California Environmental Protection Agency
AIR RESOURCES BOARD

EQUIPMENT AND PROCESS PRECERTIFICATION PROGRAM

EVALUATION OF THE AIR QUALITY PERFORMANCE CLAIMS FOR THE LOKRING™ TECHNOLOGY LOKRING™ FITTINGS

(SS40 STAINLESS STEEL AND MAS-3000 CARBON STEEL SERIES)

JUNE 2000

Equipment:	**Lokring™ Fittings SS40 Stainless Steel and MAS-3000 Carbon Steel Series**
Applicant:	**Lokring™ Technology** 960 Gateway Drive Burlington, Ontario, L7L 5K7 Canada
Applicant Contact:	Mr. David Schatz
Title:	National Technical Manager
Phone Number:	(201) 505-0707
E-mail:	dschatz@wabtec.com
Website:	www.lokring.com
Application Number:	09159801
Executive Order Number:	G-096-029-033
Executive Order Date:	June 12, 2000
Air Resources Board Contact:	Mr. Todd Sterling
Phone Number:	(916) 445-1034
E-mail:	tsterlin@arb.ca.gov
ARB Website:	www.arb.ca.gov
Precertification Website:	www.arb.ca.gov/eqpr/eqpr.htm

ABSTRACT

The purpose of this report is to document the California Air Resources Board's (ARB's) evaluation and verification of the air quality-related claims made by Lokring™ Technology concerning its SS40 Stainless Steel and MAS-3000 Carbon Steel Series Fittings.

In an effort to make progress towards attaining healthy air quality in California, regulations restrict emissions of volatile organic compounds (VOCs) from a broad spectrum of activities. Volatile organic compounds (VOCs) are emitted directly as by-products of combustion-related activities or as emissions from sources such as petro-chemical operations and solvent-containing products. The reduction of VOC emissions from all sources is part of California's clean air strategy to achieve and maintain healthy air quality in California.

As part of its Equipment and Process Precertification (Equipment Precertification) Program application package, Lokring™ Technology requested that the ARB evaluate its proposed performance claim with respect to the fact that Lokring™ fittings control VOC emissions from pipe by forming a metal-to-metal seal without the use of O-rings or other elastometric seals.

Upon successful completion of the requirements associated with the ARB's Equipment Precertification Program, a report is issued with two companion documents— an Executive Order and a certificate. These documents serve as official records that the ARB has independently verified the applicant's performance claims. Executive Orders earned under the ARB's Equipment Precertification Program are valid for three years from the date issued, presuming the holder complies with: 1) the terms and conditions identified in this report; and 2) the general requirements discussed in the Equipment Precertification Program Guidelines and Criteria.

After review of the documents discussed throughout this report, the ARB recommends that a Precertification certificate be issued to the Lokring™ Technology for its SS40 Stainless Steel and MAS-3000 Carbon Steel Series Fittings.

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY
AIR RESOURCES BOARD

EQUIPMENT AND PROCESS
PRECERTIFICATION PROGRAM

EVALUATION OF THE AIR QUALITY PERFORMANCE CLAIMS FOR THE LOKRING™ TECHNOLOGY LOKRING™ FITTINGS

(SS40 Stainless Steel and MAS-3000 Carbon Steel Series)

JUNE 2000

TABLE OF CONTENTS

I. INTRODUCTION

This report discusses the Lokring™ Technology with respect to the design of its Lokring™ fittings SS40 stainless steel and MAS-3000 carbon steel series (Lokring™ fittings), the performance claims to be verified by the Air Resources Board (ARB), the emissions testing results, and the findings and recommendations of the ARB staff concerning this technology.

This report is organized into several sections. The proceeding section, General Information, provides background information on the ARB's Equipment and Process Precertification (Precertification) Program. The next three sections: Summary of Scope; Statement of Claims; and Description of Technology; discuss the breadth of our evaluation, the performance claims, and a detailed description of the Lokring™ fittings.

The following two sections: Technical Evaluation and Evaluation of Claims present detailed information on our technical review and assessment of the Lokring™ fittings. The sections entitled: Quality Management and Environmental and Economic Benefits provide supporting information on the Lokring™ Technology's procedures to produce fittings that meet the company's claims and a brief assessment of the potential environmental and economic impacts of the technology.

Finally, the remaining sections: Recommendations and Precertification Conditions discuss the ARB staff's determination of the performance of the Lokring™ fittings relative to the company's claims. These sections also provide guidance with respect to the specific conditions that must be met for the certificate to remain valid for three years. Appendix A contains a listing of the information that we relied upon to conduct our evaluation. The remaining appendices contain some of the detailed information that supports the evaluation in this report.

