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Final Report
Valdez Marine Terminal
Marine Vapor Control Project

RFP Number 629.97.1
Vapor Control Technology and Maintenance Review

Prepared for:

Prince William Sound
Regional Citizens' Advisory Council

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1. Executive Summary

The Vapor Recovery System (VRS) at the Valdez Marine Terminal (VMT) consists of two main parts: the storage tank VRS and the marine vessel VRS. The storage tank VRS has been in place since the VMT was constructed in the 1970s. The marine vessel VRS began operation in December 1997 and was installed to meet the requirements of 40 CFR 63, Subpart Y, "National Emission Standards for Marine Tank Vessel Loading Operations," issued by the USEPA on September 18, 1995. The purpose of the storage tank VRS is to minimize emissions from the VMT's 18 crude oil storage tanks and to prevent oxygen intrusion into these tanks. The storage tank VRS maintains internal tank pressure at slightly above atmospheric by providing blanket gas to, and collecting vent gas from, each of the crude oil storage tanks. The marine vessel VRS recovers vent gas from marine tanker vessels as they load crude oil at Berths 4 and 5 and transports these vapors to the existing storage tank VRS, where the combined vapors are used for vapor balancing of the storage tanks or as fuel in the power plant boilers to reduce fuel oil consumption. Excess vapors are burned as waste gas in the plant incinerators.

The project team of Sierra Research and Robert Brown Engineers collected and reviewed a large volume of information regarding (1) the quantities of hydrocarbon emissions from the marine vessel loading operations and storage tanks at the VMT; (2) the design and construction of the marine vessel VRS; and (3) the existing and proposed maintenance programs for the marine vessel VRS and storage tank VRS. The project team also conducted three site visits to collect information and review the vapor control system design and construction. The team also observed the initial performance test for the marine vessel VRS.

VMT Emissions

The marine vessel VRS has reduced emissions of hazardous air pollutants (HAP) and volatile organic compounds (VOC) from the VMT. Emissions from the loading of marine vessels will be reduced by about a factor of 10 for the period 1998 through 2005, as compared with historic levels. The project team also estimated current controlled VOC emissions from the storage tank VRS to be about 650 tons per year.

Design and Construction

The project team performed a construction audit of the Berth 4 vapor recovery system, evaluated the quality of design, materials, and construction for the marine vessel VRS, and reviewed operating procedures and safety features for the marine vessel VRS. The Berth 4 audit compared the berth Piping and Instrumentation Diagrams (P&IDs) to the actual installed equipment at Berth 4. Four P&IDs were "as built" checked to verify the

installation as per the design drawings. The audit noted no significant discrepancies between the design on the P&IDs versus the installed equipment at Berth 4. However, the project team recommends that the Alyeska Pipeline Service Company (APSC) perform an "as built" check of the entire marine vessel VRS and either install any missing components or update the P&IDs to reflect the installation as necessary.

A representative sample of construction documents was reviewed for specific areas of the marine vessel VRS. Welding procedures, non-destructive testing results, and quality assurance and quality control documents were reviewed for Berth 5 piping, the multi-cyclone separators, and compressor discharge piping. Overall, the construction documents were complete and in good order. However, some minor discrepancies, inconsistencies, and concerns were discovered during the review and communicated to APSC. APSC subsequently corrected these discrepancies.

The team reviewed the start-up and operating procedures for the Tanker Vapor Recovery and Control System and found these procedures to be adequate and readily available to operating personnel. The team observed several vessel loading events and noted that the marine vessel VRS operating procedures were being closely followed by operating personnel.

Marine Vessel VRS Corrosion Protection

APSC has selected duplex stainless steel for the ship vapor piping from the ship up to and including the cyclone separators (immediately upstream of the compressor suction). Extensive testing has shown that duplex stainless steel is resistive to corrosion in the ship flue gas (tanker vapor) environment. Corrosion testing also indicated the need for a higher chrome content in the weld material, so APSC used 25% chrome stainless weld rod (duplex steel is 22% chrome).

