets including:

- Consequence description, category and severity,
- Application Standard reference (where applicable)
- Initiating Event (including RRF assigned),
- Conditional Modifiers (including RRF assigned),
- Independent Protection Layers (including RRF assigned),
- Risk Ranking (Current and Future), and
- Recommendations,

K. A listing of Application Standards referenced in the study,

L. A listing of IPLs credit in the LOPA, preferably organized according to the categories from Table 4.6.1,

M. A listing of all IPLs that were provisionally credited, including risk ranking with and without the IPL, and

N. A listing of remaining C-ALARP risks (future risk rank) after implementation of the relevant application standard.

NOTE: A final risk ranking of "A or B" cannot be accepted through compliance with the Application Standard.

The list of IPLs shall be provided to the department(s) responsible for the Mechanical Integrity Program for inclusion in the site Mechanical Integrity (MI) program.

The final version of the report for the LOPA study shall be approved by the Technical Service Manager. Recommendations and corrective actions shall be communicated to operating, maintenance and other employees whose work assignments are in the affected process and who may be impacted by the recommendations.

For a LOPA performed as part of a final Project PHA, the LOPA report shall be approved by the Technical Service Manager.

Each LOPA, update or revalidation, and the documentation on resolution of the resulting recommendations shall be retained for the life of the process. The final LOPA report shall be archived per MPC retention requirements. The LOPA report shall be available to employees.

7.2 LOPA of Record

LOPA of Record (LOR) is a concept where a LOPA will be updated over time, the most recent LOPA update for a unit will be referred to as the LOPA of record. While a unit LOPA is a discreet event, there may be instances in between the regular 5-year PHAs, requiring an update to the LOR.

LOR updates will be triggered by the following occurrences:

A. A five-year HAZOP/PHA revalidation or redo, and

B. A Major Project HAZOP with a Safety or Environmental event severity ranking of 4 or 5.

7.3 Management Review

LOPA recommendations should be reconciled against the HAZOP recommendations at the conclusion of the LOPA study so that a combined list of recommendations can be presented for management review. The HAZOP and LOPA teams may jointly compare their recommendations and risk ranking for the equivalent scenarios and decide whether to keep the recommendations as they are, modify them or let them be superseded by the other team's recommendations. Note that even if LOPA shows that the risk ranking of the scenario is "C" or the HAZOP recommendation does not qualify as an IPL (and cannot be credited with risk reduction), the HAZOP recommendation may still be beneficial. During the reconciliation, teams should develop a rationale to show why the recommendations are still applicable, considering the LOPA results.

NOTES:

1. While LOPA methodology can identify minimum requirements for the number and reliability of protection layers, it is not designed to evaluate the merit of additional safeguards. Safeguards can still be beneficial and improve safety even if they do not meet the strict reliability requirements to qualify as an IPL in a LOPA. For that reason, LOPA should not be the main criteria when considering the merit of HAZOP recommendations.
2. The reconciliation step does not apply when the time window for the management review of the HAZOP recommendations per RSP-1303 expires before the LOPA study is completed. In that case, the recommendations from each study are presented in separate management review meetings.

3. For projects, the project manager will be responsible for reviewing and tracking recommendations from the project LOPA study. Recommendation from the final project LOPA shall be entered into the tracking system as part of the MOC. Recommendations for completing documentation may be entered as post-start-up actions. Any pre-start-up recommendations not closed before start-up shall be presented to Refinery Site Management (similar to the requirements for projects PHAs as defined by Section 9.0 of RSP-1303).

For each recommendation, a proposed corrective action plan shall be developed and documented. Action plan shall include:

A. Any interim measures and preliminary risk mitigation plans if required per GEN-1010,

B. Proposed corrective actions to be implemented,

C. Assignment of the corrective actions, and

D. Schedule for completing the corrective actions.

Recommendations shall be presented to Refinery Management for review and evaluation, and for determination of what, if any, corrective actions should be taken to address hazards through preventative, protective, or mitigative measures. Specifically, refinery management shall resolve each recommendation by:

A. Deciding to accept, modify or reject recommendation (refer to the next section for guidelines on rejecting and modifying LOPA recommendations),

B. Finalizing the proposed corrective action plan to address each LOPA recommendation, and

C. Any extension to the schedule for resolution of recommendations shall be approved at the appropriate management level as defined by GEN-1010.