II. GENERAL INFORMATION

Under the regulations established for the program, equipment or processes eligible for Precertification must: 1) have an air quality benefit; 2) be commonly-used or have the potential to be commonly-used in the near future (market ready); and 3) not pose a significant potential hazard to public health and safety and the environment. Furthermore, to be eligible, applicants for the program must demonstrate that they have sufficient control over the manufacture of the equipment or process to ensure that they can consistently and reliably produce equipment which performs at least as well as that considered in this evaluation.

A. Equipment Precertification Program Background

The Equipment Precertification Program is a voluntary statewide program for manufacturers of commonly-used equipment or processes. A precondition for entry into the program is that the equipment has an air quality benefit. On June 14, 1996, the ARB adopted section 91400 of the California Code

of Regulations which incorporates the Criteria for Equipment and Process Precertification (Criteria). The regulation and Criteria were approved by the California Office of Administrative Law on October 31, 1996 and became effective on November 30, 1996.

Under the Equipment Precertification Program, manufacturers request that the ARB conduct an independent third-party verification of performance claims which focus on the air quality benefits of its equipment or process. If the claim is verified, the manufacturer is free to refer to the results of the ARB staff's evaluation in its marketing literature. Upon successful completion of the verification process, the ARB staff notifies air pollution control and air quality management districts (Districts) in California of its determination. As a result of the ARB's notification, the Districts have an advanced opportunity to become familiar with the performance of the equipment or process.

On September 8, 1998, the ARB received a request from Lokring™ Technology that the ARB staff determine if Lokring™ fittings were eligible for the Equipment Precertification program. After receiving confirmation from the ARB staff that the Lokring™ fittings were eligible for the program, Lokring™ Technology submitted a Precertification application package on September 15, 1999. As part of our review of the application package, we evaluated the results of emissions testing programs and other information concerning the performance of the Lokring™ fittings to determine whether the claims were verifiable.

B. Relationship to Air Quality

As defined by the ARB and the United States Environmental Protection Agency (U.S. EPA), volatile organic compounds (VOCs) are any compounds containing at least one atom of carbon, except the exempt compounds listed in Appendix B. Volatile organic compounds (VOCs) are emitted directly as by-products of incomplete combustion or as emissions from sources such as petro-chemical operations and solvent-containing products. Through a series of complex reactions, VOCs function as chemical precursors to the formation of tropospheric (ground-level) ozone.

Repeated exposure to ozone may cause permanent damage to the lungs. Even at relatively low concentrations, ozone triggers a variety of health problems including chest pains, coughing, nausea, throat irritation, and congestion. It can also worsen bronchitis, heart disease, emphysema, asthma, and reduce lung capacity. Ozone interferes with the ability of plants to produce and store food, making them more susceptible to disease, insects, and other pollutants.

Districts in California do not require that an air quality permit be obtained prior to the installation of equipment such as Lokring™ fittings. However, Districts do require that air quality permits be obtained for facilities that handle and store hydrocarbons. The reduction of VOC emissions is part

of California's clean air strategy to achieve and maintain healthy air quality in California.

C. Health and Environmental Impacts

As part of our evaluation, staff conducted a cursory review of the potential environmental impacts associated with Lokring™ fittings. Based on this review, we concluded that Lokring™ fittings would not likely present health impacts significantly different from those associated with other fittings that are currently in wide use throughout California. Please note that Lokring™ Technology, its distributors, and/or installers of Lokring™ fittings are required to meet all applicable health and safety standards with respect to the manufacture, installation, and maintenance of Lokring™ fittings.

D. Manufacture/Ownership Rights

The recommendations in this report are contingent upon Lokring™ Technology having the legal rights to produce and/or market Lokring™ fittings. Lokring™ Technology documented its ownership of these rights in its Eligibility Request, received by the ARB on September 8, 1998.

III. SUMMARY OF SCOPE

Lokring™ Technology claims that Lokring™ fittings connect pipe forming a metal-to-metal seal without the use of O-rings or other elastometric seals. The fittings are used to seal pipes transmitting materials such as VOCs. Most VOC emissions resulting from the handling and storage of hydrocarbons are leaks from process equipment and evaporation from open areas. Generally, the control of VOC emissions involves the use of efficient air pollution control equipment (including state-of-the-art fittings), modifying processes, increasing monitoring and inspection frequency, and improving maintenance practices.

IV. STATEMENT OF CLAIMS

The following is the claim verified by ARB staff concerning Lokring™ Technology's Lokring™ fittings. The verification of this claim is predicated on the presumption that Lokring™ fittings are manufactured, installed, and maintained in accordance with the instructions contained in Lokring™ Technology 's LP-105 Installation Procedure.

Lokring™ Technology's Lokring™ SS40 stainless steel and MAS-3000 carbon steel series fittings (1/4 inch through 3 inch) installed on qualified matching pipe (meeting ASTM specifications) have a helium leak rate that is no greater than 1 x 10^{-9} standard cubic centimeters per second which is equivalent to an estimated volatile organic compound emission rate that is no greater than 2.4 x 10^{-12} kilograms per hour (4.6 x 10^{-8} pounds per year).