The cyclone separators are designed to remove virtually all entrained liquids from the tanker vapor stream, resulting in vapors that are essentially chloride free. The piping and equipment downstream of the cyclone separators are predominantly 316L stainless steel, which is susceptible to chloride stress corrosion cracking, even at low temperatures. The presence of just a few ppm of chlorides is detrimental to 316L stainless steel, making it very important that the cyclone separators operate efficiently. Any chloride that may get past the cyclone separators will show up in the liquid that accumulates in the compressor discharge knock-out drums. Also, if the compressor discharge liquid has a very low pH, this would indicate the presence of excessive SO_2 in the ship vapors. This SO_2 could eventually attack the remaining carbon steel low-pressure piping system if it were to pass through the VMT storage tanks as blanket gas and condense in the low-pressure piping. Therefore, the project team recommends that APSC periodically collect liquid samples from the compressor discharge knock-out drums and analyze the samples for chlorides and pH.

Storage Tank VRS High- and Low-Pressure Piping

The high-pressure piping system carries vapors from the vapor recovery compressor discharge to the crude oil storage tanks. The low-pressure piping system carries vapors from the storage tanks to the compressor suction. APSC's primary means of corrosion control for the existing vapor recovery piping system has been the replacement of carbon steel piping with corrosion-resistant 316L stainless steel material. All of the high-pressure piping in the existing vapor recovery system has been replaced with 316L stainless steel, with the exception of 200 feet of piping in a seldom-used bypass line and several short riser piping sections immediately upstream of the incinerators. This remaining high-pressure piping has exhibited little corrosion in the past, and can be easily isolated while the vapor recovery system is operating if corrosion should become a problem in the future.

We expect that this new stainless steel piping should resolve the history of corrosion problems that have occurred in the high-pressure piping system. However, the new stainless steel piping should be monitored regularly for corrosion, and the performance of the multi-cyclone separators should be closely monitored (by testing the compressor discharge knock-out drum liquid for chloride content) to prevent chlorides from entering the high-pressure system.

Only the low-pressure piping between the boiler flue gas coolers and the compressor suction has been replaced with 316L stainless steel. The remaining low-pressure vapor recovery piping has shown some signs of deterioration. However, APSC made a decision not to replace approximately 1,100 feet of low-pressure piping that was originally identified for replacement, based upon the historically lower corrosion rate for the low-pressure piping. The team recommends that APSC closely monitor the corrosion rate in the low-pressure piping system in accordance with APSC specifications and, further, that APSC propose appropriate monitoring frequencies in its Operation and Maintenance Plan (prepared pursuant to Section 63.562(e) of the Marine Vessel Loading Rule) to prevent corrosion penetrations and subsequent intrusion of air into the low-pressure piping system.

Safety

Safety-related documents for the marine vessel VRS and storage tank VRS were reviewed to ensure that both systems were adequately designed and that all mitigating measures addressing safety, environmental issues, and operations from the system Process Hazard Analyses (PHAs) and Risk Assessments have been implemented. The review of these documents continued throughout the project. The team confirmed during the July 1998 site visit that all outstanding mitigating measures from the PHAs and risk assessments were addressed and implemented.

On March 25, 1998, an inadvertent activation of the Fenwal automatic fast-acting valve (AFAV) occurred at Berth 5. On July 24, 1998, a scheduled preventive maintenance check determined that the AFAV at Berth 5 would not stroke as required. The valve was subsequently removed and taken to the maintenance shop for analysis and repair, and the Berth 5 vapor recovery system was taken out of service. The project team was on-site during the week of July 27, 1998, shortly after the failure. A project team member attended the APSC maintenance meeting concerning the status and schedule for repair of the AFAV, and also inspected the removed and disassembled AFAV.

APSC published a Root Cause Analysis addressing the AFAV failure, which determined that corrosion and paste resulting from the combination of sodium bicarbonate with hydrocarbon condensate between the valve body and the valve gate caused the gate to be tightly bound in an open position. The sodium bicarbonate extinguishing agent had been in the system since the inadvertent discharge on March 25, 1998. Although the valve gate was anodized and Teflon impregnated, it suffered rapid corrosion in the four-month period since the discharge, as evidenced by pitting found after the cleaning. APSC is implementing new maintenance and operating procedures, including more frequent stroking of the AFAV, to prevent this event from occurring again in the future. The measures proposed by APSC appear to be adequate to prevent similar failures of the AFAV. However, APSC should also include, as part of its Operation and Maintenance Plan, a specific schedule of valve function checks and AFAV stroking that is acceptable to the United States Coast Guard. The quarterly function checks originally required by the manufacturer appear to be inadequate to address this AFAV failure mechanism.

