SECTION 3 FLARING REDUCTIONS PREVIOUSLY REALIZED

In accordance with Regulation 12-12-401.2, this section of the FMP provides detailed descriptions of the equipment, processes, and procedures installed or implemented within the last five years to minimize the frequency and magnitude of flaring events at the Benicia Refinery. Because flare minimization activities started about 30 years ago at the Benicia Refinery, this section also includes some of the more important measures that have been implemented prior to the most recent five year period.

Table 8 provides an approximate chronological listing of flare minimization measures implemented at the Benicia Refinery for the South, North, and/or Acid Gas Flares. For each measure, the year of installation or implementation is provided if a precise date in known. Otherwise, a general time period is provided. Additionally, the effectiveness of these measures in minimizing the frequency and magnitude of flaring events at the Benicia Refinery is qualitatively shown as "significant," "moderate," or "minor."

Table 8
Flaring Reductions Previously Realized

Year Installed/ Implemented	Equipment Added, Process Changed, or Procedure Implemented	Minimization of Flaring
1975/76 to present	Equipment clearing procedures during shutdown prior to conducting maintenance activities are discussed in Section 5.1.1.	Significant
1975	Installed Fuel Gas Compressors (C-2201 A/B) and modified the Fuel Gas Unit to significantly reduce the refinery's use of purchased natural gas. As a result of this project, compression of low pressure fuel gas (LPFG) with the Stage 1 compressors is used to fuel the gas turbines. Additionally, the Stage 2 compressors are used for compression of low pressure tail gas (LPTG) which is used to feed the H2U. Prior to the installation of the Compressors, tail gas was let down to LPFG, which loaded up the LPFG system and caused flaring.	Significant
1975	Installed a Coker Gas Compressor (C-902) to reduce the volume of Coker Gas sent to the Cat Gas Compressor (C-701). This unloading of C-701 reduced the quantity of FCCU and Coker Gas sent to the Flare Gas Header and downstream flares (the Flare Gas Compressors had not yet been installed).	Significant
1976	Installed the first Flare Gas Compressor (C-2101 A) to provide recovery capacity of up to 6 mmscfd of flared gases. Prior to installation of this compressor, all gases sent to the Flare Gas Header were flared.	Significant

Table 8
Flaring Reductions Previously Realized

Year Installed/ Implemented	Equipment Added, Process Changed, or Procedure Implemented	Minimization of Flaring
1983	Installed the second Flare Gas Compressor to provide a spare compressor of the same capacity as the first recovery compressor. This spare compressor reduces flaring during compressor maintenance and unplanned compressor shutdown due to equipment failure or malfunction. Additionally, during high loading of the Flare Gas Header it is possible to operate both compressors in parallel and recover additional flare gas to the Fuel Gas Unit.	Significant
1984	VNHF eductor system was added to allow for recycled use of H_2 at H2U. This unloads the lower H_2 grids and reduces quantity of H_2 sent to LPFG, thus reducing the potential for flaring because of a fuel gas imbalance.	Moderate
1984 to present	Created the first LPFG pressure computer control application that was designed to minimize letdown of LPFG to flare. The program optimizes auxiliary components (propane and butane) in the LPFG system in a proactive manner to back off on the combustion of auxiliary fuels as a preventative measure to minimize flaring of excess fuel gases. By automating the management of these gases, the balance is always being monitored and more effectively managed than could be achieved by operations personnel in a manual approach.	Significant
1984	HCU off gas from D-403 was rerouted from the suction of the Fuel Gas Compressors (C-2201 A/B) to the high pressure discharge to provide more compressor capacity. This modification has served to unload Stage 2 of the C-2201 A/B compressors and results in less flow from T-1202 to LPFG, thus reducing the potential for flaring because of a fuel gas imbalance.	Moderate
1987	The H2U 2^{nd} and 3^{rd} stage oily condensate system blowdown was recovered back to the compressor suction. This project provides for the recovery of H_2 instead of being vented to the Flare Gas Header.	Moderate
Late 80's	Installed a second electrical power feed from PG&E, the local utility provider. This second feed decreases the likelihood of power outages which typically result in significant flaring.	Significant

Table 8
Flaring Reductions Previously Realized

Year Installed/ Implemented	Equipment Added, Process Changed, or Procedure Implemented	Minimization of Flaring
Late 80's to present	Revised the H_2 grid pressure control programs to stabilize low pressure H_2 grid pressure and reduce loss of H_2 to LPFG. The H_2 grid is separate from the Fuel Gas Unit, and supplies H_2 to the hydrofiners and the HCU. The H_2 grid has several cascading pressure levels whereby H_2 from one unit is re-used in another unit at a lower pressure level. The lowest pressure H_2 grid typically lets down some H_2 to the tail gas system for control, but excess H_2 may also be let down to LPFG. The H_2 grid pressure control program adjusts H_2 production to reduce H_2 letdown to LPFG, thus reducing the potential for flaring because of a fuel gas imbalance	Significant
Late 80's to present	Unit Flare Check Sheets were developed, implemented, and are periodically reviewed and updated. These check sheets are used by operators when the base-load to the Flare Gas Header is above its normal operating level. Use of these check sheets provides for a systematic search of potential gas streams that should not be flowing to the Flare Gas Header. During normal refinery operations, a reduction in flow to the Flare Gas Header does not reduce flaring because these gases are recovered during normal refinery operations. However, reducing or minimizing routine flows to the Flare Gas Header can reduce the quantity of flaring during a flaring event caused by maintenance activities, fuel gas imbalance, or an emergency event.	Minor

Table 8
Flaring Reductions Previously Realized

Year Installed/ Implemented	Equipment Added, Process Changed, or Procedure Implemented	Minimization of Flaring
Late 80's to present	Conducted routine maintenance of pressure relief devices (PRD's) connected to the Flare Gas Header, consistent with API 510, This routine maintenance of PRD's can reduce leakage from PRD's to the Flare Gas Header and marginally reduce the base-load flow to the Flare Gas Header. During normal refinery operations, a reduction in flow to the Flare Gas Header does not reduce flaring because these gases are recovered during normal refinery operations. However, reducing or minimizing routine flows to the Flare Gas Header can reduce the quantity of flaring during a flaring event caused by maintenance activities, fuel gas imbalance, or an emergency event. API 510 is an industry inspection code for pressure vessels which is now part of the California Safety Orders. Safety valves protect vessels from overpressuring. The safety valves must be tested and repaired per API 510 at sufficient intervals to maintain the relief equipment in safe operating condition. The intervals between relief equipment inspections are determined by experience in the particular service. Inspection intervals for safety valves are typically in the range of 24-36 months, but may be increased to a maximum of 10 years.	Minor
Late 80's to present	Liquid phase and vapor phase chemical cleaning during shutdown prior to maintenance activities are discussed in Section 5.1.1.	Moderate
Late 80's to present	Utilized "Ny-Cool" to reduce the time required to cool down reactors for maintenance. A cooler gas stream requires less time to cool down a reactor at a constant flow rate. "Ny-Cool" injects sub-cooled liquid nitrogen into a gas stream, such as nitrogen or hydrogen. As liquid nitrogen vaporizes into the gas stream, the gas is cooled, thereby reducing the time required to cool the reactor, resulting in less purge gas sent to the Flare Gas Header and less flaring.	Moderate

Table 8
Flaring Reductions Previously Realized

Year Installed/ Implemented	Equipment Added, Process Changed, or Procedure Implemented	Minimization of Flaring
Early 90's to present	Numerous comprehensive projects and improvements were implemented to allow longer runs between turnarounds. Most refinery projects include an element of improved reliability which increases run length. Examples of reliability improvement projects include upgraded metallurgy, improved designs, and equipment replacements. Shutdown and startup associated with turnarounds generate significant quantities of gas that result in flaring. Increased run length between maintenance turnarounds results in less frequent flaring events from unit shutdowns and startups.	Significant
1991	Developed an online computer tool (TDC Schematic 89) that displays on a single screen real-time operating data associated with flaring. This allows operators to quickly understand and troubleshoot flaring issues.	Moderate
~1992	Initiated procedures to balance flare loading during upsets/emergencies by equalizing South and North Flares to minimize excessive flaring and smoking at the South Flare. Flare balancing does not minimize the total quantity of flaring but does reduce emissions by improving flare performance during upsets/emergencies.	Minor
Mid 90's	Updated operating procedures to minimize flaring during loss of either the Coker Gas Compressor (C-902) or Cat Gas Compressor (C-701). Loss of either compressor results in significant flaring. The FCCU and CKR feed rates are reduced and the remaining compressor is used to fullest extent possible.	Significant
90's to present	Initiated proactive operating procedures to minimize the frequency and magnitude of flaring when it can reasonably be anticipated. Proactive procedures represent a change in operating philosophy and a general awareness, not a set of specific procedure changes. Prior to this time, the refinery's approach to minimizing flaring events was reactionary in nature (e.g., try to minimize flaring after it occurred). However, the procedures initiated at this time focus on approaches to minimizing flaring before these events occurred. Increased operator awareness and attention to flare minimization is a significant cultural change and an important management expectation.	Moderate

Table 8
Flaring Reductions Previously Realized

Year Installed/ Implemented	Equipment Added, Process Changed, or Procedure Implemented	Minimization of Flaring
90's to present	Upgraded condensers to improve performance during hot weather periods. This improved performance reduces production of fuel gas and decrease the likelihood of a fuel gas imbalance during hot weather periods. Examples of upgraded condensers include redesigned exchangers and additional surface area. Increased condenser capacity further cools the vapor stream and recovers additional light hydrocarbons, such as propane and butane, which would otherwise load up the Fuel Gas Unit and potentially cause flaring. Condenser upgrades have been implemented throughout the refinery, particularly in light hydrocarbon processing units such as VLE, CLE, and ALKY.	Significant
1995	Developed programs that monitor flows to the Acid Gas Flare system. Alarms built to warn of impending flaring and action required.	Minor
1996	Installed automatic trip valves (on steam to reboilers) to towers (T-1061 and T-1064) at ALKY to eliminate flare load during tower upset by tripping heat source (steam) on high tower pressure.	Moderate
1996	Installed automatic trip valve (on steam to reboiler) added to a tower (T-4302) at MTBE (now part of ALKY) to eliminate flare load during tower upset by tripping heat source (steam) on high tower pressure.	Moderate
Mid to late 90's	Upgraded cooling water supply system for Cat Gas Compressor by providing cooling water booster pump. With this pumping configuration, condensing capacity was upgraded (E-707's) and interstage coolers (E-710's) on the Cat Gas Compressor were made more effective. These actions increased the capacity for condensing and recovering materials as liquids and reduced gas flows to the Flare Gas Header.	Moderate

Table 8
Flaring Reductions Previously Realized

Year Installed/ Implemented	Equipment Added, Process Changed, or Procedure Implemented	Minimization of Flaring
1999 to present	Starting with the 1999 refinery-wide turnaround, a much higher emphasis was required for individual unit Process Coordinators of a major turnaround to minimize flaring by improving unit shutdown and startup procedures, scheduling, and flare balance. Additionally a Refinery Coordinator position was created for major turnarounds to work out plans to stagger unit shutdowns and startups to minimize flaring. Flaring was significantly reduced during the 1999 refinery-wide turnaround, and was then again significantly reduced during the 2004 refinery-wide turnaround by: 1) revising shutdown and startup procedures to minimize flaring from each process unit; and 2) improving the sequence of shutdowns and startups of all process units to reduce flaring to the extent practicable. Sequencing unit shutdowns and startups reduces the volume of gas flared at any time and increases recovery of flare gas. Figure 2 in Section 1 shows that flaring during the 2004 refinery-wide turnaround year was about half of what it was during the 1999 refinery-wide turnaround year. Turnaround length is typically set by available product coverage through exchanges and trades from alternate suppliers, and expected maintenance workload on major process units such as the PS, FCCU, and CKR. The shutdown and startup sequences are typically set by process and safety considerations. For example, during a Refinery-wide turnaround, the FCCU is shutdown after and started up before the CKR, in order for CKR gas to be processed in CLE rather than flared.	Significant
1999	Upgraded the Cat Gas Compressor (C-701) control systems to a Triconex system which greatly increases reliability. The improved reliability of C-701 reduces the potential for unplanned shutdown of C-701 that result in significant flaring from the FCCU.	Significant

Table 8
Flaring Reductions Previously Realized

Year Installed/ Implemented	Equipment Added, Process Changed, or Procedure Implemented	Minimization of Flaring
Late 90's to present	Both proactive and reactive operating procedures are identified in a Fuel Gas Seriatim to address flaring that may occur because of fuel gas imbalance during hot weather. The FCCU and CKR typically produce about 70 percent of the refinery's fuel gas. Therefore, the Fuel Gas Seriatim focuses on unit adjustments and production cuts at the FCCU and CKR because changes at these units have the greatest potential to minimizing or eliminate flaring by preventing a fuel gas imbalance. The Fuel Gas Seriatim, which is regularly updated, includes a sequenced list of operating procedures. These procedures generally include cutting feed rates to the FCCU and/or CKR, cutting reaction temperature at the FCCU, and cutting makeup fuels to the Fuel Gas Unit. The sequence of steps taken to cut unit production may change, depending upon operating conditions including the ability to cut feed rate further (unit turndown) and tank inventories. When hot weather is expected, the Fuel Gas Seriatim is typically implemented early in the day in a proactive effort to prevent a fuel gas imbalance before one occurs. During a fuel gas imbalance, flaring is needed because of excess fuel gas that is not needed at refinery furnaces, boilers, gas turbines, and COGEN. Therefore, the Fuel Gas Seriatim minimizes flaring by minimizing the potential for a fuel gas imbalance.	Significant
Late 90's to present	Utilized upfront planning to allow staged purging of equipment in the FCCU and CKR. Developed procedures which scheduled the purging of equipment in specific stages to ensure that the vapor load to the flare header is manageable for recovery of flare gas. In contrast, un-staged purging may result in simultaneous purging of equipment which increases the flare load and hence potential flaring.	Moderate
Late 90's to present	Utilized procedures that enable unit startup with minimum flaring. For example, the FCCU and associated CLE is started up before the CKR to allow CKR gas to be processed in CLE rather than flaring it. Also, the FCCU and CKR wet gas compressors are commissioned during startup to route FCCU and CKR vapors to CLE rather than to the Flare Gas Header.	Moderate