V. DESCRIPTION OF TECHNOLOGY

Lokring™ fittings are used in refinery, petrochemical, and chemical plant piping systems, and utilities based on manufacturer's specifications. The Lokring™ fittings connect small

diameter piping without threading or welding. Lokring™ fittings are available in various configurations and dimensions. Figure 1 shows a schematic of the various types of Lokring™ fittings including a cross-sectional view of a coupling.

Lokring™ fittings are designed to be used for field fabrication, rapid repair, installation in tight access areas, and tie-ins to shop fabrication piping. The installation of Lokring™ fittings can be completed in six minutes. Lokring™ fittings are installed with hydraulic tooling and form a metal-to-metal seal without the use of O-rings or other elastometric seals. Lokring™ fittings are installed without open flame making them suitable for installations in operating areas where welding is not feasible due to explosive atmospheres as well as environments where the use of a threaded connection is not acceptable.

Lokring™ fittings rely on a patented elastic strain pre-load technology to permanently join small diameter nominal pipe (1/4 inch through 3 inch) without threading or welding. During installation, following insertion of the pipe end into the Lokring™ fittings, hydraulic tooling is used to advance each swage ring axially over the Lokring™ fitting's body, radially compressing (swaging) the Lokring™ fitting's body on to the outside diameter of the pipe. As the pipe is compressed first elastically and then plastically by the swaging action of the Lokring™ fittings, the circumferential sealing lands machined in the bore of the Lokring™ fittings body grip and seal the pipe outer diameter (OD), forming a metal-to-metal seal without the use of O-rings or other elastomeric seals. A detailed description of the installation instructions for Lokring™ fittings is available in its LP-105 Installation Procedure. The Lokring™ Technology requires a qualified or certified pipe fitter (installer) to install Lokring™ fittings.

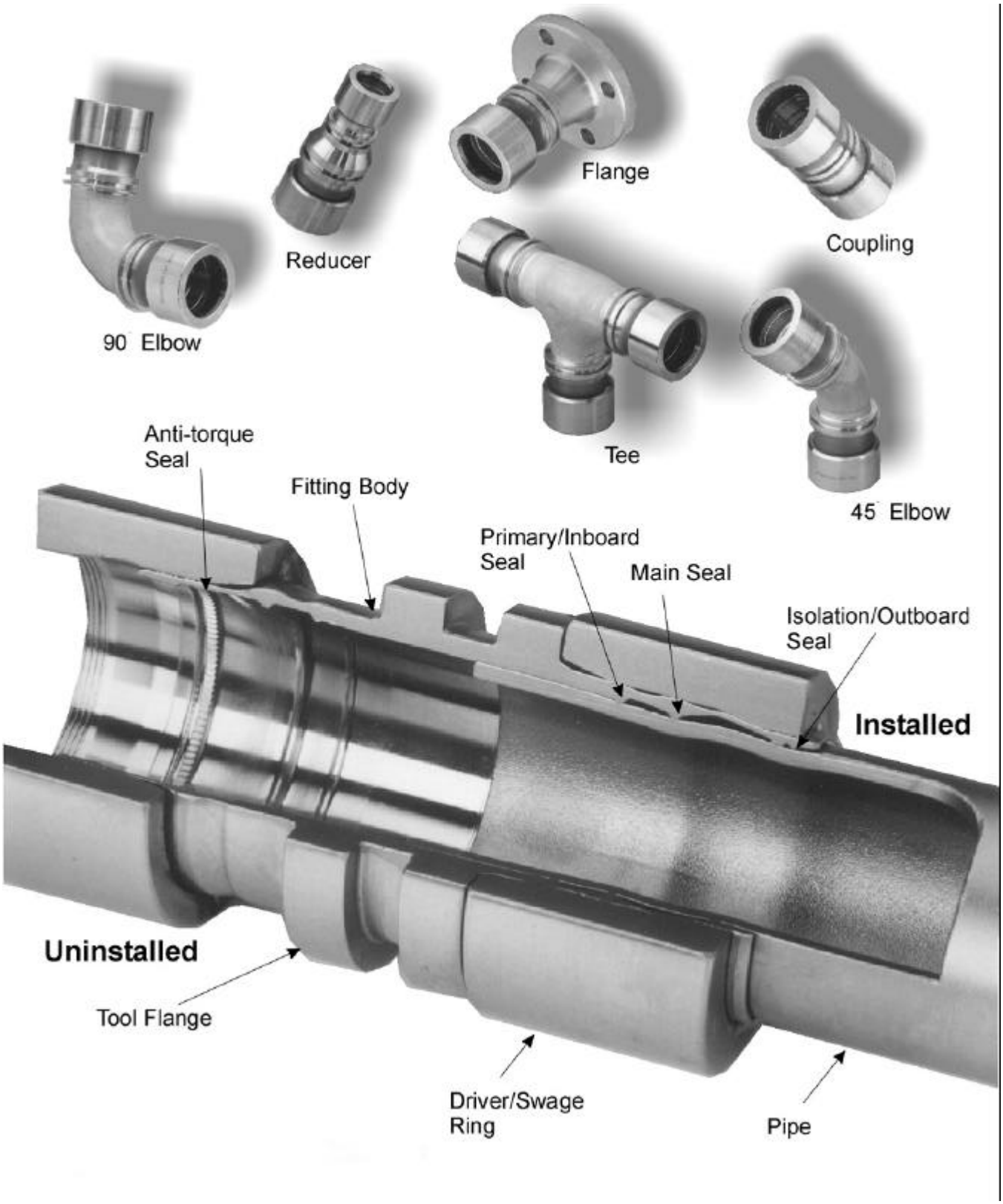
Lokring™ stainless steel couplings and carbon steel repair couplings are designed with a "thru-bore" feature, which permits the coupling to slide completely over the prepared pipe end. This facilitates the repair of existing piping by eliminating the need to "spring" the cut pipe ends apart axially to install the coupling. All stainless steel and carbon steel Lokring™ fittings have an internal shoulder, which acts as a stop for the pipe when the pipe is inserted into the Lokring™ fittings.