Preventive Maintenance Programs

In its April 28, 1997 VMT Facility Inspection Report, the Alaska Department of Environmental Conservation (ADEC) noted that APSC deferred preventive maintenance on its storage tank pressure sensors, boiler opacity monitors, waste gas heat content monitor, and marine vessel VRS oxygen analyzers during 1996. APSC explained in its July 18, 1997 response that the deferred maintenance was due to the installation of a new Acomputer based integrated maintenance management system,@ called the APassport@ system, for tracking and reporting of maintenance activities. Apparently the transition between the old system and the new Passport system resulted in some delays in

preventive maintenance activities. The project team recommends that preventive maintenance procedures for the storage tank pressure sensors, waste gas heat content analyzer, oxygen analyzers, and storage tank P/V valves should be included in the Operation and Maintenance Plan prepared pursuant to Section 63.562(e) of EPA's Marine Vessel Loading Rule. The provisions of the plan would become enforceable under the EPA rule, and would require strict adherence by APSC. The plan should place special emphasis on identifying and resolving operation and maintenance problems associated with the storage tank P/V valves, and should require that records be kept of all preventive maintenance activities.

During the July 1998 site visit, the audit team requested preventive maintenance records for 59 instruments randomly selected from marine vessel VRS P&IDs. Only 20 items were located in APSC's preventive maintenance computer database. This sampling indicated that APSC did not have an adequate preventive maintenance database of all safety and operational components and that significant effort was required to complete the database. However, APSC subsequently conducted a more thorough review of its computer database and, on October 27, 1998, APSC provided most of the requested preventive maintenance data (three identified instruments were determined not to be on a preventive maintenance schedule). Since the team was able to review only a small sample of preventive maintenance records representing less than 1% of the total marine vessel VRS safety, environmental, and operating instruments, it is recommended that APSC verify that preventive maintenance data for the entire marine vessel VRS is easily accessible on its computer database.

Corrosion Monitoring

The corrosion monitoring and control program for the existing storage tank vapor control system high- and low-pressure piping includes a combination of annual Ultrasonic Testing, Real-Time Radiography, Conventional Radiographic Testing, and Internal Video Inspection. This current corrosion monitoring program is based on APSC Master Specification B-513, ATerminal Vapor Recovery System Pipe Investigation Specification.@ The project team recommends that, in addition to the current Specification B-513 corrosion monitoring program, APSC should periodically monitor the pH of the condensate collected in the low-pressure piping system, and may need to monitor the SO_2 content of the collected ship vapors if warranted by increased corrosion rates or low pH data. APSC should propose a monitoring frequency in its Operation and Maintenance Plan prepared pursuant to Section 63.562(e) of the Marine Vessel Loading Rule. APSC should focus its corrosion monitoring efforts on any low-pressure piping that has shown corrosion in past inspections, and should identify these Aservice legs@ in its Operation and Maintenance Plan. Finally, APSC should continue treating boiler flue gas from its on-site boilers in the existing SO_2 scrubbers using chloride free caustic. This will reduce the contribution of acidic vapors from the boiler flue gas and thereby reduce the potential for a corrosive environment in the low-pressure piping system.

Operation and Maintenance Plan

Section 63.562(e) of the Marine Vessel Loading Rule requires that APSC develop and implement an operation and maintenance plan by the compliance date for the VMT (March 19, 1998). We believe APSC's operation and maintenance plan is inadequate, that APSC has interpreted the requirements of Section 63.562(e) too narrowly, and that the plan should include operation and maintenance requirements for the entire marine terminal and storage tank vapor recovery systems. We recommend that ADEC, which has been delegated authority to implement the Marine Vessel Loading Rule, review the requirements of Section 562(e) and APSC's Operation and Maintenance Plan, and find the plan inadequate for failing to provide adequate procedures for correcting a variance of all air pollution control equipment associated with the marine vessel VRS and the storage tank VRS pursuant to Section 63.152(e)(3)(iii). Alternatively, ADEC should request copies of all relevant operation and maintenance requirements associated with the marine vessel VRS and storage tank VRS, and use these documents to determine compliance pursuant to Section 63.562(e)(1).