Refinery Management can use a variety of criteria to select and prioritize recommendations and the associated corrective actions, including the effectiveness of risk reduction, technical feasibility, implementation schedules, competing priorities and costs. All management decisions shall be documented, and a system shall be utilized to track implementation of corrective actions to be made.

The HAZOP report and the LOPA report should be updated to reflect the changes from the reconciliation and the decisions from the management review. If the HAZOP report was finalized prior to the review of the LOPA recommendations, it is not necessary to update the HAZOP report – any changes to the HAZOP recommendations should be documented in the recommendation tracking system.

7.4 Declining a Recommendation

A recommendation can be justifiably declined where it can be documented in writing, and based on adequate evidence, that one or more of the following is true:

A. The analysis upon which the recommendation is based contains factual errors.

B. The recommendation is not necessary to protect the health and safety of the

- employer's own employees,
- employees of contractors, or

- offsite receptors (i.e., the public).

C. An alternative measure would provide a sufficient level of protection.

D. The recommendation is infeasible.

NOTES:

1. Option (b) only applies if the installation is in compliance with an approved application standard (where applicable) and the risk has been accepted per GEN-1010.
2. Option (c) only applies if the installation follows an approved application standard (where applicable).
3. Option (d) does not apply for LOPA recommendations. If the recommendation is infeasible, a different means of reducing the risk shall be identified (c) or the risk shall be accepted (b).

The rejection of a recommendation shall be communicated back to the LOPA (and HAZOP team, if the LOPA recommendation superseded a HAZOP recommendation), with the team then re-evaluating the recommendations relative to refining management comments. Any subsequent recommendations of the team shall be handled in the same manner as original recommendations. Reasons for declining a recommendation shall be documented in the final LOPA report.

When rejecting a LOPA recommendation results in a remaining A or B risk, follow GEN-1010 response criteria for "no action taken".

7.5 Recommendation Tracking

After approving a list of recommendations and associated corrective actions, Refinery Management shall maintain a system for managing, monitoring, and tracking implementation.

Recommendations shall be reviewed with Refinery Management and shall be finalized and placed into the electronic tracking system within 60 days of completion of the study team meetings. For each recommendation, a responsible party shall be assigned and a written schedule for completion of the action item developed.

At a minimum, the tracking system shall:

A. Track all recommendations developed by the LOPA study,

B. Document the initial risk ranking of the recommendation,

C. Document who is assigned as the responsible party,

D. Document the date when actions are to be completed,

E. Document closure of recommendations, and

F. Ensure that recommendations and their status are available for review by the next LOPA revalidation team.

All documentation and tracking information must be up to date, readily available, and easy to audit.

7.6 Auditing and IPL Validation

Annual Self-audits shall be completed on a representative sampling of LOPAs. The Self-audits will include a review of a sample of IPLs to ensure that they are valid. The IPL Validation during the audit includes the following checks:

A. IPLs are in place,

B. IPLs are in service and active (if the process is operating), and

C. IPL meets the criteria specified in the corporate LOPA standard in Appendix B.

NOTE: These criteria are specific to the type of IPL.

The figure below shows a flow chart detailing the development of LOPA recommendation with consideration of the application standards.