Lokring™ carbon steel fittings (MAS-3000 series) are designed for use on carbon steel pipe to ASTM A-106 and A-53. Lokring™ stainless steel fittings (SS40 series) are designed for use on stainless steel pipe to ASTM A-312 and carbon steel pipe to ASTM A-106 and A-53. Specifications are in accordance with the Lokring™ Technology's test plan TP-1190-01.

VI. TECHNICAL EVALUATION

A. Description of Field Testing

Lokring™ fittings were subjected to a battery of accelerated environmental and mechanical tests by Lawrence



Cross-Sectional View of a Coupling

Figure 1 – Types of Lokring™ Fittings

Livermore National Laboratory (LLNL) and Deposition and Leak

Detection Services Inc. (DLDS) in California. Test parameters included burst, bending, fatigue, tensile, torsion, thermal cycling, thermal shock, vibration, corrosion, fire testing and gas leak. The gas leak test evaluated the Lokring™ fittings ability to resist helium leakage from outside to inside (inboard test) and from inside to outside (outboard test).

The gas leak test results were used to estimate a VOC emissions rate for the Lokring™ fittings. The gas leak testing protocol for the Lokring™ fittings employed the U.S. EPA Reference Method 21 in conjunction with the procedure described in the U.S. EPA Protocol for Generating Unit Specific Emissions Estimates for Equipment Leaks for Volatile Organic Compounds and Volatile Hazardous Air Pollutants. Helium was chosen as the test gas because it is one of the lightest commercial gases available. It is an appropriate surrogate for detecting VOC emissions, all of which are heavier.

The inboard test method was in accordance with the requirements of ASTM E498-73. Lokring test samples were placed on a vacuum monitor (mass spectrometer) with the inside of the sample evacuated to approximately $1x10^{-5}$ torr as the helium was introduced from the outside. The system was monitored for five minutes.

The outboard test method was in accordance with the requirements of ASTM E493-73. Lokring samples were internally pressurized with helium gas and placed in a vacuum chamber that was attached to a monitor (mass spectrometer). The internal pressure was 4,500 pounds per square inch (psi). The area inside the chamber was then evacuated to approximately $1x10^{-5}$ torr. The system was monitored for 15 minutes.

LLNL conducted the inboard and outboard tests using 1/2 -inch OD tube, 304 stainless steel Lokring samples. The limit of detection (LOD) of the LLNL mass spectrometer was 1×10^{-9} standard cubic centimeters per second (std cc/sec).

DLDS conducted the inboard and outboard tests using one 1/2 -inch OD tube, 304 stainless steel and one 5/8-inch OD tube, 316L stainless steel Lokring samples. DLDS also conducted both tests on 1/2 -inch and 1-1/2-inch NPS pipe samples. The LOD of the DLDS mass spectrometer was 2×10^{-11} std cc/sec.

B. Description of Test Results

In the positive pressure and vacuum tests, neither LLNL nor DLDS were able to detect helium from the Lokring™ Technology's Lokring™ fittings at the LOD of the mass spectrometers. As shown in Appendix C, the ARB staff used the LODs of the two test results to calculate estimated VOC emission rates for the Lokring™ fittings. Methane was chosen as the surrogate for expressing the VOC emission rate.