Table 8
Flaring Reductions Previously Realized

Year Installed/ Implemented	Equipment Added, Process Changed, or Procedure Implemented	Minimization of Flaring
2000 to present	Increased/improved preventive maintenance on the Flare Gas Compressors (C-2101 A/B), which has resulted in improved reliability and less downtime. Recent activities have included cleaning and/or replacement of demisters pads. Onstream time for the compressors is generally at or exceeding industry standards for this type of compressor in dirty gas service. In the past, less maintenance was performed on the Compressors during shutdowns in order to get the Compressors back in service as soon a possible. Now, enhanced preventative maintenance is performed on each compressor when it comes down for maintenance, resulting in improved service factors and less major maintenance required. Increased service factor allows the Compressor to remain on-line longer to recover flare gas.	Moderate
2000-2005	Monitoring points for flow rates and temperatures were added to flare systems and added to the online computer tool for flaring (TDC Schematic 89). These changes provided more information and help to quickly trouble-shoot flaring issues.	Minor
2000 to 2002	Added overhead pressure control valves to towers (T-803 and T-805) at CLE. With the control valves, tower pressure can be slowly reduced in a controlled fashion to the Flare Gas Header rather than manually opening an 8-inch block valve which quickly releases gas to the Flare Gas Header.	Minor
2002	Installed COGEN plant which is a major fuel gas consumer, generates power, and produces steam for the refinery. The addition of the COGEN plant increased the refinery's usage of fuel gas, providing additional capacity for the reuse of recovered flare gases. The installation of COGEN, significantly reduces the likelihood of a refinery fuel gas imbalance that results in flaring. The addition of the COGEN plant also provides a third source of electric power to the refinery which reduces the likelihood of power outages (there are two power feeds from the PG&E grid). Power outages result in very significant flaring because the entire refinery is simultaneously shutdown and all process gases must be flared. Additionally, restarting the refinery after power has been restored also causes flaring.	Significant

Table 8
Flaring Reductions Previously Realized

Year Installed/ Implemented	Equipment Added, Process Changed, or Procedure Implemented	Minimization of Flaring
2002 to present	Operating procedures are identified in a Fuel Gas Seriatim to respond to a fuel gas imbalance caused by a trip at COGEN (sudden loss of a fuel gas consumer). The Fuel Gas Seriatim, which is regularly updated, includes a sequenced list of operating procedures to be implemented where practical and feasible. These procedures generally include cutting feed rates to the FCCU and/or CKR, cutting reaction temperature at the FCCU, and cutting makeup fuels to the Fuel Gas Unit. The sequence of steps taken to cut unit production may change, depending upon operating conditions, including the ability to cut feed rate further (unit turndown) and tank inventories. Flaring occurs when a trip at COGEN causes a fuel gas imbalance. Implementation of the Fuel Gas Seriatim is a reactionary step to restore fuel gas balance and stop flaring after it has occurred.	Moderate
2004	New Panametrics flow meters installed at South and North Flares. This allows better tracking of flare load and troubleshooting.	Minor
2004	Rail Car Rack Vapor Recovery Project installed. Instrumentation controls were added to ratably control rail car loading and venting to the Flare Gas Recovery System, preventing flaring. The rate of depressuring rail cars to the flare header is controlled by monitoring flare header pressure to ensure the water seals at the flare drums are not broken, and all vapors in the flare header are recovered by the Flare Gas Compressors.	Moderate
2004	Rerouted Coker Gas from Coker Gas Compressor (C-902) to middle section of the CLE Absorber Deethanizer Tower (T-801). As a result, there was a reduction in the quantity of gas sent from CLE to the Fuel Gas Unit, thus reducing the potential for flaring because of a fuel gas imbalance.	Minor
2005	An automatic sampler was added to the flare system. This allows the refinery to better assess the flare gas quality consumed by the various fuel gas consumers, which helps minimizes flaring.	Minor

Table 8
Flaring Reductions Previously Realized

Year Installed/ Implemented	Equipment Added, Process Changed, or Procedure Implemented	Minimization of Flaring
2006	Installed Pilot Operated Safety Valve on the CLE Heavy Cat Naphtha Steam Stripper Tower (T-807A) in order to raise tower operating pressure. When pressures are too high, this enables the tower overhead to be routed directly to the Fuel Gas Unit rather than to the Flare Gas Header, thus reducing load on the Flare Gas Compressors and the potential for flaring.	Minor
2006	Converted the cooling system for the Flare Gas Compressors (C-2101 A/B) from cooling water to glycol in 4Q2006. The objective of this project is to improve compressor reliability by converting the cooling system coolant to an independent, dedicated system that does not foul the compressor cooling system. Poor system cooling in the past has caused premature valve and piston problems, thus reducing the overall machine availability. This project will reduce the probability that both Flare Gas Compressors could be off-line at the same time, which would result in flaring.	Minor
2006	Purchased portable ultrasonic flow monitoring equipment to be used together with the Unit Flare Check Sheets to troubleshoot leaking valves to the Flare Header when the base load increases. This equipment will reduce flaring by reducing the amount of time needed to identify leaking valves. Leaking valves adversely increase the base load to the Flare Gas Header and Flare Gas Compressor. In addition, the new flow detectors may be used in an evaluation to identify miscellaneous routine gas streams to the Flare Header. The new flow detectors must be placed directly on the valves to detect leakage.	Minor

Table 8
Flaring Reductions Previously Realized

Year Installed/ Implemented	Equipment Added, Process Changed, or Procedure Implemented	Minimization of Flaring
2006	The following specific measures were implemented to minimize fuel gas production during the high ambient temperature conditions which resulted in flaring in June 2006. The seriatim was reevaluated and steps were added to it. Selected Mogas Reformulation Unit (MRU) pressure vessel target pressures were increased to improve hydrocarbon recovery. Additionally, some process unit targets were modified. These preventative measures will improve the effectiveness of the Fuel Gas Seriatim. Please refer to the discussions on the Fuel Gas Seriatim provided previously in this section under the implementation date: "Late 90's to present" which had a significant flare minimization impact.	Minor
2006	The following specific measures were implemented to prevent reoccurrence of the failure of the 'Coker Unit reactor level slide control valve' during a routine performance check which resulted in flaring in August 2006. The preventative maintenance procedure for the routine control check on this valve was modified so that it is not fully closed during the control check. The revised procedure will minimize the potential for flaring by reducing the likelihood of the valve failing closed. Affected operating personnel were notified of the revised procedure.	Minor
2006	The following specific measures were implemented to prevent reoccurrence of the failure of the make-up natural gas regulator which resulted in flaring in August 2006. The storage tank natural gas pressure regulator was temporarily closed and later repaired. The regulator performance is monitored as part of the tank compressor operations to ensure it is operating properly and not contributing flow to the fuel gas system. Piping line-ups were discussed and verified with on-shift personnel. These improvements will reduce the potential for flaring under the conditions that contributed to this flaring event.	Minor

Table 8
Flaring Reductions Previously Realized

Year Installed/ Implemented	Equipment Added, Process Changed, or Procedure Implemented	Minimization of Flaring
2006	The following specific measures were implemented to prevent reoccurrence of the failure Refinery's Energy Isolation Procedure which resulted in flaring in October 2006. The Refinery's Energy Isolation Procedure was reviewed with the responsible technician and with the other operating personnel. The review ensures adherence to procedures that will minimize flaring.	Minor
2006	The following specific measures were implemented to prevent reoccurrence of the failure of the backup fuel gas recovery compressor solenoid valve which resulted in flaring in December 2006. In the event the backup fuel gas recovery compressor has a solenoid valve failure, a spare solenoid valve is maintained in storehouse stock. The on-site replacement spare enabled a timely replacement and restart of the back-up fuel gas recovery compressor. Automatic stock reorder points are established to ensure maximum availability for equipment repairs. Although vendor supply can affect delivery, Valero's system makes every attempt to restock in a manner that ensures spare availability and therefore increased reliability. These supply and reorder systems help minimize flaring by allowing back-up equipment to be available more quickly.	Minor
2007	Valero had originally planned to implement Valve Alert software to monitor reciprocating compressors in the refinery. After multiple trials, a 3rd party compressor analysis contractor, T.F. Huggins was found to be better suited to Valero's needs for monitoring compressors in the refinery. Valero chose this system because it was a better resource for managing the 3rd party work, report archiving and overall program management. The new system will improve reliability of reciprocating compressors by tracking performance to determine when maintenance is needed. Improved performance tracking will allow maintenance schedules to be optimized and improve overall machine availability. This will reduce the probability that both Flare Gas Compressors could be off-line at the same time, which would result in flaring. Additionally, the system will be used for other reciprocating compressors which may help to minimize compressor failures that could result in process unit shutdowns and associated flaring.	Minor

Table 8
Flaring Reductions Previously Realized

Year Installed/ Implemented	Equipment Added, Process Changed, or Procedure Implemented	Minimization of Flaring
2007	Valero's Process Engineering Department conducted a system evaluation to identify miscellaneous gas streams that are routinely routed to the Flare Gas Header and determine if these streams can be eliminated or re-routed directly to the Fuel Gas Unit. The objective of this evaluation was to identify potential opportunities to reduce the number and volume of routine gas streams to Flare Gas Header. Although no routine sources were identified, Valero will continue to analyze projects where opportunities may exist to reduce routine gas streams to the Flare Gas Header. If the base load to the Flare Gas Header is reduced, the base load on the Flare Gas Compressor will also be reduced. Thus, there will be more available capacity to capture and recover flare gas that might otherwise be flared due to emergencies and/or startup, shutdown, and maintenance activities.	Moderate
2007	Pre-Turnaround Flare Minimization Planning. Implemented a planning process for turnarounds that incorporates a review of the procedures to develop opportunities for flare minimization. This planning and review process has been consistently applied to turnaround operations and resulted in lessons learned for improved flare minimization techniques. These flare minimization techniques have been successfully applied at subsequent turnarounds of similar units. For example, Valero has developed revised shutdown procedures for hydroprocessing units to safely recover some of the low Btu gasses that are generated. These procedures originally developed at a single unit have been transferred to other similar units. The flare minimization improvement cycle will continue as this planning program evolves.	Moderate
2007	The following specific measures were implemented to prevent reoccurrence of the PG&E connection and synchronization failures which resulted in flaring in January 2007. PG&E Installed an AC undervoltage relay to supervise the operation of the DC undervoltage relay. Both relays require activation before the Valero Refinery breakers are tripped. The AC undervoltage relays are independent from each other and do not have a common point of failure.	Moderate

Table 8
Flaring Reductions Previously Realized

Year Installed/ Implemented	Equipment Added, Process Changed, or Procedure Implemented	Minimization of Flaring
2007	The following specific measures were implemented to prevent reoccurrence of the PG&E system reliability failures which resulted in flaring in January 2007. PG&E implemented a Management of Change process whereby changes to the PG&E system that directly or indirectly impact the Valero Refinery's operations will be reviewed and approved jointly by the Valero Refinery and PG&E at appropriate levels of engineering and management before changes are implemented. Implemented procedures to ensure PG&E will communicate with the Valero Refinery before any operations or maintenance activities at the PG&E substation that could potentially impact the Valero Refinery's operations. These include notifications for contemporaneous switching notification, planned equipment changes and installation of signs at the PG&E substation.	Moderate
2007	The following specific measures were implemented to prevent reoccurrence of the HCU and compressor equipment failures which resulted in flaring in May 2007. 1) Automatic shut-down systems on the HCU reactors due to high reactor temperature to mitigate a potential catastrophic event. 2) The failed HCU thermocouple was replaced and insulation was repaired. 3) The maintenance on the compressors was conducted; 'A' compressor repairs are still in progress. 'B' compressor was repaired as quickly as possible and returned to service on May 3, 2007. 4) After one leaking thermowell was detected, Operations made a decision to inspect and secure five similar thermowells in an effort to mitigate similar issues. 5) Affected process unit throughputs were reduced to minimize fuel gas production and related flaring.	Minor

Table 8
Flaring Reductions Previously Realized

Year Installed/ Implemented	Equipment Added, Process Changed, or Procedure Implemented	Minimization of Flaring
2007	The following specific measures were implemented to prevent reoccurrence of fuel gas compressor failures which resulted in flaring in July 2007. A. The Fuel Gas Compressor valves were reengineered to provide an adequate safety margin for a full range of gases (molecular weight) sent to the online Fuel Gas Compressor under all operating conditions. The new valves were installed in the C2201A which was placed into primary service after its major maintenance and repairs on August 15, 2007. The new valves are were installed in C2201B during maintenance scheduled for first quarter 2008. B. The Valero Refinery has recently implemented a predictive maintenance and performance testing program for both the C2201A and C2201B Fuel Gas Compressors, as well as other Valero Refinery compressors. The goal of this program is to identify potential problems, prior to an event such as a high discharge temperature trip.	Minor
2007	The following specific measures were implemented to prevent flaring from the Ultra Low Sulfur Diesel Unit (ULSD) that was brought online in July 2007. The impact of this new unit on actual flaring has been minimized by engineering the operation to significantly limit the circumstances under which the safety valves will be required to relieve. This is accomplished by over-engineering the major process vessels to allow them to withstand higher internal pressures than otherwise demanded by design codes. In so doing, the set pressures of the various relief valves have been raised. As a result, potential pressure events will be confined within the process vessels without lifting the safety valves and venting to the flare system.	Minor

Table 8
Flaring Reductions Previously Realized

Year Installed/ Implemented	Equipment Added, Process Changed, or Procedure Implemented	Minimization of Flaring
2007	The following specific measures were implemented to prevent flaring from the ALKY D1002 Maintenance in August 2007. Standing Orders procedures have been updated. Operators are now required to consider the following additional factors regarding the startup of the second flare gas compressor: a. Check loading on current running flare gas compressor. b. Check availability of second flare gas compressor. c. Consider any room available in the fuel gas system. d. Consider impact of flare gas composition on fuel gas quality. Flaring Minimization forms will be completed more often than previously planned. Initially the forms were to be used for unit Shutdowns, Startups, and Turn-Around activities. These forms will now be completed where partial unit S/D, S/U, TA and maintenance activities could impact flaring.	Minor
2007	The following specific measures were implemented to prevent flaring from the C701 Check Valve failure in October 2007. In the interim period prior to the next "refinery-wide turnaround" scheduled for 2010, Valero has implemented procedures to ensure that the D-801 check valve will be blocked in whenever the Cat Gas Compressor (C-701) is out of service while the Cat Light Ends (CLE) unit is still in service. These revised operating procedures could help to minimize the likelihood of flaring during a "mid-cycle turnaround".	Minor
2007	The following specific measure was implemented to prevent flaring from the C701 Nozzle Control Wiring failure in November 2007. A. During the November 21, 2007 downtime, temporary jumpers were installed that enabled the A and B nozzle controllers to function properly.	Minor

Table 8
Flaring Reductions Previously Realized

Year Installed/ Implemented	Equipment Added, Process Changed, or Procedure Implemented	Minimization of Flaring
2008	Catalyst Selection Planning. Implemented a Catalyst Selection review process that standardizes the selection process. Catalyst selection depends on equipment requirements and maintenance planning and scheduling coordination. A standardized selection process ensures that opportunities for flare minimization are assessed at the early planning stages.	Minor
2008	The following specific measures were implemented to prevent flaring from the FCC Piping Failure in February 2008. A. FCCU Replacement Piping. The Valero Refinery installed, as a prevention measure, FCCU replacement piping that was stress relieved (heat treated) to eliminate any residual weld stresses . B. Contemporaneous Flare Gas Monitoring for H2S Content. In the past, flare minimization has focused on volume reduction as the primary means to reducing flare emissions. Currently Valero is developing procedures to incorporate flare gas sampling results into flare minimization strategies as the sample results become available. C. Review Low Btu Gases. Valero will continue to evaluate opportunities for improvement of flare minimization procedures associated with the use of low Btu gases, such as nitrogen.	Minor
2008	The following specific measures were implemented to prevent flaring from the HCU Piping Failure in April 2008. Valero conducted repairs to a failed section of HCU equipment pipeline. The weld was cut out and the elbow was cut back a half inch to ensure that the damaged base metal was removed. The welds were made using a special technique supplied by a contractor. The other weld on the same elbow was inspected using in-situ metallographic examination and no creep damage was found.	Minor

SECTION 4 PLANNED FLARING REDUCTIONS

In accordance with Regulation 12-12-401.3, this section of the FMP provides detailed descriptions of the equipment, processes, and procedures that are planned to be installed or implemented to minimize the frequency and magnitude of flaring events at the Benicia Refinery.