Leak Inspection and Monitoring

Section 63.563(c) of the Marine Vessel Loading Rule requires inspection and monitoring of all duct work and piping and connections to vapor collection systems and control devices once each calendar year; that any potential leak discovered by visual, audible, olfactory, or any other detection method be monitored within five days; and that a first effort to repair any leak detected be made within 15 days or prior to the next marine vessel loading operation, whichever is later. The Project Team believes that APSC should be required to comply with these leak inspection provisions for both the new marine vessel VRS and existing storage tank VRS. APSC has asserted that the piping to the storage tanks is subject to the inspection and monitoring requirements of the Marine Vessel Loading Rule, but that the storage tanks are not. We recommend that ADEC, which has been delegated authority by EPA to implement the Marine Vessel Loading Rule, should strongly advocate that the storage tanks are subject to the Marine Vessel Loading Rule, and should clarify this point with APSC and EPA as soon as possible.

Marine Vessel Loading Rule Compliance

The Marine Vessel Loading Rule generally requires the control of VOC emissions from two loading berths at the VMT beginning March 19, 1998. The rule sets limits on the volume of uncontrolled loading at the VMT, and establishes specific testing, monitoring, notification and record keeping criteria. The most significant compliance concern identified by the project team is the ability of the VMT to comply with the uncontrolled throughput limits in the Marine Vessel Loading Rule without installing vapor control at a third marine vessel loading berth. The Alaska Department of Revenue (DOR) issued its Fall 1998 forecast of crude oil throughput at the VMT on December 1, 1998. This Fall

1998 forecast is projecting throughputs that are much lower than the Fall 1997 forecast, but still slightly higher than the Spring 1994 forecast used to develop the Marine Vessel Loading Rule. The Fall 1998 forecast still indicates that the VMT will exceed the Marine Vessel Loading Rule's uncontrolled throughput limits in the years 2001, 2002, and 2003.

An analysis of APSC's 1998 loading records indicates that the marine vapor control system easily complied with the 1998 uncontrolled throughput limit of 275,000 barrels per day (annual average). However, for the period March 19 through December 31, 1998 (the period that the Marine Vessel Loading Rule was effective), uncontrolled loading exceeded APSC's expectations, and had actual throughput reached the levels anticipated when the Marine Vessel Loading Rule was written, APSC may not have complied with the 1998 uncontrolled throughput limit of 275,000 barrels per day.

Based on the Fall 1998 DOR forecast and our review of 1998 uncontrolled loading activity and berth use data at the VMT, we believe it is unlikely that APSC will be able to comply with the uncontrolled throughput limits in the Marine Vessel Loading Rule in the years 2001 through 2003. APSC should consider construction of a third berth vapor recovery system that can be installed and operational by the year 2001 when uncontrolled crude throughput is expected to exceed Marine Vessel Loading Rule requirements. If APSC waits until it exceeds its throughput limit in late 2001 as currently projected, then it will not have the new system installed and operational until the 2004 calendar year, and will have missed controlling emissions from the third berth during the peak uncontrolled throughput years.

Marine Vessel Loading Rule Compliance Test

APSC conducted a performance test of its waste gas incinerators beginning August 1, 1998, and extending through August 7, 1998. The project team observed the first performance testing run on August 1, 1998; preliminary data taken during the test indicated that the VOC destruction efficiency was exceeding the Marine Vessel Loading Rule requirement of 98%. The team noted that the test was conducted in accordance with Marine Vessel Loading Rule requirements. The final test report, issued on October 1, 1998, indicated that the incinerators were operating in compliance with Marine Vessel Loading Rule requirements.