Using the LLNL test results (no samples detected at the LOD of 1×10^{-9} std cc/sec), the ARB staff calculated an estimated emission rate of 2.4×10^{-12} kilograms per hour (kg/hr) or 4.6×10^{-8} pound/year (lb/yr). Using the DLDS Inc. test results (no samples detected at the LOD of 2×10^{-11} std cc/sec), the ARB staff calculated an estimated emission rate of 4.8×10^{-14} kg/hr or 9.3×10^{-10} lb/yr. As mentioned previously, DLDS Inc. used a mass spectrometer with a lower LOD to conduct tests than that used by LLNL. Therefore, ARB staff used the LLNL results as a conservative basis for the verification of the Lokring™ Technology's claim.

The estimated VOC emissions calculated using the LODs of the LLNL and DLDS results are well below the existing leak control requirements of Districts in California. For example, the South Coast Air Quality Management District 's Rule 1173 (Fugitive Emissions of VOCs) states that any liquid or gas leak over 50,000 parts per million detected by district inspection shall constitute a violation. The allowable leakage rate is approximately 0.30 kg/hr [5 milliliters per minute (5 ml/min)] based on 50 drops/min (10 drops is approximately 1 ml).

VII. EVALUATION OF CLAIMS

This section presents additional information relating to the claim verified by the ARB as part of this evaluation. The ARB staff verification of this claim is based on the evaluation of the information listed in Appendix A. As stated earlier, the ARB's evaluation and recommendations presented in this report are predicated on the expectation that Lokring™ fittings are manufactured, installed, and maintained in accordance with the instructions contained in Lokring™ Technology's LP-105 Installation Procedure. The claim language is precise because it directly correlates with the supporting documentation included with the application package. Below the claim are supporting comments, which may be used to interpret the significance of the claim verified in this report. To assist the reader, the claim is displayed in bold text.

Lokring™ Technology's Lokring™ SS40 stainless steel and MAS-3000 carbon steel series fittings (1/4 inch through 3 inch) installed on qualified matching pipe (meeting ASTM specifications) have a helium leak rate that is no greater than 1×10^{-9} standard cubic centimeters per second which is equivalent to an estimated volatile organic compound emission rate that is no greater than 2.4×10^{-12} kilograms per hour (4.6×10^{-8} pounds per year).

With respect to VOC emissions, the Lokring™ fittings should be considered to be non-welded, metal-to-metal seals without the use of O-rings or other elastometric seals. The emission rate presented in the claim was estimated assuming that helium is an appropriate testing gas surrogate for VOC emissions. In addition, the LOD (1×10^{-9} std cc/sec) of the LLNL test results was

used as the basis for estimating the emission rate for the Lokring fittings of 2.4 x 10^{-12} kg/hr (4.6 x 10^{-8} lb/yr).

VIII. QUALITY MANAGEMENT

A. Practices and Standards

Lokring™ Technology has extensive quality management practices and standards for its Lokring™ fittings. The standards are described in detail in the Thermo Sealed Castings Ltd. & Unity Machining, Quality Assurance Manual, Revision D, October 22, 1998. Lokring™ fittings quality system is registered to the ISO 9001 and QS 9000 standards. The Manual contains established quality management practices for the following areas:

- Quality System, Contract Review, Design Control, Data Control
- Inspection and Testing, Test Status, Process Control, Product Identification
- Measuring and Testing Equipment, Control of Nonconforming Product
- Corrective and Prevention Action, Handling, Storage, Packaging and Delivery
- Control of Quality Records and Audits, Training and Services
- Statistical Techniques, Sector-specific Requirements
- Customer-specific Requirements

The ARB staff reviewed the Lokring™ Technology's Standard Practice Instructions (SPI 4.1, Rev 03) as a part of the evaluation of the Lokring™ fittings. As a result of the evaluation, ARB staff has determined that the quality management program is sufficiently comprehensive to support precertifying the Lokring™ Technology's Lokring™ fittings.

B. Installation and Maintenance Requirements

The requirement for the installation and maintenance of Lokring™ Technology's Lokring™ fittings are contained in the LP-105 Installation Procedures for Lokring™ Carbon and Stainless Steel Fittings.

The Lokring™ fittings installation equipment consists of a Loktool Kit and a hydraulic power supply. The correct selection and maintenance of Loktool installation tooling is critical to a safe and successful application. The Loktool kits are identified by a simple code, which denotes the enclosed Loktool head, the appropriate fitting series, and pipe sizes for which the tool is to be used. The tool needs to be cycled several times without Lokring™ fittings to assure that quick disconnects are fully secured, and no air is trapped in the system. The power supply needed to install Lokring™ fittings consists of a 15 foot flexible hydraulic hose and one of three 10,000 pounds per square inch (psi) rated hydraulic pumps (electric, pneumatic or manual).