The items listed in this section fall into two general categories. The first category contains items that can best be described as management practices for improving the general reliability of the operations in the refinery. These practices help to identify specific changes in the field that when implemented will improve unit reliability and, among other things, will reduce flaring. The general effects of improved reliability are discussed in Section 1.7.3. However, the refinery undertook a major reliability evaluation starting in 2003 and several specific steps were outlined for implementation or evaluation to improve reliability even further.

The second category contains specific improvements such as new projects and procedures that will be implemented to directly or indirectly reduce the frequency and/or magnitude of flaring events. These specific improvements typically have been identified as an outcome of the management practice process, this FMP process, and/or the causal analysis process.

4.1 Management Practices that Result in Flare Minimization

The practices that are discussed here are ones that are relatively new (there are many practices already in place) and that the refinery depends on for identifying specific steps that can be taken in the refinery that will directly or indirectly reduce flaring. As such they are tools needed to make the process for continuous improvement work, but the practice by itself does not necessarily have a direct and predictable impact on flaring per se. However, these tools ultimately lead to the specific identification of many individual improvements that cumulatively have a profound impact on flaring.

- **Incident Investigation Process.** All abnormal events and potential incidents are documented in a First Report of Incident (FRI). Examples of such events/incidents include safety incidents, environmental incidents (including flaring events), equipment failures, operator errors, and product quality excursions. Depending on the severity of the incident, a formal Incident Investigation may be conducted, including formation of an investigation team, to be completed and documented in an Incident Investigation Report (IIR). FRI/IIRs summarize the pertinent facts for each incident, identify the root cause of the incident, list contributing factors and identify corrective actions to prevent recurrence. Root causes are assigned using the TapRoot© categorization system.

  The FRI/IIR process is used to implement the evaluation of cause and contributing factors, consideration of measures to minimize flaring, and recurrent failure evaluation described in Section 1.7 and depicted in Figure 4. FRI/IIRs are tracked in a refinery wide database (IMPACT) that allows trend analysis to be done. Approximately 1000 to 1300 FRI/IIRs are generated a year. The IIR process drives continuous improvement in personnel and operational safety, reliability and environmental compliance, and through these improvements will directionally reduce flaring. It is imperative to understand and learn from incidents that are outside the norm. FRI/IIRs help distribute lessons learned across all parts of the Benicia Refinery.

The current version of this process was implemented in 2003, and the system is documented in the refinery Accident Procedure Manual (APM 1-4-0).

- **Materials Operating Envelope (MOE) Reliability System.** The MOE reliability system is a management system that was identified for implementation in the refinery wide reliability study completed in 2004/2005. The objective of the system is to eliminate equipment failures related to materials of construction failures by helping to stay within operating parameters so that corrosion is minimized. Flaring is reduced as a result of this system for two primary reasons. First, a reduction in equipment failure will reduce the frequency of emergency process unit shutdown, maintenance, and subsequent startup, all of which can cause flaring. Secondly, improved corrosion management will ultimately reduce the frequency of unplanned shutdown, maintenance, subsequent startup to correct a corrosion issues.

  With the MOE reliability system, detailed evaluations are performed on each process unit to verify that the appropriate metallurgy is in place for the materials processed and the operating conditions (pressure, temperature, etc) under which the equipment operates. The results of the MOE reviews are then incorporated into the refinery corrosion monitoring program, which is stewarded by operations and technical personnel. For example, the MOE reliability system indicated that the HCU reactor effluent piping should be inspected. The inspection found that the piping was corroding faster than anticipated. The piping was replaced with alloy lined piping during a scheduled HCU maintenance turnaround, thereby avoiding a potential unscheduled HCU downtime with associated flaring.

4.2 Specific Improvements that Result in Flare Minimization

Table 9 provides specific flare minimization measures for the Benicia Refinery. For each measure, the anticipated year of installation or implementation is provided. Additionally, the effectiveness of the these measures in minimizing the frequency and magnitude of flaring events is qualitatively shown as "significant", "moderate", or "minor".

Table 9
Planned Flaring Reductions

Year of Planned Installation/ Implementation	Planned Equipment Addition, Process Change, or Procedure Implementation	Planned Minimization of Flaring
2010	The following specific measures are planned to prevent flaring from the ALKY D1002 Maintenance in August 2007. During the next "refinery-wide turnaround" scheduled for 2010, Valero plans to resolve the D-1002 safety valve bypass problem by replacing it or some other engineering or operational solution. The valve cannot be repaired or replaced outside of turnaround. The D-1002 safety valve bypass is directly connected to the flare and cannot be safely replaced while the Alky Unit or the flare line is operational. There is a low likelihood that the D-1002 safety valve bypass can lead to flaring until the next "mid-cycle turnaround" in 5 to 6 years. In the event that the alternate route for venting to the flare is required prior to replacement of the D-1002 safety valve bypass, Operations is aware of the plugged bypass and will continue to coordinate maintenance activities as best possible to minimize flaring.	Minor
2010	The following specific measures are planned to prevent flaring from the C701 Check Valve failure in October 2007. During the next "refinery-wide turnaround" scheduled for 2010, Valero plans to resolve the D-801 check valve problem by replacing it with a new check valve, an assisted check valve, a motor operated valve, or some other engineering or operational solution. The cost is estimated to be between $50,000 and $200,000. The check valve cannot be repaired or replaced outside of turnaround. The D-801 check valve is only needed when the Cat Gas Compressor (C-701) is out of service while the Cat Light Ends (CLE) unit is still in service. This only occurs under two scenarios; (1) during a "mid-cycle turnaround" about every 5 to 6 years if C-701 is taken out of service for maintenance or (2) if there is a malfunction at C-701 or GT-701, the gas turbine which drives C-701. There is a low likelihood that the D-801 check valve can lead to flaring until the next "mid-cycle turnaround" in 5 to 6 years (revised operating procedures could help to minimize the likelihood of flaring during a "mid-cycle turnaround").	Minor

Table 9
Planned Flaring Reductions

Year of Planned Installation/ Implementation	Planned Equipment Addition, Process Change, or Procedure Implementation	Planned Minimization of Flaring
2010	The following specific measure were determined to be feasible and will be implemented to prevent flaring from the C701 Nozzle Control Wiring failure in November 2007. A. During the 2010 refinery wide turnaround the temporary wiring will be removed and the wiring problem corrected	Minor

4.3 Flare Minimization for Newly Planned Hydrogen Plant

A new Hydrogen Unit (H2U) is currently planned at the Benicia Refinery. If constructed, the new H2U will be more efficient and will replace one of the existing units. It is anticipated that it will significantly reduce criteria pollutants and GHG emissions. Additionally since the new H2U will use refinery fuel gas instead of natural gas as the primary feed stock, there will be fewer instances of flaring when the refinery has an oversupply of refinery fuel gas. Startup and shutdown of the new H2U is not expected to result in flaring, and there will be no new flare installed as a result of this project.

Flare minimization steps associated with major maintenance activities, including startup and shutdown, have not been fully developed because the new H2U, if constructed is a new process unit. The Benicia Refinery has generic experience starting and shutting down the two existing hydrogen trains and is using this experience to develop the initial H2U procedures. However, the procedures will be refined and improved based on specific experience with the new unit once it is placed into service.

4.4 Flare Minimization for Newly Planned Butamer Plant

A new Butamer Unit (ULSD) is currently planned at the Benicia Refinery. If constructed, this unit should reduce potential flaring from the Alkylation Unit by providing a more reliable source of isobutane to Alky.

Flare minimization steps associated with major maintenance activities, including startup and shutdown, have not been fully developed because the new Butamer, if constructed is a new process unit. The Benicia Refinery has generic experience starting and shutting down other units and is using this experience to develop the initial Butamer procedures. However, the procedures will be refined and improved based on specific experience with the new unit once it is placed into service.

4.5 Flare Minimization for New CARB PHASE III Modifications

A new CARB Phase III Modifications project is planned at the Benicia Refinery. If implemented, these changes will reduce flaring by helping to maintain the run lengths of the HCNHF and LCNHF at the higher operating severities necessary to meet the tighter gasoline specifications,.

Flare minimization steps associated with major maintenance activities, including startup and shutdown, have not been fully developed because the design of the new CARB Phase III equipment is still underway. The Benicia Refinery has generic experience starting and shutting down other similar equipment and is using this experience to develop the initial CARB Phase III equipment procedures. However, the procedures will be refined and improved based on specific experience with the new equipment once it is placed into service.

4.6 Flare Minimization for Benicia Asphalt Plant Atmospheric Safety Valve Gas Recovery Project

To improve/ safety of the community, personnel and equipment, a project is being developed to reroute an atmospheric safety device in the Crude Unit at the Benicia Asphalt Plant (BAP) to the Refinery flare header. Currently, this safety valve relieves to atmosphere and is regulated under BAAQMD 8-28. If constructed, this project to improve safety of the Crude Unit includes both rerouting this safety valve to the Refinery flare header, and recovering the Crude Unit offgases currently combusted in the BAP vacuum heater to the refinery fuel gas system. Because the refinery fuel gas system is at a higher pressure than the BAP heater gases, the gases will first be routed to the flare gas system where it will be recovered by the flare gas compressors that route the gas into the fuel gas system. The volume of BAP heater gases routed to the refinery systems is de minimus compared to the volume handled by the Refinery Fuel gas system. (BAP gases volume~0.15 MMSCFD; refinery fuel gas system~75 MMSCFD)

If constructed, this project will also remove the requirement for caustic scrubbing the Crude Unit offgas at the BAP. Scrubbing the BAP offgas in the refinery's more robust fuel gas scrubbing system benefits safety and removes caustic scrubbing chemicals from the BAP.

Flare minimization steps associated with major maintenance activities, including startup and shutdown, have not been fully developed because the BAP Crude Unit safety valve and offgas reconfiguration is new. The Benicia Refinery has generic experience starting and shutting down other units and is using this experience to develop the initial configuration operating procedures. However, the procedures will be refined and improved based on specific experience with the new configuration once it is placed into service.

4.7 Flare Minimization for New Scrubber Unit and New CO Furnaces

A new Scrubber Unit is planned at the Benicia Refinery. If constructed, the scrubber will treat SO_2 emissions from the CKR and the FCCU which are currently unabated and vented to the Main Stack. The plan will also replace two CO furnaces at the PS with more efficient CO furnaces. If constructed, the new scrubber will exhaust through a new dedicated stack. If constructed, the new furnace and scrubber configuration will further reduce emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_X), sulfur trioxides (SO_3) and green house gases (GHG).

Flare minimization steps associated with major maintenance activities, including startup and shutdown, have not been fully developed because the design of the new CO furnaces is still underway. The Benicia Refinery has generic experience starting and shutting down the existing CO furnaces and is using this experience to develop the new CO furnace procedures. However, the procedures will be refined and improved based on specific experience with the new CO furnaces once they are placed into service.

SECTION 5 PREVENTION MEASURES

In accordance with Regulation 12-12-401.4, this section of the FMP provides a discussion of prevention measures that the Benicia Refinery has considered for implementation. The discussion provides general background and specific information regarding various refinery activities that impact the recoverability of refinery fuel gas in the Flare Gas Recovery System. Based on a review of flaring that has occurred historically at the Benicia Refinery, a summary is provided of measures that the refinery has considered for minimizing flaring from maintenance activities including a determination as to the feasibility and effectiveness of the considered approaches. Where approaches have been identified as being feasible and effective they have subsequently been incorporated into normal refinery operations. Measures that have been evaluated but determined not to be feasible or effective are also discussed, along with supporting information for the infeasibility and ineffectiveness.

5.1 Prevention Measures – Maintenance Activities

In this section, refinery maintenance including startup, shutdown, and turnaround activities are discussed, and measures that have been considered to minimize flaring during planned and unplanned maintenance activities are reviewed. Section 1.6.1 provides a summary of reasons for flaring as a result of maintenance activities.

The evaluation of prevention measures to reduce flaring as a result of maintenance is primarily based upon a review of the historical causes of flaring events, especially those that have occurred during the last five years. The Benicia Refinery has expended significant effort to reduce sources of flow to the Flare Gas Header from these activities, and the implementation of these good practices has been a key factor in achieving the reductions of approximately 50 percent in flaring volumes during the last five years. The refinery's evaluations have concluded that modifications to operational, planning, and maintenance approaches are a more feasible and effective strategy than major capacity additions to the existing Fuel Gas Unit (as discussed in Section 5.2).

In accordance with Regulation 12-12-401.4.1, the evaluation of prevention measures presented in this section is based on a review of flaring events that have occurred during maintenance activities in the last five years. These events are presented along with a summary of the measures that have been considered, and in many cases, where practical and feasible, implemented to reduce the flow of gases to the Flare Gas Recovery System.

In this section, prevention measures are not considered for the Acid Gas Flare because there are no major maintenance activities which utilize the Acid Gas Flare. The Acid Gas Flare is primarily used for emergency and upset conditions. Outside of emergency and upset conditions, the Acid Gas Flare has limited use. For example, during turnarounds at the SGU, various equipment such as pumps, vessels, and exchangers are drained, washed, and then steamed to the Acid Gas Flare. During startup and shutdown of the SGU, relatively small quantities of liquid in various lines are blown down to the Acid Gas Flare system (liquids are removed at the SGU Liquid KO Drum and gasses are sent to the Acid Gas Flare). Regular maintenance of pumps in sour water service requires that they are steamed to the Acid Gas Flare. Limited use of the Acid Gas Flare during startup, shutdown, and minor maintenance activities has not and will not exceed either of the reportable thresholds (0.5 mmscfd or 500 lb/day of SO_2).