Storage Tanks

There are 18 crude oil storage tanks at the VMT. Hydrocarbon vapors from these storage tanks are collected in a vapor recovery piping system and commingled with vapors from the marine vessel VRS. This arrangement makes the storage tanks and associated vapor control system an integral part of the marine vessel VRS, and any venting or other VOC release from the storage tank VRS during a marine vessel loading event will result in a reduction in overall control efficiency for the marine vessel VRS. The ADEC Permit to

Operate for these storage tanks allows 850 minutes per year of routine uncontrolled venting from the tank pressure/vacuum valves. This venting could result in a violation of the Marine Vessel Loading Rule. ADEC should address the ability of the marine vessel VRS to comply with the Marine Vessel Loading Rule, and specifically the requirement that captured VOCs be controlled by 98%, during routine venting of the VMT storage tanks.

Report Organization

Following this Executive Summary, Section 2 of this report provides a detailed description of the marine vessel and storage tank vapor recovery systems. Section 3 describes the information collection efforts of the project team. Section 4 then provides emissions data for marine loading activities and storage tanks at the VMT based on the most recent crude production projections. Section 5 includes a review of the design and construction of the vapor recovery system. Section 6 focuses on equipment maintenance and monitoring programs for the vapor recovery system, and Section 7 evaluates the ability of the vapor recovery system to comply with applicable regulations. Recommendations are included with each section, and are summarized in Table 1.

Table 1
Summary of Recommendations
VMT Vapor Control Technology and Maintenance Review

Topic	Recommendation
1. Design and Construction	APSC should perform an "as built" check of the entire marine vessel VRS and either install any missing components or update the P&IDs to reflect the installation as necessary.
2. Corrosion Monitoring	APSC should periodically collect liquid samples from the compressor discharge knock-out drums and analyze the samples for chlorides and pH.
3. Corrosion Protection and Monitoring	The new stainless steel piping for the high-pressure vapor piping system should be monitored regularly for corrosion, and the performance of the multi-cyclone separators should be closely monitored to prevent chlorides from entering the system.
4. Corrosion Protection and Monitoring	APSC should closely monitor corrosion rates in the low-pressure piping system to prevent corrosion penetrations and subsequent intrusion of air into the system. APSC should focus its corrosion monitoring efforts on any low-pressure piping that has shown corrosion in past inspections, and should identify these Aservice legs@ in its Operation and Maintenance Plan.
5. Safety	APSC should implement a specific schedule of valve function checks that includes more frequent stroking of the AFAV. The quarterly function checks originally required by the manufacturer appear to be inadequate to address recent AFAV failures.
6. Preventive Maintenance	Preventive maintenance procedures for the storage tank pressure sensors, waste gas heat content analyzer, oxygen analyzers, and storage tank P/V valves should be included in the Operation and Maintenance Plan prepared pursuant to EPA's Marine Vessel Loading Rule.
7. Preventive Maintenance	APSC should verify that preventive maintenance data for the entire marine vessel VRS is accessible on its computer database.
8. Corrosion Protection and Monitoring	APSC should monitor the pH of the condensate collected in the low-pressure piping system, and possibly the SO_2 concentration in the tanker ship vapors. APSC should propose a monitoring frequency in its Operation and Maintenance Plan prepared pursuant to the Marine Vessel Loading Rule.
9. Corrosion	APSC should continue treating boiler flue gas from its on-site boilers in the existing SO_2

Protection	scrubbers using chloride-free caustic.
10. Operation and Maintenance Plan	ADEC should review APSC's Operation and Maintenance Plan, and should find the plan inadequate for failing to identify procedures for correcting a variance of all air pollution control equipment associated with the marine vessel VRS and the storage tank VRS.
11. Insp. And Monitoring	ADEC should determine that the storage tank VRS is subject to the Marine Vessel Loading Rule, and should require that APSC perform leak inspection and monitoring of this system.
12. Marine Vessel Loading Rule Compliance	APSC should consider construction of a third berth vapor recovery system that can be operational by the year 2001 when uncontrolled crude throughput is expected to exceed rule requirements.
13. Marine Vessel Loading Rule Compliance	ADEC should address the ability of the marine vessel VRS to comply with the Marine Vessel Loading Rule during routine venting of the VMT storage tanks.