There are three visual inspections performed after installation of Lokring™ fittings: 1) visual verification of installation and inspection marks; 2) verification that the swage ring of the fitting is compressed against the tool flange; and 3) verification that the trailing edge of the fitting body is protruding from underneath the swage ring. After installation and visual inspection, the Lokring™

fittings are system pressure checked according to industry standards such as API or ASME B31.1 and B31. 3, examination, inspection and testing. Typical post installation tests include hydrostatic (water), or pneumatic air/nitrogen, or helium tests to verify successful installation.

C. Other Certifications/Approvals

Lokring™ fittings conform to ASME B31.3 and B31.1 standards utilizing ASTM materials of construction. Lokring™ fittings also comply with standards for the United States Navy, United States Coast Guard, Lloyds of London, and hold a Canadian Registration number (0A0481.987065432YT) which is required by the provinces of Canada prior to installation of Lokring™ fittings in pressure containing systems.

D. Warranties

Lokring™ Technology provides a one-year warranty for its Lokring™ fittings. A copy of the warranty is provided in Appendix D.

IX. ENVIRONMENTAL AND ECONOMIC BENEFITS

As part of our review, we evaluated the potential air quality impacts of Lokring™ fittings. The use of Lokring™ fittings, in accordance with manufacturer's instructions, will control emissions from pipe connections and are at minimum equivalent to a welded fitting with respect to the potential for emissions.

As part of our evaluation, the ARB staff also visited a refinery in Southern California where Lokring™ fittings were installed on "steam" and "condensate" lines. The ARB staff observation under operating conditions indicated that the installed fittings (MAS-3000 carbon steel series) are leak-tight, metal-to-metal seals without the use of O-rings or other elastomeric seals. The ARB staff verified that the installed Lokring™ fittings (3-inch NPS, MAS-3000 carbon steel series) performed successfully in the refinery's "steam" and "condensate" line without any leakage during the site visit. The customer claimed that they were satisfied with the performance of the Lokring™ fittings.

X. RECOMMENDATIONS

After evaluating the information discussed in this report, the ARB staff recommends that Lokring™ fittings be precertified under its Precertification Program. Specifically, we have independently verified the claims of Lokring™ Technology concerning its Lokring™ fittings as presented in the claims section of the report.

By accepting Precertification under the ARB's program, Lokring™ Technology assumes, for the duration of the three-year Precertification period, responsibility for maintaining the quality of the manufactured equipment and materials at a level equal or better than was provided to obtain this Precertification. Precertification under the ARB's program is also contingent on the recipient agreeing to be subject to quality monitoring by the ARB, as provided by law.

The ARB makes no express or implied warranties as to the

performance of the manufacturer's product or equipment. Nor, does the ARB warrant that the manufacturer's product or equipment is free from any defects in workmanship or material caused by negligence, misuse, accident, or other causes. The ARB staff believes, however that Lokring™ Technology's Lokring™ fittings will achieve the performance levels presented in the claims section of this report. Our determination is based on our evaluation of the data submitted by Lokring™ Technology as well as the other information identified in this report. Our recommendations are predicated on the expectation that installation and maintenance are performed in accordance with Lokring™ Technology's LP-105 Installation Procedures.

XI. PRECERTIFICATION CONDITIONS

The recommendations in this report are conditional upon Lokring™ fittings being manufactured, installed, and maintained, in accordance with Lokring™ Technology's instructions for their use, as contained in Lokring™ Technology's LP-105 Installation Procedures. A copy of these instructions must be provided to each installer and user of Lokring™ fittings prior to installation. In order for the Precertification to remain valid, Lokring™ Technology must retain the manufacturing rights for Lokring™ fittings.

APPENDIX A

MATERIALS AVAILABLE FOR EVALUATION

MATERIALS AVAILABLE FOR EVALUATION

1. Request to determine Eligibility for the ARB Equipment Precertification Program from Mr. David Schatz of Lokring™ Technology to Mr. Richard Corey of the ARB transmitting the Eligibility Request Form, September 8, 1998.

2. Letter from Mr. Richard Corey of the ARB to Mr. David Schatz of Lokring™ Technology notifying Lokring™ Technology that the Lokring™ fittings were eligible for the ARB Equipment Precertification Program, and transmitting an estimate of fees required for precertification and an application form, October 6, 1998.

3. Application for the ARB Equipment Precertification Program from Mr. Terry Woods of Lokring™ Technology to Mr. Richard Corey of the ARB, transmitting an application fee and the ARB Precertification Program application (with attached Lokring™ Technology Application Guide: Organizational Information Agreement; Patented or Pending Information; Product Development and Data; Performance Claim and Support Data; Required Documents Design; Mass Balance; Range of Operating Conditions; Permits; Other Certifications; Health and Safety Work; Work Safety Issues; User Manuals; Quality Management Practices; Warranties; Customer References; Lokring™ Technology Sample of Projects and Applications), September 13, 1999.