5.1.1 Background Information Regarding Maintenance Activities

In refinery operations, maintenance activities often result in a higher than normal flow of gases to the flare gas recovery system. In order to perform maintenance activities, process equipment and the associated piping must first be cleared of hydrocarbons before the system is opened to the atmosphere. This is required for both safety and environmental reasons, including compliance with Regulation 8-10 (Process Vessel Depressurization). The approach used to clear the equipment depends on the physical properties of the hydrocarbons to be removed (e.g., vapor pressure, viscosity, and temperature), and on the configuration of the equipment that is to be maintained.

The typical first step is to recover as much of the hydrocarbon as possible by transfer to other equipment that is not in the part of the equipment that is being prepared for maintenance. For example, liquid hydrocarbons can be pumped (or transferred under pressure) to product, slop, or sour water tankage another process unit, or liquid K.O. drums; gases under pressure may be depressurized to the tail gas system and/or Fuel Gas Unit, depending upon composition and pressure. For example, vent gas may be sent to the tail gas system if it has a high hydrogen content (about 75 percent), no olefins, and is above about 200 psig; and then sent to the Fuel Gas Unit if pressure is between 200 and 70 psig. Otherwise, hydrocarbon containing vent streams can be sent to the Fuel Gas Unit if pressure is above 70 psig. Once pressure is below 70 psig, all vent streams must be sent to the Flare Gas Header.

Heavy hydrocarbons that are viscous and/or sticky at ambient temperatures are often flushed from equipment using lighter hydrocarbons, for example light cycle oil (LCO) a diesel range material commonly used in refineries for this service. The LCO can then be pumped from the equipment.

Although depressurization and pump-out can be used to remove the bulk of the hydrocarbon from the equipment, there will generally always remain some residual material. The next step in clearing typically requires a low-pressure destination that can accept a wide range of hydrocarbon materials in order to avoid putting these materials to the atmosphere. At most refineries, including the Benicia Refinery, the Flare Gas Header is typically the preferred (and generally the only) location within the refinery that meets these criteria. Equipment containing materials that are gases at ambient temperature and pressure are normally vented to this system for potential recovery of gases as fuel gas.

Equipment is typically freed of hydrocarbons following depressurization, by purging with an inert gas such as nitrogen (or steam as discussed below). Hydrocarbons are also commonly removed by a sequence of nitrogen pressurization steps, followed by depressurization while directing the resulting mixture of nitrogen and hydrocarbon to the Flare Gas Header. Steam purging can sometimes be substituted for nitrogen purging, but not for processes that need to be kept dry in order to avoid corrosion or catalyst damage, or for other process reasons.

For equipment containing residual hydrocarbon liquid, steam or nitrogen is often used to "blow" the liquid to the knockout drums typically located near the process units. The liquid hydrocarbons (and water if steam purging is used) are then separated from the vapor phase in the knockout drum. The liquid phase is typically returned to the refinery's recovered oil system where the water is separated from the oil and sent to wastewater treatment, and the oil is re-processed in the PS, FCCU, or CKR. The gas phase, typically nitrogen with hydrocarbon vapor, continues on to the Flare Gas Recovery System. Once the bulk of the liquid hydrocarbon has been displaced, the flow of steam or nitrogen is continued to remove any residual hydrocarbon by vaporization.

If heavier hydrocarbon materials are present, different strategies are often used. Steam can be more effective than nitrogen or inert gases for heavier materials, as it increases their volatility by increasing temperature. Hot hydrogen is used in some processes to "hot strip" hydrocarbons off of catalyst beds. Proprietary solvents such as "Zyme-flow" or other chemical washing agents are also sometimes used in aqueous solution ("liquid phase chemical cleaning") for removal of residual hydrocarbons. When aqueous solvents are used, they are typically circulated in the equipment and then treated. Steam may be used in combination with a chemical cleaning agent ("vapor phase chemical cleaning") to clear heavy materials from equipment. Vapor phase chemical cleaning may also be used together with liquid phase chemical cleaning.

Implementing these procedures has resulted in the capture of significant hydrocarbon emissions related to equipment opening that previously were released untreated to the atmosphere. However, in many circumstances these practices require a high volume and high velocity flow of steam or nitrogen to be effective. High flow rates of inert gas can create several sets of circumstances where flare gas recovery may not be possible. These problems typically relate either to the change in fuel gas composition (molecular weight), condition (temperature), or high rate of flow as discussed in the following section.

5.1.2 Flaring During Major Maintenance Activities

Table 10 provides a summary of flaring events that have occurred as a result of major maintenance activities during the past five years. Table 10 was prepared by comparing flaring data and process unit records for planned turnarounds to conduct major maintenance. Starting on August 20, 2005, a flaring event was defined as a vent gas flow rate 0.5 mmscfd or more and prior to this date, a flaring event was defined as a vent gas flow rate of 1 mmscfd or more. In Section 5.1.2, prevention measures are evaluated to minimize the flaring events identified by this five-year lookback along with any other flaring that may reasonably be expected to occur as a result of major maintenance activities.

In accordance with Regulation 12-11-501, vent gas meters were installed at each flare during the first quarter of 2004. Prior to installation of these flow meters, the data used to prepare Table 10 was obtained from flow meters that were not required or approved by the BAAQMD. Since flare monitoring and flaring records (the cause of flaring) were not maintained prior to adoption of Regulations 12-11 and 12-12, there is less clarity in the older data presented in this five year lookback. It is possible that some flaring events that resulted from major maintenance were missed. Additionally, it is possible that some of the flaring events listed in Table 10 did not actually exceed the vent gas flow rate thresholds[5].

Table 10
Flaring During Major Maintenance Activities, 5 Year Lookback

Date	Process Unit	Description of Activity Resulting in Flaring
June 2008 June 2007 May 2006 September 2005 February 2003	LCNHF	• During unit shutdown, hot strip vessels with H_2 then N_2. • During unit shutdown, cool reactor (and purge downstream vessels) with N_2. • If necessary to meet vessel depressurization requirements (Regulation 8-10), pressure vessels with N_2 then release. • During unit startup, warm reactor with hot H_2. • During unit startup, activate catalyst with H_2.
October 2007 June 2007 January/February 2007 May 2006 March 2004 February 2004 January 2003 February 2002	HCNHF	• During unit shutdown, hot strip vessels with H_2 then N_2. • During unit shutdown, cool reactor (and purge downstream vessels) with N_2. • If necessary to meet vessel depressurization requirements (Regulation 8-10), pressure vessels with N_2 then release. • During unit startup, warm reactor with hot H_2. • During unit startup, activate catalyst with H_2.

[5] Review of flaring events prior to 2004 provides limited information. Since the previous meters were not used for regulatory purposes, flaring event durations and volumes cannot be specified with certainty. In many cases, predominate causes of flaring cannot be reliably determined due to limited documentation and the elapsed time since the flaring event.

Table 10
Flaring During Major Maintenance Activities, 5 Year Lookback

Date	Process Unit	Description of Activity Resulting in Flaring
March 2008 October 2006 November 2005 March/April 2005 April 2003 December 2003 February 2002	CFHU	• During unit shutdown, hot strip vessels with H_2 then N_2. • During unit shutdown, cool reactor (and purge downstream vessels) with N_2. • If necessary to meet vessel depressurization requirements (Regulation 8-10), pressure vessels with N_2 then release. • During unit startup, warm reactor with hot H_2. • During unit startup, activate catalyst with H_2.
September 2006 February 2003	JHF	• During unit shutdown, hot strip vessels with H_2 then N_2. • During unit shutdown, cool reactor (and purge downstream vessels) with N_2. • If necessary to meet vessel depressurization requirements (Regulation 8-10), pressure vessels with N_2 then release. • During unit startup, warm reactor with hot H_2. • During unit startup, activate catalyst with H_2.
June 2002	DHF	• During unit shutdown, hot strip vessels with H_2 then N_2. • During unit shutdown, cool reactor (and purge downstream vessels) with N_2. • If necessary to meet vessel depressurization requirements (Regulation 8-10), pressure vessels with N_2 then release. • During unit startup, warm reactor with hot H_2. • During unit startup, activate catalyst with H_2.
October 2007 January 2007 June 2004	VNHF	• During unit shutdown, hot strip vessels with H_2 then N_2. • During unit shutdown, cool reactor (and purge downstream vessels) with N_2. • If necessary to meet vessel depressurization requirements (Regulation 8-10), pressure vessels with N_2 then release. • During unit startup, warm reactor with hot H_2. • During unit startup, activate catalyst with H_2.

Table 10
Flaring During Major Maintenance Activities, 5 Year Lookback

Date	Process Unit	Description of Activity Resulting in Flaring
April 2007 February 2006 February 2003	HCU	• During unit shutdown, depressure products to the Flare Gas Header. • During unit shutdown, hot strip vessels with H_2 then N_2. • During unit shutdown, cool reactor (and purge downstream vessels) with N_2. • During unit shutdown, to meet vessel depressurization requirements (Regulation 8-10), pressure vessels with N_2, then release. • During unit startup, warm reactor with hot H_2. • During unit startup, activate catalyst with H_2. • During unit startup, send off-spec products to the Flare Gas Header.
March 2008 February 2006 June 2004 February 2003	NRU	• During unit shutdown, depressure products to the Flare Gas Header. • During unit shutdown, hot strip vessels with H_2, then N_2. • During unit shutdown, to meet vessel depressurization requirements (Regulation 8-10), pressure vessels with N_2, then release. • During unit startup, warm reactor with hot H_2 and N_2. • During unit startup, send off-spec products to the Flare Gas Header.
August 2008 February 2004	DIM	• During unit shutdown, depressure vessels. • During unit shutdown, to meet vessel depressurization requirements (Regulation 8-10), pressure vessels with N_2, then release. • During unit startup, send off-spec products to the Flare Gas Header.
August 2007 February 2004	ALKY	• During unit shutdown, depressure vessels. • During unit shutdown, to meet vessel depressurization requirements (Regulation 8-10), pressure vessels with N_2 then release. • During unit startup, send off-spec products to the Flare Gas Header.

Table 10
Flaring During Major Maintenance Activities, 5 Year Lookback

Date	Process Unit	Description of Activity Resulting in Flaring
October/November 2007 October 2006 February 2002	CKR PS (Vacuum Column) & CFHU	• During unit shutdown, depressure products to the Flare Gas Header. • During unit shutdown, to meet vessel depressurization requirements (Regulation 8-10), strip vessels with steam. • During unit startup, send off-spec products to the Flare Gas Header.
February 2007 Oct./Nov. 2004	MRU HSU (Heartcut Saturation Unit)	• During unit shutdown, hot strip vessels with H_2, then N_2. • During unit shutdown, cool reactor (and purge downstream vessels) with N_2. • If necessary to meet vessel depressurization requirements (Regulation 8-10), pressure vessels with N_2, then release. • During unit startup, activate/dry catalyst with N_2, then H_2.
Oct./Nov. 2004	Refinery-Wide Turnaround	For FCCU/CLE and PS/VLE (Atmospheric Column): • During unit shutdown, depressure FCCU then CLE to the Flare Gas Header. • During unit shutdown, depressure PS (Atmospheric Column) then VLE to the Flare Gas Header. • During unit shutdown, to meet vessel depressurization requirements (Regulation 8-10), strip vessels with steam and N_2. • During unit startup, send off-spec products to the Flare Gas Header. For Units other than FCCU/CLE, PS/VLE (Atmospheric Column): • See the activities described in each of the above.

5.1.3 Measures Considered to Minimize or Eliminate Maintenance Flaring

In accordance with Regulation 12-12-401.4.1, prevention measures must be evaluated to minimize or eliminate flaring that can reasonably be expected to occur as a result of maintenance activities, including shutdown and startup. The Benicia Refinery has reviewed the history of its maintenance-related flaring, focusing especially on the past five years. Based on this review and as part of this FMP update, a list of maintenance-related flaring was developed and categorized by common cause (left hand column of Table 11). For each type of maintenance-related flaring, potential prevention measures were evaluated to determine if there are additional flare minimization or elimination practices that could be practically and feasibly implemented at the Benicia Refinery. A primary conclusion of this evaluation is that the most feasible and effective flare minimization and elimination practices have already been implemented (see Table 8 in Section 3) or are planned (see Table 9 in Section 4).

As documented in Section 1.4, flaring has been cut at the Benicia Refinery by about 50 percent since about 2003. This reduction in flaring has been primarily achieved by focusing on continual improvement with respect to (1) planning and preparation for maintenance activities; (2) equipment reliability improvements which both decrease the frequency of flaring caused emergencies and unplanned maintenance and decrease the frequency of planned maintenance by increase process unit run length between major maintenance activities; and (3) proactive initiation of production cuts to reduce fuel gas production when a fuel gas imbalance is anticipated. As a standard practice and in accordance with the FMP process, the Benicia Refinery will continually evaluate additional potential prevention measures and implement the ones that are feasible and practical. Table 11 provides a summary of the Benicia Refinery's evaluation of additional prevention measures that could minimize or eliminate maintenance-related flaring than can reasonably be expected to occur. For prevention measures that have been determined to be practical and feasible, a schedule for expeditious implementation is provided in the right hand column of Table 11.

Table 11
Evaluation of Prevention Measures to Minimize or Eliminate Maintenance Flaring

Maintenance Activity and Process Units	Description of Prevention Measure	Feasibility/ Implementation Schedule
Depressure hydrocarbon containing vessels to Flare Gas Header during shutdown of HCU, NRU, DIM, ALKY, CKR, PS, FCCU, CLE, VLE, LCNHF, HCNHF, CFHU, JHF, DHF, VNHF, ULSD, and MRU	Minimize flaring through maintenance planning and preparation (see Section 5.1.4).	Formal maintenance planning procedures were implemented in 2007 and will continue to be updated as experience is gained.
	Minimize or eliminate flaring by expanding the existing Flare Gas Recovery System.	Not cost-effective as documented in Section 5.2.2.2.
Hot strip reactors with H_2 then N_2 during shutdown of LCNHF, HCNHF, CFHU, JHF, DHF, VNHF, ULSD, HCU, NRU, MRU, and ALKY	Minimize flaring through maintenance planning and preparation (see Section 5.1.4).	Formal maintenance planning procedures were implemented in 2007 and will continue to be updated as experience is gained.
	Recycle H_2/N_2 within the reactor and minimize that quantity of gas that is purged to the Flare Gas Header. This practice is currently utilized at the CFHU, JHF, ULSD, HCU, and NRU because these units include recycle gas compressors as an inherent part of the reactor circuit design. Therefore, consideration of this prevention measure only applies to the LCNHF, HCNHF, DHF, VNHF, MRU, and ALKY.	Based on the design of the Benicia Refinery, it is not technically feasible to recycle H_2/N_2 at the LCNHF, HCNHF, DHF, VNHF, MRU, and ALKY. These units are not designed for recycle and do not have recycle gas compressors.