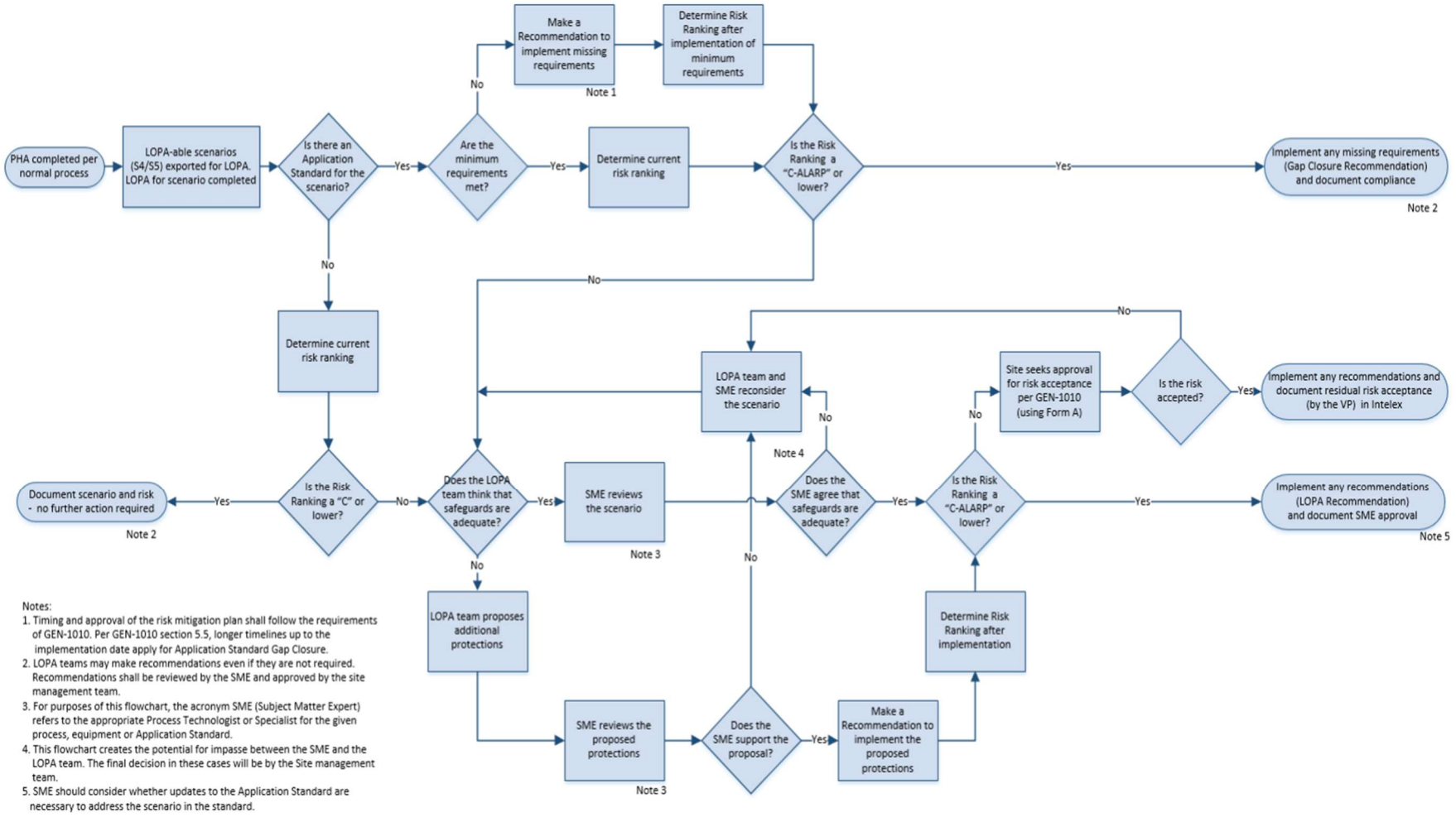


Figure 1 Flow Chart for Developing LOPA Recommendations

The following is a sample template for the Study Approval Form for the LOPA (RSP-1315-000-FORM1).