4. Letter from Mr. Richard Corey of the ARB to Mr. Terry Woods of Lokring™ Technology notifying Lokring™ Technology that the ARB had received its application (with attached Lokring™ Technology Application Guide) and application fee, that its application was sufficiently complete, October 8, 1999.

5. Memorandum from Mr. Raymond E. Menebroker of the ARB's Stationary Source Division to Mr. George Lew of the ARB's Monitoring and Laboratory Division requesting assistance in the evaluation of the testing information for Lokring™ fittings, October 18, 1999.

6. Letter from Mr. Terry Woods of Lokring™ Technology to Ms. Kitty Martin of the ARB, transmitting the revised claim language of Lokring™ fittings, October 21, 1999.

7. Letter from Mr. Richard Corey of the ARB to Mr. Mark Crossman of Lokring™ Technology documenting the ARB staff site visit (October 13, 1999) to a refinery in Southern California to observe installed Lokring™ fittings, October 29, 1999.

8. Memorandum from Mr. George Lew of the ARB's Monitoring and Laboratory Division to Mr. Raymond E. Menebroker of the ARB's Stationary Source

Division commenting on the evaluation of the performance of Lokring™ fittings, November 8, 1999.

9. Fax transmittal from Mr. Al McKay of Lokring™ Technology to Mr. Hafizur Chowdhury of the ARB providing the Lokring™ fittings Test Reports from Lawrence Livermore National Laboratory and Deposition and Leak Detection Services, Inc., January 1, 2000.

10. Letter from Mr. Richard Corey of the ARB to Mr. David Schatz of Lokring™ Technology notifying Lokring™ Technology with an invoice for the final payment, April 28, 2000.

11. Electronic mail transmittal from Mr. Al McKay of Lokring™ Technology to Mr. Hafizur Chowdhury of the ARB providing the updated version of Lokring™ Technology Standard Product Warranty, May 2, 2000.

12. UPS mail delivery by Mr. Andrew Bonnema of Lokring™ Technology to Mr. Hafizur Chowdhury of the ARB providing composite Lokring™ fittings drawing in a Zip Disk, May 8, 2000.

13. Code of Federal Regulations, Title 40, Part 60, Appendix A, Reference Test Method 21, Determination of Volatile Organic Compound Leaks, U.S. Government Printing Office Washington, D.C., June 22, 1990.

14. U.S. EPA Protocol for Generating Unit Specific Emissions Estimates for Equipment Leaks for Volatile Organic Compounds and Volatile Hazardous Air Pollutants (Document 450/3-88-010), 1988.

APPENDIX B

DEFINITION OF VOLATILE ORGANIC COMPOUNDS

DEFINITION OF VOLATILE ORGANIC COMPOUNDS

The United States Environmental Protection Agency and the California Air Resources Board define volatile organic compounds as any compound that contains at least one atom of carbon, except the following exempt compounds.

acetone
ethane
methyl acetate
parachlorobenzotrifluoride (1-chloro-4-trifluoromethyl benzene)
perchloroethylene (tetrachloroethylene)
carbon monoxide
carbon dioxide
carbonic acid
metallic carbides or carbonates
ammonium carbonate
methane
methylene chloride (dichloromethane)
1,1,1-trichloroethane (methyl chloroform)
trichlorofluoromethane (CFC-11)
dichlorodifluoromethane (CFC-12)
1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113)
1,2-dichloro-1,1,2,2-tetrafluoroethane (CFC-114)
chloropentafluoroethane (CFC-115)
chlorodifluoromethane (HCFC-22)
1,1,1-trifluoro-2,2-dichloroethane (HCFC-123)
1,1-dichloro-1-fluoroethane (HCFC-141b)
1-chloro-1,1-difluoroethane (HCFC-142b)
2-chloro-1,1,1,2-tetrafluoroethane (HCFC-124)
trifluoromethane (HCFC-23)
1,1,2,2-tetrafluoroethane (HFC-134)
1,1,1,2-tetrafluorethane (HFC-134a)
pentafluoroethane (HFC-125)
1,1,1-trifluoroethane (HFC-143a)
1,1-difluoroethane (HFC-152a)
cyclic, branched, or linear completely methylated siloxanes
cyclic, branched, or linear, completely fluorinated alkanes
cyclic, branched, or linear, completely fluorinated ethers with no unsaturations
cyclic, branched, or linear, completely fluorinated tertiary amines with no unsaturations
sulfur-containing perfluorocarbons with no unsaturations and with the sulfur bonds to carbon and fluorine