Table 11
Evaluation of Prevention Measures to Minimize or Eliminate Maintenance Flaring

Maintenance Activity and Process Units	Description of Prevention Measure	Feasibility/ Implementation Schedule
	Route the low Btu gases (H_2 and N_2) to the Fuel Gas Unit and add natural gas to meet Btu specifications for fuel gas.	The use of natural gas to increase Btu content is not feasible because the quantity of natural gas needed would cause a fuel gas imbalance which would still result in flaring.
Hot strip reactors with H_2 then N_2 during shutdown of LCNHF, HCNHF, CFHU, JHF, DHF, VNHF, ULSD, HCU, NRU, MRU, and ALKY (Continued)	Segregate low Btu gases (H_2 and N_2) and routine base-load flare gases. Route the low Btu gases to the flare and the routine base-load flare gases to fuel gas recovery.	Based on the design of the Benicia Refinery, it is not technically feasible to segregate the low Btu gases and routine base-load flare gases. Additionally, even if this could be accomplished, flaring would not be reduced because fuel gas needs to be added to the low Btu gases to ensure effective combustion at the flares.
	Minimize or eliminate flaring by expanding the existing Flare Gas Recovery System.	Not cost-effective as documented in Section 5.2.2.2.

Table 11
Evaluation of Prevention Measures to Minimize or Eliminate Maintenance Flaring

Maintenance Activity and Process Units	Description of Prevention Measure	Feasibility/ Implementation Schedule
Cool reactors (and purge downstream vessels) with N_2 during shutdown of LCNHF, HCNHF, CFHU, JHF, DHF, VNHF, ULSD, HCU, MRU, and ALKY	Minimize flaring through maintenance planning and preparation (see Section 5.1.4).	Formal maintenance planning procedures were implemented in 2007 and will continue to be updated as experience is gained.
Cool reactors (and purge downstream vessels) with N_2 during shutdown of LCNHF, HCNHF, CFHU, JHF, DHF, VNHF, ULSD, HCU, MRU, and ALKY	Recycle N_2 within the reactor and minimize that quantity of gas that is purged to the Flare Gas Header. This practice is currently utilized at the CFHU, JHF, ULSD, HCU, and NRU because these units include recycle gas compressors as an inherent part of the reactor circuit design. Therefore, consideration of this prevention measure only applies to the LCNHF, HCNHF, DHF, VNHF, MRU, and ALKY.	Based on the design of the Benicia Refinery, it is not technically feasible to recycle N_2 at the LCNHF, HCNHF, DHF, VNHF, MRU, and ALKY. These units are not designed for recycle and do not have recycle gas compressors.
Cool reactors (and purge downstream vessels) with N_2 during shutdown of LCNHF, HCNHF, CFHU, JHF, DHF, VNHF, ULSD, HCU, MRU, and ALKY	Route the low Btu gases (N_2) to the Fuel Gas Unit and add natural gas to meet Btu specifications for fuel gas.	The use of natural gas to increase Btu content is not technically feasible because the quantity of natural gas needed would cause a fuel gas imbalance which would still result in flaring.

Table 11
Evaluation of Prevention Measures to Minimize or Eliminate Maintenance Flaring

Maintenance Activity and Process Units	Description of Prevention Measure	Feasibility/ Implementation Schedule
Cool reactors (and purge downstream vessels) with N_2 during shutdown of LCNHF, HCNHF, CFHU, JHF, DHF, VNHF, ULSD, HCU, MRU, and ALKY (continued)	Segregate low Btu gases (N_2) and routine base-load flare gases. Route the low Btu gases to the flare and the routine base-load flare gases to fuel gas recovery.	Based on the design of the Benicia Refinery, it is not technically feasible to segregate the low Btu gases and routine base-load flare gases. Additionally, even if this could be accomplished, flaring would not be reduced because fuel gas needs to be added to the low Btu gases to ensure effective combustion at the flares.
	Monitor various operating parameters including fuel gas Btu content and adjust flare gas compressor operation as appropriate. The benefits and reductions in flaring must be carefully compared to the risks of recovering these low Btu gases. For example, serious consequences can occur from the impacts of low molecular weight gases on compressors and from impacts of low Btu value gas on NOX and other limits.	This prevention measure was implemented in 2008 and has been successful in increasing the volume of low Btu gasses that can be safely recovered. This technique may not be suitable in all cases and is not capable of recovering all low Btu gases. Valero will continue to evaluate additional opportunities where this technique can be safely implemented and where this technique may be enhanced to recover additional low Btu gases.
	Minimize or eliminate flaring by expanding the existing Flare Gas Recovery System.	Not cost-effective as documented in Section 5.2.2.2.

Table 11
Evaluation of Prevention Measures to Minimize or Eliminate Maintenance Flaring

Maintenance Activity and Process Units	Description of Prevention Measure	Feasibility/ Implementation Schedule
If necessary to meet vessel depressurization requirements (Regulation 8-10), pressure vessels with N_2 then release and/or strip vessels with steam during shutdown of LCNHF, HCNHF, CFHU, JHF, DHF, VNHF, ULSD, HCU, NRU, MRU, DIM, ALKY, CKR, PS, FCCU, CLE, and VLE	Minimize or eliminate flaring through maintenance planning and preparation (see Section 5.1.4).	Formal maintenance planning procedures were implemented in 2007 and will continue to be updated as experience is gained.
	Minimize or eliminate flaring by expanding the existing Flare Gas Recovery System.	Not cost-effective as documented in Section 5.2.2.2.

Table 11
Evaluation of Prevention Measures to Minimize or Eliminate Maintenance Flaring

Maintenance Activity and Process Units	Description of Prevention Measure	Feasibility/ Implementation Schedule
Warm reactors with hot H_2 during startup of LCNHF, HCNHF, CFHU, JHF, DHF, VNHF, ULSD, HCU, NRU, MRU, and ALKY	Minimize flaring through maintenance planning and preparation (see Section 5.1.4).	Formal maintenance planning procedures were implemented in 2007 and will continue to be updated as experience is gained.
	Recycle H_2 within the reactor and minimize that quantity of gas that is purged to the Flare Gas Header. This practice is currently utilized at the CFHU, JHF, ULSD, HCU, and NRU because these units include recycle gas compressors as an inherent part of the reactor circuit design. Therefore, consideration of this prevention measure only applies to the LCNHF, HCNHF, DHF, VNHF, MRU, and ALKY.	Based on the design of the Benicia Refinery, it is not technically feasible to recycle H_2 at the LCNHF, HCNHF, DHF, VNHF, MRU, and ALKY. These units are not designed for recycle and do not have recycle gas compressors.
	Route the low Btu gases (H_2) to the Fuel Gas Unit and add natural gas to meet Btu specifications for fuel gas.	The use of natural gas to increase Btu content is not technically feasible because the quantity of natural gas needed would cause a fuel gas imbalance which would still result in flaring.

Table 11
Evaluation of Prevention Measures to Minimize or Eliminate Maintenance Flaring

Maintenance Activity and Process Units	Description of Prevention Measure	Feasibility/ Implementation Schedule
Warm reactors with hot H_2 during startup of LCNHF, HCNHF, CFHU, JHF, DHF, VNHF, ULSD, HCU, NRU, MRU, and ALKY (continued)	Segregate low Btu gases (H_2) and routine base-load flare gases. Route the low Btu gases to the flare and the routine base-load flare gases to fuel gas recovery.	Based on the design of the Benicia Refinery, it is not technically feasible to segregate the low Btu gases and routine base-load flare gases. Additionally, even if this could be accomplished, flaring would not be reduced because fuel gas needs to be added to the low Btu gases to ensure effective combustion at the flares.
	Minimize or eliminate flaring by expanding the existing Flare Gas Recovery System.	Not cost-effective as documented in Section 5.2.2.2.
Activate catalyst with H_2/N_2 during startup of LCNHF, HCNHF, CFHU, JHF, DHF, VNHF, ULSD, HCU, NRU, MRU, and ALKY	Minimize or eliminate flaring through maintenance planning and preparation (see Section 5.1.4).	Formal maintenance planning procedures were implemented in 2007 and will continue to be updated as experience is gained.
	When selecting catalysts, evaluate the potential impacts on flaring between the various catalyst options. Catalyst activation does not generally result in significant flaring. Flaring as a result of catalyst activation can be significantly reduced or eliminated through maintenance planning and preparation. As a result, catalyst selection does not generally have an impact on flaring.	Formal catalyst selection procedures were implemented in 2008 and will continue to be updated as experience is gained.

Table 11
Evaluation of Prevention Measures to Minimize or Eliminate Maintenance Flaring

Maintenance Activity and Process Units	Description of Prevention Measure	Feasibility/ Implementation Schedule
Activate catalyst with H_2/N_2 during startup of LCNHF, HCNHF, CFHU, JHF, DHF, VNHF, ULSD, HCU, NRU, MRU, and ALKY (continued)	Recycle H_2/N_2 within the reactor and minimize that quantity of gas that is purged to the Flare Gas Header. This practice is currently utilized at the CFHU, JHF, ULSD, HCU, and NRU because these units include recycle gas compressors as an inherent part of the reactor circuit design. Therefore, consideration of this prevention measure only applies to the LCNHF, HCNHF, DHF, VNHF, MRU, and ALKY.	Based on the design of the Benicia Refinery, it is not technically feasible to recycle H_2 at the LCNHF, HCNHF, DHF, VNHF, MRU, and ALKY. These units do not have recycle gas compressors and are not designed for recycle.
	Route the low Btu gases (H_2/N_2) to the Fuel Gas Unit and add natural gas to meet Btu specifications for fuel gas.	The use of natural gas to increase Btu content is not technically feasible because the quantity of natural gas needed would cause a fuel gas imbalance which would still result in flaring.
	Segregate low Btu gases (H_2/N_2) and routine base-load flare gases. Route the low Btu gases to the flare and the routine base-load flare gases to fuel gas recovery.	Based on the design of the Benicia Refinery, it is not technically feasible to segregate the low Btu gases and routine base-load flare gases. Additionally, even if this could be accomplished, flaring would not be reduced because fuel gas needs to be added to the low Btu gases to ensure effective combustion at the flares.
	Minimize or eliminate flaring by expanding the existing Flare Gas Recovery System.	Not cost-effective as documented in Section 5.2.2.2.

Table 11
Evaluation of Prevention Measures to Minimize or Eliminate Maintenance Flaring

Maintenance Activity and Process Units	Description of Prevention Measure	Feasibility/ Implementation Schedule
Send off-spec products to the Flare Gas Header during startup of the HCU, NRU, DIM, ALKY, CKR, PS, FCCU, CLE, VLE, and MRU	Minimize flaring through maintenance planning and preparation (see Section 5.1.4).	Formal maintenance planning procedures were implemented in 2007 and will continue to be updated as experience is gained.
	During startup of FCCU and CKR, utilize multiple compressors in a staged process to slowly start the units and minimize the production of off-spec products.	Based on the design of the Benicia Refinery, it is not technically feasible to use multiple compressors during startup of the FCCU and CKR. These units do not do not have multiple compressors. Additionally, the use of multiple compressors would not reduce the production of off-spec products because startup feed rates at the FCCU and CKR are established based on the minimum feed rates to maintain a stable startup, not based on compressor operations.
	Minimize or eliminate flaring by expanding the existing Flare Gas Recovery System.	Not cost-effective as documented in Section 5.2.2.2.

Table 11
Evaluation of Prevention Measures to Minimize or Eliminate Maintenance Flaring

Maintenance Activity and Process Units	Description of Prevention Measure	Feasibility/ Implementation Schedule
Refinery wide shutdown and startup for major maintenance at the PS and FCCU	Schedule maintenance activities such that maintenance events are staggered over several years and avoid refinery-wide shutdowns and subsequent startups.	Based on the design of the Benicia Refinery, it is not technically feasible to conduct major maintenance at the PS and FCCU without a refinery-wide shutdown and subsequent startup. The Benicia Refinery is very integrated for energy efficiency and tankage inventory purposes. As a result, when major maintenance is needed at the PS or FCCU the remaining process units need to be shutdown. Maintenance activities at units other than the PS and FCCU are staggered to minimize flaring.

5.1.4 Benicia Refinery Maintenance Planning and Preparation

In this section the role of planning and preparation is discussed as it relates to flare minimization associated with planned and unplanned maintenance activities including startup, shutdown, and turnaround activities. In recent years, the Benicia Refinery has implemented a flare minimization planning process that has become a part of the refinery's normal operating practice prior to conducting maintenance activities that may cause flaring. This pre-maintenance planning is conducted to identify practices and procedures that may help to minimize flaring. These same practices and procedures are also used to the greatest extent possible in the event of an unplanned maintenance activity. In all cases, it should be emphasized that these procedures and practices are always implemented in a manner that does not compromise the safety of refinery operations, or would present a risk of exposure to refinery personnel or the community.

5.1.4.1 Flare Minimization Planning for Planned Maintenance Activities

For planned maintenance activities at the Benicia Refinery, flare minimization planning is currently being conducted to minimize the frequency and magnitude of flaring associated with planned maintenance. This flare minimization planning process shown in Figure 7 presents the thought process logic that is followed to ensure the potential for flaring is considered before maintenance activities are conducted. Additionally, use of this flare minimization planning process ensures continuous improvement because the process includes (1) consideration of measures to minimize flaring prior to conducting planned maintenance, (2) an evaluation of causes, contributing factors, and/or lessons learned for every significant flaring event, and (3) consideration of measures to minimize future flaring after a flaring event has occurred as a result of maintenance.