Reference: For the most up-to-date working copy of this form, go to:

http://reweb.cbg.mapllc.com/_GetFile/GetDocFromLibrary.aspx?lib_no=32&doc_no=3286&rev_no=2

RSP-1315-000-FORM1

LOPA Study Approval Form
For LOPA Studies per RSP-1315-000

Location	*The site where the study is done, e.g. Canton Refinery*		
Unit	*The Process Unit and/or section of the process unit for which the study is done*		
LOPA Basis	*The HAZOP that provided the scenarios for the LOPA study (e.g. Pipestill 5-year PHA, 2019)*		
Scope	*Describe the scope of the study, for example what parts of the process are included and excluded (utilities, tank farm, vendor skids, etc.). If LOPA scenarios other than Safety and Environmental Severity 4 and 5 will be included, this should be specified here.*		
Reason for Study *(check one)*	New Project / Process ☐ Initial PHA	Existing Unit / Process ☐ 5-year PHA ☐ Major Project Revision	Other (list below) ☐ _____
Schedule	Expected start date:	Expected finish date:	Required finish date:
Unit PHA Team Tile / Function	**Name**	**Required for All Team Meetings**	**Substitution Allowed**
Facilitator		☒ Yes	☐ Yes ☐ No
Scribe		☒ Yes	☐ Yes ☐ No
Unit Technical Service Engineer		☒ Yes	☐ Yes ☐ No
MPC Engineering Department Representative		☒ Yes	☐ Yes ☐ No
Unit Operator with Board Experience		☒ Yes	☐ Yes ☐ No
Control Systems Engineer		☒ Yes	☐ Yes ☐ No
List additional full- or part-time team members here…		☐ Yes ☐ No	☐ Yes ☐ No
		☐ Yes ☐ No	☐ Yes ☐ No
		☐ Yes ☐ No	☐ Yes ☐ No
		☐ Yes ☐ No	☐ Yes ☐ No
		☐ Yes ☐ No	☐ Yes ☐ No
		☐ Yes ☐ No	☐ Yes ☐ No
Report approver	*The person who approves the final report, this is the Technical Service Manager*		
Additional Comments or Requirements	*Space for any other comments or notes if needed*		
Approval	*The Study Approval Form must be signed by the Technical Service Manager or Designee before the start of the LOPA study. This field should contain the name, signature and date.*		

SAMPLE

Figure 2 Example Study Approval Form

Comments on the Study Approval Form:

A. The Study Approval Form shall be completed and signed before the start of the LOPA study.

B. The Core Team Roles are listed in the table and already marked as Required - "Yes".

C. Additional full- or part time team roles and members (see Section 4.0) can be listed on the form.

D. If the core team members and other required team members (or their substitutes) are not present, the LOPA meeting will need to be cancelled.

E. The facilitator can also cancel the meeting if the provided team members or substitutes do not have sufficient experience or knowledge for an effective LOPA study.

F. When completing the form, careful consideration should be given as to which team members are required to attend (other than the core team members) and for which team members substitutions are acceptable. For team members with specialized knowledge, substitutions may not be appropriate. If a required team member becomes not available and a substitution is not allowed, the TOR will need to be revised and re-approved.

8.0 TRAINING

Training for refinery personnel is accomplished by issue of this refinery procedure (R-12-017) as a medium impact review.

Training for LOPA team members is conducted on the first day of the scheduled LOPA study session and requires a formal training session. This includes the general LOPA requirements per this procedure and examples of LOPA scenario development and input of required data, including qualified LOPA scenarios, PFDs, CMs, Qualified IPLs, Recommendation development, etc.

Refresher training will be conducted when changes are made to the LOPA process or procedures.

9.0 REVIEW AND REVISION HISTORY

Revision #	Preparer	Date	Description
0	Terry Hering	8/08/2022	Completely rewritten to provide an outline only of the LOPA process (previous version was a copy of the corporate standard RSP-1315-000) per recommendations from the 2021 PSM Compliance and Collaborative Audits. Edits made on PS-17 latest version are contained within this document. Reformatted and Numbered per Document Control Policy, R-63-001.