APPENDIX C

VOLATILE ORGANIC COMPOUNDS EMISSIONS CALCULATIONS

VOLATILE ORGANIC COMPOUNDS EMISSIONS CALCULATIONS

Our objective is to calculate the Volatile Organic Compounds (VOCs) emissions based on the limits of detection (LOD) of 2×10^{-11} std cc/sec and 1×10^{-9} std cc/sec of the mass spectrometers of the testing laboratories, Deposition and Leak Detection Services (DLDS) and by Lawrence Livermore National Laboratory (LLNL) in California. Both laboratories conducted leak tests on Lokring™ fittings. Methane (CH_4) was chosen as the surrogate for expressing the VOC emission rate. The calculation is based on standard ambient temperature (20°C). We will use both LODs to calculate the VOC emissions in kilograms per hour (kg/hr) and pounds per year (lb/yr). The following equations will be used for both calculations.

$$\mathbf{VOC_{(kg/hr)} = [E_H / (MV_{@\ std\ cc/sec})] \times (MW_{CH_4}) \times CF \quad \ldots\ldots(1)}$$

$$\mathbf{VOC_{(lb/yr)} = VOC_{(kg/hr)} \times CF \quad \ldots\ldots(2)}$$

Where,

E_H = Emissions of helium = 1×10^{-9} std cc/sec (reported as helium LOD)

MW_{CH_4} = Molecular weight of methane = $(1 \times 12)_C + (1 \times 4)_H$ = 16 g/mole

T = Standard temperature = 20°C

CF = Conversion Factors for converting to kg/hr or to lb/yr

MV = Molar volume at normal conditions = 22.4 L/mole

Therefore,

$MV_{@\ std\ cc/sec}$ = (22.4 L/mole) x [(20 +273)°K / 273°K] x (1000 cc/L)
= 24041.0 std cc/mole

<u>Calculation using Lawrence Livermore National Laboratory's Limit of Detection:</u>

$\mathbf{VOC_{(kg/hr)} = [E_H / (MV_{@\ std\ cc/sec})] \times (MW_{CH_4}) \times CF}$
= (1×10^{-9} std cc/sec) x (mole/24041.0 std cc) x (16 g/mole) x (kg/1000g) x (3600 sec/hr)
= 2.4×10^{-12} kg/hr

$$\mathbf{VOC_{(kg/hr)} = 2.4 \times 10^{-12}\ kg/hr}$$

$\mathbf{VOC_{(lb/yr)} = VOC_{(kg/hr)} \times CF}$
= (2.4×10^{-12} kg/hr) x (8760 hr/yr) x (2.2 lb/kg)
= 4.6×10^{-8} lb/yr

$$\mathbf{VOC_{(lb/yr)} = 4.6 \times 10^{-8}\ lb/yr}$$

<u>Calculation using Deposition and Leak Detection Services Limit of Detection:</u>

In this case, we will use E_H = 2 x 10^{-11} std cc/sec (reported as helium LOD)

VOC $_{(kg/hr)}$ = [E_H / ($MV_{@\ std\ cc/sec}$)] x (MW_{CH_4}) x CF
= (2 x 10^{-11} std cc/sec) x (mole/24041.0 std cc) x (16 g/mole) x (kg/1000g) x (3600 sec/hr)
= 4.8 x 10^{-14} kg/hr

$VOC_{(kg/hr)}$ = 4.8 x 10^{-14} kg/hr

VOC $_{(lb/yr)}$ = VOC $_{(kg/hr)}$ x CF
= (4.8 x 10^{-14} kg/hr) x (8760 hr/yr) x (2.2 lb/kg)
= 9.3 x 10^{-10} lb/yr

$VOC_{(lb/yr)}$ = 9.3 x 10^{-10} lb/yr

APPENDIX D

LOKRING TECHNOLOGY'S WARRANTY

Lokring™
Standard Product Warranty

"Lokring warrants that goods delivered hereunder shall be free from defects in material and workmanship under normal use and service for a period of 1 (one) year from shipment. If during such one (1) year period, (i) Lokring is notified promptly upon discovery of defect in the goods, including a detailed description of such defect, (ii) Lokring is afforded opportunity to inspect such goods at the installation site prior to any attempt to repair or retrofit and if requested to do so, Buyer returns such goods to Lokring for further examination. FOB destination: and (iii) examination of such goods by Lokring determines that such goods were defective and such defects were not caused by accident, abuse, misuse, neglect, alteration, improper installation, repair or alteration at other than the direction of Lokring, improper testing or use contrary to instruction of Lokring, then within a reasonable time Lokring shall at its sole option either repair, replace, or credit the customer for such goods. Any goods replaced under this warranty shall be returned to the customer transportation charges prepaid and Lokring will reimburse the customer for any transportation charges incurred under section (ii) above. The performance of this warranty does not extend the warranty period of any goods beyond the period applicable to the goods originally delivered.

In no event shall Lokring be liable for claims for any other damages whatsoever (whether direct, immediate, foreseeable, consequential, or special) suffered by Buyer or anyone else arising out of any breach by Lokring. This express warranty is in lieu of and excludes all other warranties, guarantees, and/or representations, expressed or implied."