Prior to conducting maintenance activities at the Benicia Refinery, potential causes of flaring are identified. These potential causes can be generally categorized as one or more of the following:

- Clearing vessels and reactors of their gas contents to the tail gas system, Fuel Gas Unit, and/or liquid KO drums
- Clearing vessels and reactors of their liquid contents to liquid KO drums.
- Hot stripping reactors with hydrogen and/or nitrogen
- Cooling or purging reactors with nitrogen
- Final clearing of vessels and reactors with nitrogen or stream to meet the BAAQMD's vessel depressurization requirements (Regulation 8-10)
- Other unit shutdown activities
- Vessel and reactor warm-up with hydrogen and/or nitrogen
- Catalyst activation/drying with hydrogen and/or nitrogen
- Routing of off-spec products to the Fuel Gas Unit and/or liquid KO drums
- Other unit startup activities

Once potential causes of flaring have been identified during the planning process, potential flare minimization measures can be identified for possible implementation during the planned maintenance. The identification of flare minimization measures is a dynamic process and can generally be categorized as one or more of the following:

- Stage and coordinate multiple activities as appropriate to reduce the flow rate to the Flare Gas Header

- Maximize initial vessel clearing to the tail gas system and/or the Fuel Gas Unit
- Adjust the rate of nitrogen and/or hydrogen usage as appropriate to eliminate flaring or minimize the duration of flaring
- Evaluate fuel gas balance
- Utilize the second (backup) Flare Gas Compressor as appropriate if the compressor is available and there is not a fuel gas imbalance
- Check other sources that may be adding to the base-load flow rate to the Flare Gas Header
- Implement unit adjustments and production rate cuts as appropriate to reduce fuel gas production if a fuel gas imbalance is a contributing cause of flaring
- Minimize the production of off-spec products
- Other flare minimization measures

After the maintenance activities are conducted, if the flaring event exceeds 0.5 mmscfd or 500 lb/day of SO_2, a formal evaluation of cause and contributing factors is conducted and measures to minimize future flaring are considered. Additionally, if the maintenance activities result in flaring a level below the thresholds listed above, lessons learned are captured even if a formal evaluation is not conducted. The results of formal evaluations and lessons learned are used during the planning process for future maintenance activities that are similar in nature.

Currently at the Benicia Refinery, the pre-maintenance flare minimization planning process outline above is conducted for all major maintenance activities. Other than the formal evaluations of cause and contributing factors, the planning process is not formally documented. Never the less, this pre-maintenance flare minimization process has helped to reduce flaring at the Benicia Refinery by about 50 percent since 2003. The Benicia Refinery is currently preparing formal documentation and procedures for conducting pre-maintenance flare minimization planning and is committed to completing this work in 2007.

5.1.4.2 Flare Minimization During Unplanned Maintenance and Feed Outages

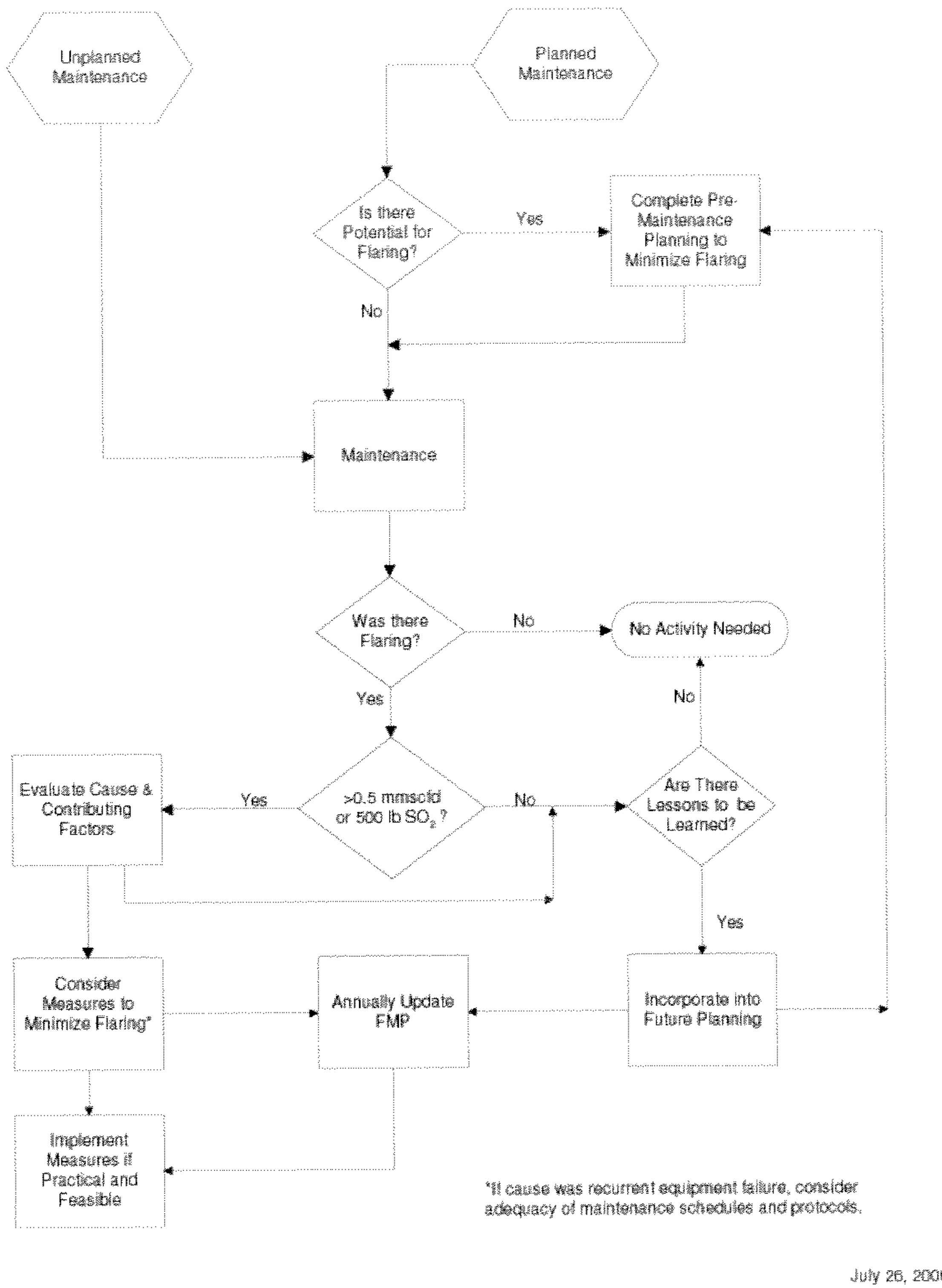
There are occasions (primarily as a result of equipment malfunction) when a relatively immediate decision is made to shutdown a process unit or block of process units, typically within a period of minutes or hours, allowing very little time for planning. In these cases, it is often not possible to make all the up-front adjustments necessary to minimize flaring to the same extent as is possible when the shutdown is planned in advance. Despite this, actions that can be taken to minimize flaring are implemented to the greatest extent possible. For these cases, the refinery utilizes the same general procedures that have been developed to minimize the frequency and magnitude of flaring during maintenance events, as shown in Figure 7. The flare minimization measures that are considered for planned maintenance (listed above) are also considered for unplanned shutdowns and lessons learned are informally captured for future consideration during similar future events. If flaring events from unplanned shutdowns exceed 0.5 mmscfd or 500 lb/day of SO_2, a formal evaluation of cause and contributing factors is conducted and measures to minimize future flaring are considered.

5.2 Prevention Measures – Fuel Gas Quantity and Quality

As discussed in Section 1.6.2, flaring can occur as a result of fuel gas quantity and quality issues if (1) the quantity of fuel gas generated is larger than can be managed by the Flare Gas Compressors, Fuel Gas Unit, and/or fuel gas consumers; or (2) the quality (composition) of fuel gas is such that it must be routed to the flare because it cannot be utilized by the fuel gas consumers. When flaring is caused by fuel gas quantity and quality issues, the general cause of flaring is often maintenance activities, equipment failure and malfunction, emergency situations and/or safety reasons. This section examines potential prevention measure to reduce flaring by reducing fuel gas quantity and quality issues. Specifically, this section examines both the advantages and the feasibility of adding flare gas recovery capacity.

Figure 7

Flare Minimization Flowchart for Maintenance



All prevention measures that are considered in this section for fuel gas quantity and quality are focused on reducing flaring loads at the South and North Flares. Any reduced flaring associated with a particular prevention measure will result in decreased emissions of all pollutants including sulfur dioxide (SO_2) and will also result in increased treatment and recovery of sulfur containing gases. To decrease SO_2 emissions and increase treatment and recovery of sulfur containing gases, flare gas must be diverted from the flares and sent to the Fuel Gas Unit where the sulfur compounds are treated in the Fuel Gas Treatment Scrubber (T-1201). This scrubber has a maximum capacity of about 70 mmscfd of sour fuel gas and receives an average of about 50 mmscfd of sour fuel gas. The Fuel Gas Treatment Scrubber is sufficiently sized to accommodate recovered flare gas that is diverted from the flares (the 50 mmscfd average sour fuel gas flow to T-1201 includes an average of about 5 mmscfd of recovered flare gas). Additional Fuel Gas Treatment Scrubbing capacity will not reduce flaring or SO_2 emissions. Therefore, the only way to decrease SO_2 emissions is to reduce flaring.

Flaring at the Acid Gas Flare is not caused by issues of gas quantity and quality (i.e. a larger recovery and treatment system will not reduce flaring because the Acid Gas Flare does not utilize a recovery and treatment system). A recovery and treatment system for the Acid Gas Flare is not practical for several reasons. First, acid gas does not have a heating value (i.e., there are little or no hydrocarbons in acid gas), so there is no use for recovered acid gas as fuel gas. Additionally, use of the Acid Gas Flare is very limited and is primarily used for emergency and upset situations so there is normally no flow in the Acid Gas Flare Line. As such, treatment and recovery are not practical because scrubbers cannot handle flow rates between zero and the design flow rate of the Acid Gas Flare, as well as the high concentration of H_2S in the acid gas during emergencies and upsets. Finally, even if recovery and treatment were possible, it would not be warranted because utilization of the Acid Gas Flare and the resulting emissions are too small. In 2005 and 2006, there were no Acid Gas Flaring events in excess of the reportable levels. Emergency and upset events provide the only potential for Acid Gas Flare events in excess of 0.5 mmscfd or 500 lb/day of SO_2. Limited use of the Acid Gas Flare during startup, shutdown, and minor maintenance activities has not and will not exceed either of the reportable thresholds.

5.2.1 Existing Flare Gas Recovery Capacity at Benicia Refinery

In this section the capacity of that system is reviewed in further detail, and considered in light of flaring event information from 2005. Options for possible expansion of the system capacity are also evaluated, including the possible addition of flare gas compressor, gas treating, and/or gas storage capacity.

The capacity of a Flare Gas Recovery System is generally taken as the total installed nameplate capacity of the Flare Gas Compressor(s). Where spare units are provided that are not operated simultaneously, the spare capacity is not included as a part of total system capacity. However, Flare Gas Compressor capacity alone does not fully define the total capacity of the system in all cases. In order to recover flare gas for use at the Fuel Gas Unit, three criteria must be met. First, there must be sufficient flare gas compressor capacity. Second, there must be sufficient fuel gas scrubbing or treatment capacity. Finally, there must either be available storage volume or a user (e.g., furnace, boiler, gas turbine or COGEN) with a need for the fuel gas. If any of these conditions are not met, then the gas cannot be recovered into the fuel gas header. The capacity of the existing Flare Gas Recovery System components at the Benicia Refinery is summarized in Table 12.

Table 12
Summary of Benicia Refinery Flare Gas Recovery System Capacity

Flare Gas Recovery System	Flare Gas Recovery Capacity	Storage Capacity	Scrubbing Capacity for Recovered Flare Gas	Total Fuel Gas Scrubbing Capacity
Main System with North and South Flares	6 mmscfd at 0 psig, 80 °F (one operating, one spare)	None	Sufficient to process recovered fuel gas	70 mmscfd total (includes all fuel gas sources)
Acid Gas Flare	None	None	None	None

The Benicia Refinery Flare Gas Recovery System does not include any dedicated capacity for storage of fuel gas or flare gas. However, on a continuous basis the refinery optimizes the producers and consumers of fuel gas to maximize the capacity available for treatment and reuse of recovered gases by employing the following strategies:

- Adjusting the sources of fuel that are made up to the Fuel Gas Unit including imported natural gas, propane, butane or other refinery marginal fuel sources;
- Adjusting the operations of units that produce fuel gas range materials (FCCU and CKR) including at times reducing severity of operations in the FCCU to reduce fuel gas production if it would put the refinery in a flaring situation, and at times reducing the feed rate to high gas producing units;
- Adjusting the refinery profile for consumption of fuel gas by ensuring the COGEN is at its maximum capacity (within constraints on exporting power), or shifting rotating equipment to steam turbine drivers (maximizes the fuel gas fired boilers).

The total fuel gas scrubbing capacity that is indicated is an integral part of the refinery fuel gas management system. This capacity is closely matched with the fuel gas consumers' (furnaces, boilers, gas turbines, and COGEN) usage requirements. The capacity indicated as being available for recovered flare gas scrubbing will vary depending on the balance between fuel gas production and consumption; it will vary both on a seasonal basis and during the course of the day.

With this system for flare gas recovery in place, the Benicia Refinery has recovered a daily average flow of 4.5 mmscfd during the 2005 calendar year. Total gases flared during that time period were an average of 0.2 mmscfd, demonstrating that the Flare Gas Recovery System effectively recovered and reused greater than 95 percent of the gases routed to the flare gas header(s) in 2005. On an annual basis, out of 1,700 mmscf total volume measured in the flare gas header, 1,630 mmscf were recovered.

5.2.2 Evaluation of Options for Additional Flare Gas Recovery, Scrubbing and Use

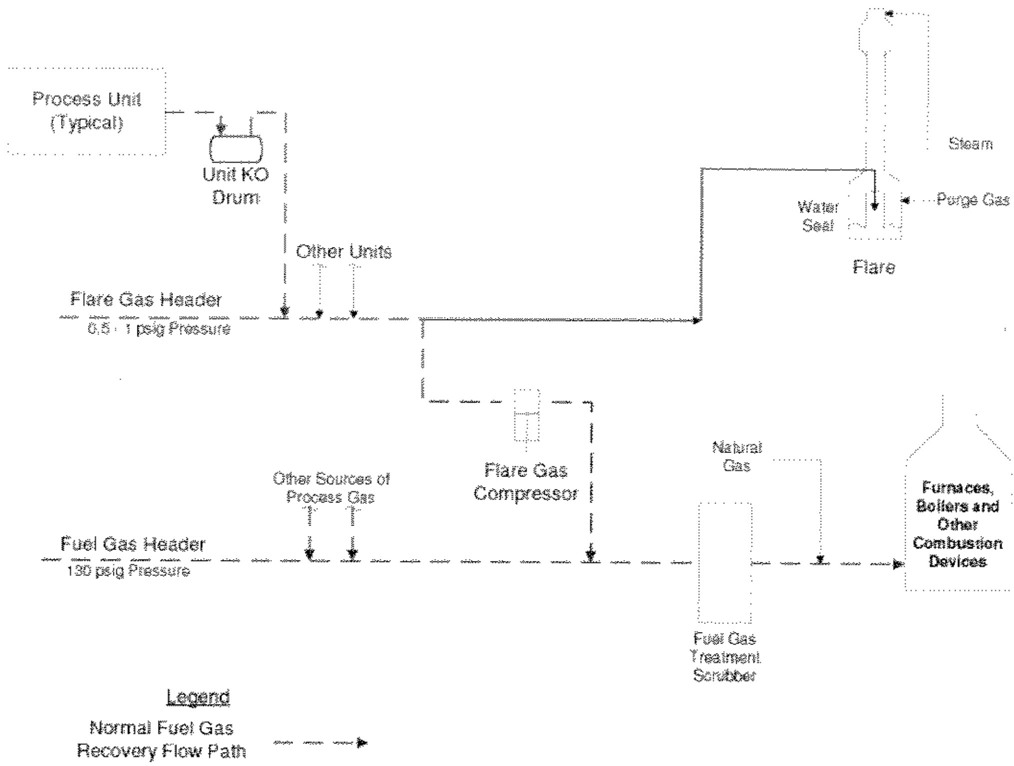
To address the requirements of Regulation 12-12-401.4, the Benicia Refinery has considered the feasibility of further reducing flaring through additional recovery, scrubbing, and/or storage of Flare Gas Header gases, or to use the recovered gases through other means. This evaluation considers the impact these additional systems would have on the volume of flared gases remaining in excess of what has already been recovered (as noted in the previous section), and the associated mass flow of hydrocarbons emitted after combustion in the flare control device.

5.2.2.1 Typical Flare Gas Recovery System Components

A typical Flare Gas Header is connected to both a flare gas recovery system and to one or more flares. Normally all vapor flow to the Flare Gas Header is recovered by a Flare Gas Compressor, which increases the pressure of the flare gas allowing it to be routed to a fuel gas treatment scrubber for removal of contaminants such as sulfur and then to the refinery fuel gas consumers. Gas in excess of what can be handled by the Flare Gas Compressor(s), the treatment scrubber(s), and/or the fuel gas consumers flows to a refinery flare so it can be safely disposed of by combustion. Therefore, in order to reduce the volume of gas flared, three essential infrastructure elements are required: (1) sufficient compressor capacity to increase the pressure of the gas to the point where it can be used in the refinery fuel system; (2) sufficient storage volume to dampen out the variation in volumetric flow rate to the flare gas header; and (3) sufficient capacity of treatment scrubber systems to condition the gas (primarily by removal of sulfur) for use as fuel gas. Figure 8 shows the configuration of a typical flare gas recovery system and its components.

Figure 8

Typical Flare Gas Recovery System



Many types of systems are used for compression of flare gas. Options include centrifugal, reciprocating, and rotary compressors, as well as liquid jet ejectors. Each of these options has advantages and disadvantages that lead to it being better suited for use under certain sets of conditions. Centrifugal compressors generally have low maintenance requirements, but are more sensitive to variation in gas properties (e.g., molecular weight) than a reciprocating machine. Reciprocating compressors, although designed to operate best with a gas that has a specific molecular weight, can operate with a range of compositions so long as inter-stage temperature limits (350 to 400 F is typical) are not exceeded. Typical maximum practical capacity for a single reciprocating compressor is about 4 mmscfd of gas at the compressor inlet. Rotary screw compressors are less expensive, but generally less reliable than other options. Liquid ring compressors are less efficient than most reciprocating or centrifugal machines, and cannot achieve as high an outlet pressure, however they have a high tolerance for variation in composition and the presence of entrained liquids. They are also less likely to go into surge mode than centrifugal or reciprocating compressors. Liquid jet ejectors are very reliable; as they have no moving parts in contact with the gas stream. They can handle a rapidly varying vapor load, but are much less efficient than other types of compressors, so have high power requirements as a result.

Options for storage of flare gas are analogous to those for storage of other refinery gases such as propane and butane. Gases can be stored at low pressure in expandable gas-holders with either liquid (water) or dry (fabric diaphragm) seals. The volumes of these systems expand and contract as gas is added or removed from the container. Very large vessels, containing up to 10 mmscf of gas can be constructed by using multiple "lifts," or stages. Gases can also be stored at higher pressures, and correspondingly lower volumes, in steel bullets or spheres, but a compressor would be required to capture the excess flare gas. The optimal pressure vessel configuration depends on system design pressure and total required storage volume.

For any type of gas storage facility, selection of an acceptable site and obtaining the permits necessary for construction both present difficulties. Despite a refinery's demonstrated commitment and strong track record with respect to safe handling of hazardous materials, the surrounding community can be expected to have concerns about any plan to store large volumes of flammable gas containing hydrogen sulfide and other sulfur compounds. Safety concerns are expected to impact site selection as well, with a relatively remote location preferred. Modifications to the recovery, storage, and treatment scrubbing of recovered refinery fuel gases are subject to the provisions and approval of federal and local regulations including Process Safety Management (PSM) and California Accidental Release Prevention Program (CalARP). Although the objective of the project would be a reduction in flaring, there are expected to be multiple hurdles along the path to a construction/land use permit.

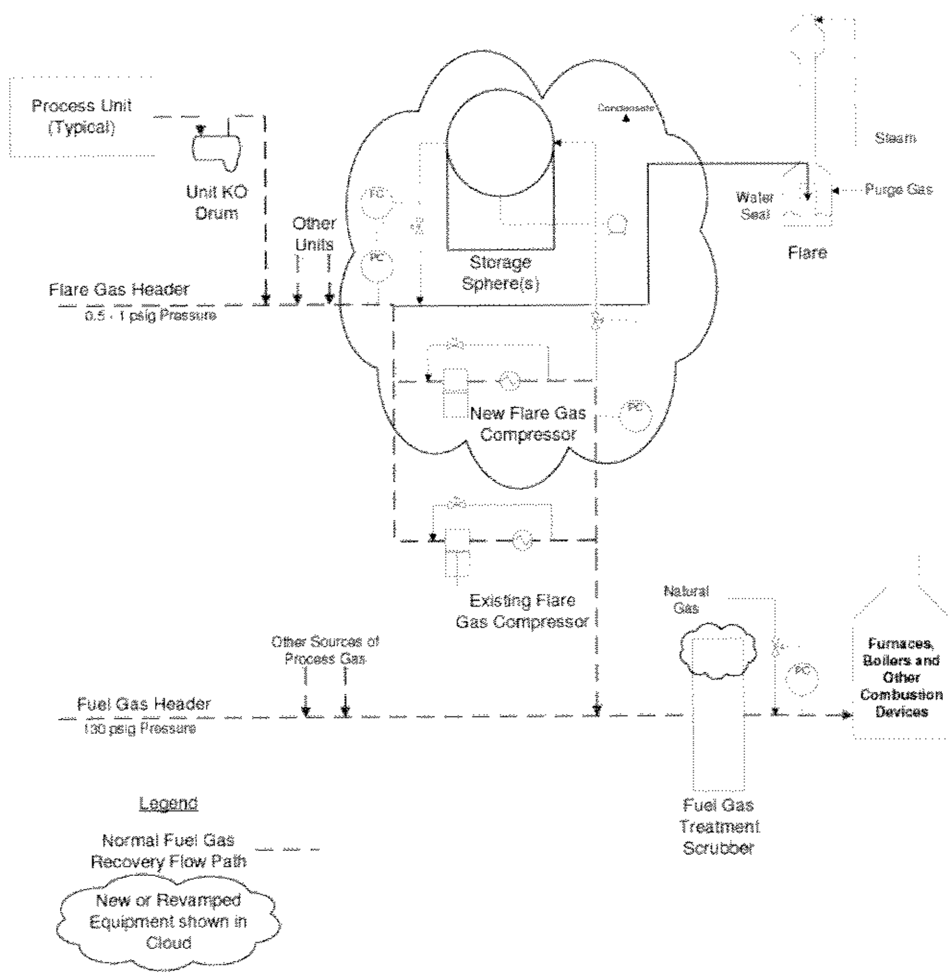
Fuel gas treatment scrubbers are used to condition flare gas prior to combustion as fuel at furnaces, boilers, gas turbines and COGEN. Treatment scrubbing is focused on removal of sulfur compounds, with some systems improving fuel value by removing carbon dioxide as well. A range of technology options exist, most of which are based on absorption of acid gases into a "lean" amine solution with regeneration of the resulting "rich" solution by stripping at lower pressure. In order to recover additional fuel gas, it is necessary to have sufficient capacity to match the capacity of gas treating systems to the peak flow rate of the flare gas requiring treatment.

5.2.2.2 Feasibility of Expanding the Existing Flare Gas Recovery System

In order to assess the potential effect of additional flare gas recovery, a hypothetical design for an upgraded system was developed. The impact that this system would be expected to have on non-methane hydrocarbon (NMHC) emissions and other pollutants have been evaluated based on the refinery's recent flaring history from 2005. Results of this evaluation are provided for three system sizes. The budgetary level (order of magnitude) cost information provided in this section has been developed based on total installed cost data from similar installations where available, in combination with equipment vendor quotes and standard industry cost estimation procedures. Figure 9 shows the configuration of a typical flare gas recovery system, modified to increase its recovery capacity as discussed below.

Figure 9

Flare Gas Recovery with Storage Sphere



The evaluation is based on the need for installation of three new major systems in order to increase recovery of flare gases from current levels:

- Additional Flare Gas Compressor capacity – the estimated cost to provide additional compressor capacity to recover flare gas flowing in the Flare Gas Header in excess of current compressor capacity, for transfer to storage and/or treatment scrubbing. Costs provided are for one un-spared compressor system to be added to the existing Flare Gas Header. The estimate is for a reciprocating compressor with all necessary appurtenances for operation, that is knock out pots, coolers, and instrumentation for a fully functional system.
- Addition of surge volume storage capacity – the estimated cost to provide temporary surge storage for a portion of the gases routed to the Flare Gas Header in excess of the volumes currently being recovered, scrubbed, and consumed. The addition of temporary surge storage volume is necessary for any further increase in flare gas recovery to allow flare gas flow (which is highly variable) to be matched to the demand for fuel gas. The cost used is based on a storage volume equal to the total volume of gas accumulated over one day at the identified flow rate, and is based on recovery in a high pressure sphere system with discharge at a controlled rate back to the flare gas header. Other lower pressure approaches were considered (low pressure gas holder, medium pressure sphere), but for the sizes analyzed a high pressure sphere was identified as the preferred approach based on operational, safety and economic considerations. For the large storage volumes needed for some of the options considered, the cost is based on the use of multiple spheres.
- Additional recovered fuel gas treatment scrubbing capacity – the cost of additional amine-based treating capacity to process recovered gases for sulfur removal so that they can be burned by existing fuel gas consumers without exceeding environmental or equipment operational limits. Installed cost data for new fuel gas treatment scrubbing systems were scaled to estimate the cost of adding scrubbing capacity for each of the evaluated flow rates. The assumption is that for small increases in scrubbing capacity the existing treatment scrubber would be modified or upgraded to allow for the increase. No additional cost has been included for expansion of the sulfur recovery system (SGU and TGU), although in actual fact it could be required.

Table 13 provides a summary of the estimated cost for the three flare gas recovery system components described above.

Table 13
Summary of Estimated Cost for Flare Gas Recovery System Expansion

Additional Capacity	Additional Fuel Compressor Capacity	New Surge Storage Capacity [1]	Additional Scrubber Capacity	Entire System
2 mmscfd	$3,600,000	$5,000,000	$2,000,000	$10,600,000
6 mmscfd	$7,800,000	$15,000,000	$4,700,000	$27,500,000
24 mmscfd	$31,200,000	$60,000,000	$6,000,000	$97,200,000

[1] 24 hours of storage of the specified flow rate.

To provide a more complete understanding of the potential impact of providing an expanded Flare Gas Recovery System, the following additional evaluation has been performed:

- Based on the 2005 BAAQMD inventory, 61.7 mmscf of gases were flared resulting in 25.5 tons of NMHC emissions and 17.6 tons of SO_2 emissions. Emissions of NMHC and SO_2 averaged 0.00083 and 0.00057 lb/scf, respectively, on this basis. Based on the EPA's Compilation of Emission Factors (AP-42), Table 13.5-1, average NO_X and CO emission estimates for flaring are 0.068 and 0.37 lb/MMBtu, respectively. Based on an average heating value for flare gas equal of 1,351 Btu/scf, the average NO_X and CO emission estimates are 0.000092 and 0.00050 lb/scf, respectively. Based on an average PM10 emission estimate of 0.01 lb/MMBtu provided by the BAAQMD and the average heating value listed above, the average PM10 emission estimate is 0.000014 lb/scf.

- The hourly average flaring data have been reviewed for the previous calendar year (2005) leading to the conclusion that, on an annual basis, the addition of 2 mmscfd of additional (unspared) compressor system (including storage and treating) capacity would capture approximately 33 mmscf of gases that were flared. This evaluation has been performed by totalizing the volume of gas currently routed to the flare that could be captured by a system with a flow capacity of 2 mmscfd. Refinery validated hourly data for flow to the North and South Flares were totaled for the evaluation. Flow in excess of the 2 mmscfd rated compressor capacity cannot be recovered by this system. Short duration (less than 1 hour) events have instantaneous flow rates higher than the hourly average, so the use of hourly data overestimate the volume that the system can capture. The accuracy of the cost/benefit analysis could be improved by using data averaged over a shorter time period (e.g., minutes instead of hours).

- A similar evaluation has been performed to determine the impact of adding 6 mmscfd and 24 mmscfd of additional Flare Gas Recovery

System capacity. This would result in the capture of an additional 59 and 72 mmscf of flared gases on an annual basis respectively.

- Applying the average pounds of NMHC emitted per scf of flared gas to the identified reduction in flared gas volumes, the estimated reduction in NMHC emissions that could be achieved was estimated to be 13.7 tpy for 2 mmscfd additional Flare Gas Recovery System capacity, and 24.5 tpy for 6 mmscfd additional Flare Gas Recovery System capacity, and 29.9 for 24 mmscfd additional capacity.
- A similar evaluation has been performed to determine the estimated reduction in emissions of the other pollutants for each of the additional Flare Gas Recovery System capacities.
- A factor that severely limits the reduction in emissions such a recovery system would achieve in practice is the capability of the fuel gas consumers to accept these gases at the time at which they are generated (from both a volume and quality perspective). The gas storage system which has been specified for each option is necessary if the improvements in flare gas recovery shown are to be realized.

In order to capture the gas associated with the type of longer duration flaring event that accounts for most emissions from the flares on an annual average basis, a very large capacity for flare gas compression and storage is needed. The third case presented, for a system with a capacity of 24 mmscfd, reflects what would be needed for control for this type of event. The system as proposed makes use of 6 flare gas compression systems at 4 mmscfd, each feeding one of 24 60-foot diameter storage spheres. The increase in treatment capacity is limited to 8 mmscfd, as flare gas would be stored prior to treatment and worked off through a treater at a gradual rate in line with the ability of the Fuel Gas Unit to accept it.

Based on this review the Benicia Refinery has concluded that further expansion of systems for the recovery, treatment and use of flared gases is not the most feasible and cost-effective approach to reducing these emissions. The Benicia Refinery has concluded that the major source of flared gases on a volume basis can be attributed to large flow rate flaring events, especially those of extended duration such as may occur during emergency events or prolonged shutdowns where systems within the refinery are out of fuel gas (and/or hydrogen) balance.

An evaluation of the cost-effectiveness of reducing emissions through a major Flare Gas Recovery System expansion is summarized in Table 14 based on the evaluations presented above for NMHC emissions. The capital cost investment has been converted to an annual basis based on BAAQMD guidelines for calculation of cost-effectiveness for Best Available Control Technology (BACT).

Table 14
Summary of Estimated Cost Effectiveness for Flare Gas Recovery System Expansion Based on NMHC Emissions

Additional Capacity, mmscfd	System Expansion Estimated Cost	Annualized Cost per BAAQMD Guidelines	Estimated Emissions Reduction, tpy	Estimated Cost Effectiveness, $/ton
2	$10,600,000	$2,700,000	13.7	$200,000
6	$27,500,000	$7,050,000	24.5	$300,000
24	$97,200,000	$25,050,000	29.9	$800,000

Table 14 shows that each of these approaches is not cost-effective. Similarly, Table 15 shows that these approaches are even less cost-effective for emissions of SO_2, NO_X, CO and PM10. In fact, these approaches are more than an order of magnitude less cost-effective than the typical thresholds used by the BAAQMD. Rather than investing further capital into equipment into a cost ineffective expansion which can only infrequently recover gases, the Benicia Refinery has allocated significant resources to the development of procedures to plan for, manage, and minimize the frequency and magnitude of large flow and duration flaring events. Further resources have also been allocated effectively to ongoing preventive maintenance programs, and to further adjust refinery operations on a severity and throughput basis. These approaches have been identified to be more cost-effective, practical, and feasible than providing additional flare gas recovery capacity.

Table 15
Summary of Estimated Cost Effectiveness for Flare Gas Recovery System Expansion Based on Emissions of SO_2, NO_X, CO, and PM10

Pollutant	Additional Capacity, mmscfd	Estimated Emissions Reduction, tpy	Estimated Cost Effectiveness, $/ton
SO_2	2	9.4	$300,000
	6	16.8	$400,000
	24	20.5	$1,200,000
NO_X	2	1.5	$1,800,000
	6	2.7	$2,600,000
	24	3.3	$7,600,000
CO	2	8.2	$300,000
	6	14.8	$500,000
	24	18.0	$1,400,000
PM10	2	0.2	$12,000,000
	6	0.4	$18,000,000
	24	0.5	$52,000,000

5.3 Prevention Measures – Equipment Failure and Malfunctions

As discussed in Section 1.6.3, equipment failure and malfunction including process upsets can result in flaring. Typically, these failures, malfunctions and upsets are not recurrent and, as such, are considered to be emergency conditions as defined by Regulation 12-12-201. Preventative maintenance that minimizes equipment failure is the best prevention measure for the minimization of flaring caused equipment failure. The Benicia Refinery has developed and implemented a preventative maintenance program that minimizes the chance of recurrent failure.

5.3.1 Benicia Refinery Preventative Maintenance

The preventive maintenance program at the Benicia Refinery is a key component of the refinery's flare minimization process. The Benicia Refinery has a progressive preventive maintenance program which reduces the frequency and magnitude of equipment failures and malfunctions that can cause unplanned shutdown events that often result in flaring. There are both environmental and financial incentives for a thorough preventative maintenance program because unplanned shutdowns typically result in both production losses and flaring.

In 2004-2005, the refinery conducted a third-party, site-wide reliability assessment to identify opportunities for equipment reliability improvements. This study not only looked at the reliability of rotating and other mechanical equipment, but also assessed technical issues such as rates of corrosion and the preferred metallurgy of key system components throughout the facility.

The results of this review revealed that the reliability of the refinery's rotating equipment and compressors is, in general, excellent. For critical un-spared rotating equipment, which can be a cause of gas flow to the Flare Gas Header if an unplanned shutdown occurs, the review showed that the refinery strives for and achieves high operating reliability. This program is closely aligned with the flare minimization process. Quarterly indicators are tracked to ensure this excellent reliability is maintained and improved when opportunities are identified.

The equipment maintenance program has been implemented with the assistance of a third-party expert, Becht Engineering, with recognized expertise in equipment reliability and maintenance systems. Becht Engineering assisted in the development and implementation of written protocols and procedures. In addition to mechanical and rotating equipment, the plant's philosophy for reliability and maintenance excellence also includes other support systems, such as electrical, instrumentation, and process control systems and components.

5.3.2 Recurrent Failure

As defined by Regulation 12-12-401.4.3, a failure is considered to be recurrent if it occurs more than twice during any five year period as the result of the same cause. Over the past five years, there has been no reportable flaring events (i.e., greater than 0.5 mmscfd) at the Benicia Refinery as a result of a recurrent failure, malfunction, or upset. The preventative maintenance program described in the previous section is designed to minimize the chances of repeat failures, malfunctions, and upsets. However, if a failure, malfunction or upset does occur at the Benicia Refinery, a concerted effort is made to reduce the likelihood of a repeat event with the same cause. If repeat failures are sufficiently minimized, "recurrent" failures become unlikely.

Existing maintenance schedules and protocols implemented by the Benicia refinery are sufficient to minimize the likelihood of recurrent failure. This is demonstrated by the fact that over the past five years, there have been no recurrent failures that have resulted in reportable flaring events. As shown in Figure 4, if a recurrent failure causes a reportable flaring event, the Benicia Refinery's flare minimization efforts would include a thorough evaluation of the adequacy of maintenance schedules and protocols. With respect to flare minimization, it should be noted that effective preventative maintenance is more important than frequent preventative maintenance because many maintenance activities in and of themselves create flaring.

The Benicia Refinery has not had a recurrent failure as defined by the Regulation 12-12-401.4.3. However, on June 3 and 6, 2002, the refinery suffered two significant power disruptions that resulted in significant flaring. A substantial and thorough internal investigation was conducted that ultimately determined the root cause to be inadequate commissioning procedures for a portion of the electrical equipment associated with the startup of the new COGEN plant. Based on the results of this investigation, commissioning procedures for all of the COGEN electrical equipment were redone and verified. As a result, since that time there has not been a similar failure and subsequent flaring event. Failure investigation and implementation of subsequent corrective action are important steps that are routinely taken by the Benicia Refinery to prevent recurrent failure and the potential flaring that may result.

5.4 Prevention Measures – Use of Production Cuts to Minimize Flaring

The Benicia Refinery routinely adjusts unit operating conditions, including cuts to production rates in an effort to minimize or eliminate flaring associated with maintenance activities, fuel gas quantity, and equipment failure and malfunction. As such, unit adjustments and production cuts have not been evaluated in Sections 5.1 through 5.3 to determine if they are a feasible prevention measure to be considered for future implementation at the Benicia Refinery (i.e., unit adjustments and production cuts are already implemented).

At the Benicia Refinery, when there is a fuel gas imbalance, flaring can be minimized or eliminated by first adjusting operating conditions and then, if needed, by cutting production rates at the FCCU and/or CKR which produce about 70 percent of the refinery's fuel gas. FCCU and/or CKR unit adjustments and production cuts result in the most significant flare minimization at the Benicia Refinery. A fuel gas imbalance can be caused by maintenance activities (e.g., shutdown of fuel gas consumers and/or production of additional fuel gas from off-spec products), non-typical refinery operating conditions (e.g., an increase in fuel gas quantity on hot days), and equipment failure and malfunction (e.g., sudden loss of a fuel gas consumer such as COGEN).

There are limitations on the use of FCCU and CKR unit adjustments and production cuts. When controlled unit adjustments and production cuts are made, it can take up to an hour or more to see measurable reductions in fuel gas production rate. Therefore, unit adjustments and production cuts may not be an appropriate response for a short-term fuel gas imbalance unless the imbalance can be anticipated in advance. The extent to which the FCCU and CKR unit adjustments and production cuts can be made is also limited. Specified operating ranges and minimum production rates are required to maintain stable operation and avoid significant flaring that would be caused by unstable operation (or complete shutdown) of the FCCU or CKR including upstream and downstream process units.

Process unit adjustments and production cuts at process units other than the FCCU and CKR are also used to minimize or eliminate flaring. During unit startup, when off-spec products are produced, the unit's reduced production rates minimize the quantity of off-spec products that are sent to the Flare Gas Header. Additionally, during major equipment failure or malfunction, unit adjustments and production cuts at multiple refinery units are often needed to stabilize refinery operations and minimize flaring.

Unit adjustments and production rate cuts have no impact on certain flaring events. For example, these approaches will not reduce flaring caused by fuel gas quality issues, such as high nitrogen and hydrogen, when the gases in the Flare Gas Header are flared instead of being compressed and sent to the Fuel Gas Unit.

APPENDIX A: ACRONYMS

ALKY	Alkylation Unit
BAAQMD	Bay Area Air Quality Management District
BAP	Benicia Asphalt Plant
BPD	Barrels Per Day
Btu	British Thermal Unit (a unit of energy)
CFHU	Cat Feed Hydrofining Unit (Hydrotreating)
CKR	Fluid Coking Unit
CLE	Cat Light Ends (Gas Plant)
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COGEN	Cogeneration Plant (produces electric power and steam)
DHF	Diesel Hydrofining Unit (Hydrotreating; located at PS)
DIM	Dimersol Unit
^{o}F	Degrees Fahrenheit
FCCU	Fluid Catalytic Cracking Unit (Cat Unit)
FG	Fuel Gas Unit
FMP	Flare Minimization Plan
H_2	Hydrogen
H_2S	Hydrogen Sulfide
H2U	Hydrogen Unit
HCNHF	Heavy Cat Naphtha Hydrofining Unit (Hydrotreating; located at CLE)
HCU	Hydrocracker Unit
HPFG	High Pressure Fuel Gas
HPTG	High Pressure Tail Gas
ID	Inside diameter
JHF	Jet Hydrofining Unit (Hydrotreating; located at PS)
KO	Knockout
lb/day	Pounds per day
LCO	Light Cycle Oil
LCNHF	Light Cat Naphtha Hydrofining Unit (Hydrotreating; located at MRU)
LPFG	Low Pressure Fuel Gas
LPTG	Low Pressure Tail Gas
MMBtu/hr	Million British Thermal Units Per Hour
mmscfd	Million Standard Cubic Feet Per Day
MRU	Motor Gasoline Reformulation Unit (Clean Fuels Unit)
MTBE	MTBE Unit (this unit is shutdown, but a portion of the unit is used by ALKY)
N_2	Nitrogen
NMHC	Non-methane Hydrocarbons
NO_X	Nitrogen Oxides
NRU	Catalytic Naphtha Reforming Unit

APPENDIX A: ACRONYMS

(Continued)

OMS	Oil Movements (Tank Farms and Blending)
PM10	Respirable Particulate Matter (< 10 micron diameter)
PRDs	Pressure Relief Devices
PS	Pipestill (Crude Unit)
psig	Pounds Per Square Inch, Gauge
scf	Standard Cubit Feet
scfm	Standard Cubic Feet Per Minute
SGU	Sulfur Gas Unit (Sulfur Recovery Unit)
SO_2	Sulfur Dioxide
TGU	Tail Gas Unit (SGU Tail Gas/Flexsorb Unit)
tpy	tons per year
ULSD	Ultra Low Sulfur Diesel Unit (Hydrotreating)
UTIL	Utilities Unit
VLE	Virgin Light Ends (Gas Plant)
VNHF	Virgin Naphtha Hydrofining (Hydrotreating; located at PS)
WWT	Wastewater Treatment Plant

APPENDIX B: PROCESS FLOW DIAGRAMS

The following drawings are included in this appendix:

36-000-03E-73503 – Refinery Flare Gas Recovery System

36-000-03E-73504 –Acid Gas Flare

Appendix B of this FMP contains refinery confidential information and are trade secrets and confidential business information (CBI) of Valero Refining Company – California (Valero) as defined by the California Public Records Act, Government Code Section 6254.7 et seq., and the Freedom of Information Act, 40 CFR Part 2 (40 CFR §2.105(a)(4)), 5 USC 552(b)(4), and 18 USC 1905. Because of the sensitive and competitive nature of the information, Valero requests that the BAAQMD afford the information CBI status and treatment indefinitely. The content of Appendix B in the public version of this FMP has been redacted. A complete copy of the FMP, including Appendix B, is included in the CBI version of the FMP provided to the BAAQMD.

APPENDIX C: PIPING AND INSTRUMENTATION DIAGRAMS

The following drawings are included in this appendix:

112-KE-31 – Fuel Gas, Fuel Oil, Flare, Close Drain & Clearing Facilities (H-Header) Distribution (D-2101 Liquid KO Drum)

114-KE-9 – Safety Facilities (D-2103 & D-2104 Liquid KO Drums)

116-KE-12 – Compressor Row Safety Facilities (D-2102 & D-2113 Liquid KO Drums)

117-KE-4B – Utility Distribution Flare System & Mist Oil (D-2107 SGU Liquid KO Drum)

122-KE-2 – Fuel Gas Scrubbing and Compression (T-1201 Fuel Gas Treatment Scrubber)

131-KE-M2 – Avenue "H" Pipeway; Interconnecting Lines (Sampler Tie-Ins)

131-KE-G1B – South Flare & OM&S Pipeway Interconnecting Lines (Ultrasonic Flow Meter, South Flare)

131-KE-G2B – South Flare, Sulfur Storage & OM&S Pipeway Interconnecting Lines (Ultrasonic Flow Meter, Acid Gas Flare)

131-KE-21B – Pipeway; Upper Level Interconnecting Lines (Ultrasonic Flow Meter, North Flare)

136-KE-7 – South Flare System (South Flare, D-2105 Water Seal Drum, Acid Gas Flare, D-2106 Water Seal Drum, & D-2108 Liquid Accumulator Drum)

136-KD-7A – South Flare System at Flare Gas Compressors (Flare Line Tie-Ins)

136-KD-7B – South Flare System Automated Flare Sampling System

136-KD-7C – South Flare System IGN-2101 Flare Pilot Igniter (South Flare & Acid Gas Flare)

136-KE-8 – North Flare Facilities (North Flare & D-2112 water Seal Drum)

36-000-03E-03537 – C-2101 A Flare Gas Compressor Process & CTW

36-000-03E-09060 – C-2101 B Flare Gas Compressors

36-000-03E-09061 – C-2101 A/B Flare Gas Compressors

43-000-03D-17468 – MTBE Production Facilities Flare Blowdown Drum (D-2131 Liquid KO Drum)

44-000-03D-30869 – MRU Blowdown Drum, Slop Oil Pumpout Pumps & Blowdown Cooler (D-2130 Liquid KO Drum)

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