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Revision Memo

11/03

Initial Release of Design Practice

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SCOPE

This section of Design Practices describes procedures for the selection of piping system components considering worker exposure and environmental impacts. It provides guidelines for reviewing emissions to the environment and procedures for review of designs to select respiratory exposure classes for individual streams. Respiratory exposure classes set specific equipment requirements for emissions control.

REFERENCES

DESIGN PRACTICES

DP II	Design Temperature, Design Pressure and Flange Rating
DP X-G	Pumps, Shaft Sealing
DP XI	Compressors
DP XVIII-A	Guidelines and Considerations for Selection of Air Pollution Control Equipment
DP XVIII-A2	Control of Hydrocarbon, VOC and Air Toxic Emissions
DP XVIII-B	Guidelines for Industrial Hygiene
DP XVIII-B1	Exposure Limits and Toxic Effects

GLOBAL PRACTICES

GP 3-2-7	Manual Sampling Systems
GP 3-6-4	Vents, Drains, Flushing and Cleaning Connections
GP 3-12-1	Valve Selection Criteria
GP 3-16-1	Flanges, Gaskets, Bolting and Fittings
GP 10-1-3	Shaft Sealing Systems for Centrifugal and Rotary Shaft Pumps
GP 15-9-1	Control Valves
GP 15-8-1	Process Stream Analyzers

EXXONMOBIL MANUALS, APPLICATION GUIDES AND REPORTS

TMEE-23	Pump Sealing Technology Manual
TMEE-46	Emissions Estimating Guide
TMEE-61	Leak Detection and Repair (LDAR) Manual
TMEE-82	Safety and Environmental Procedures for Capital Projects
EE.5E-T.83	Verification of an Atmospheric Dispersion Model for Industrial Hygiene Purposes
EE.2E-T.86	Development of a Near-Field Atmospheric Dispersion Equation for Industrial Hygiene Controls
EE.15E.91	Reduction of Fugitive Emissions From Valves and Pumps
EE.69E.91	Reduction of Fugitive Emissions from Valves and Pumps
EE.19E.92	Identification and Abatement of Machinery Fugitive Emissions
EE.32E.92	Five Ring Graphite Packing Systems Effective in Reducing Emissions from Rising Stem Block Valves

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EE.101E.92 Plant Performance Evaluation of Traditional Versus New Low-Emission Control Valve Packings

EE.38E.92 Testing Low-Emission Valve Packings -- Results of PERF Project 90-05

EE.15E.93 Improved Valve Stem Packing Design Criteria and Materials Selection

EE.35E.93 Selection Guide for Storage Tank Emission Controls

MR.19DQ.93 Equipment Selection Matrix for Industrial Hygiene Design Review

ExxonMobil Biomedical Sciences, Inc., 2003 ExxonMobil Occupational Exposure Limits for Chemical Contaminants, (published annually).

ExxonMobil Biomedical Sciences, Inc., Documentation of the ExxonMobil Occupational Exposure Limits for Chemical Contaminants.

EEOP ExxonMobil Chemical Company Environmental Engineering and Operating Practices

OTHER LITERATURE

American Petroleum Institute, Fugitive Emissions from Equipment Leaks I: Monitoring Manual, API Publication 342, May 1998.

Buonicore, A.J. and Davis, W.T., Air Pollution Engineering manual, Eds. Van Nostrand Reinhold, 1992.

Chemical Substances TLV Committee, 2003 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, American Conference of Government Industrial Hygienists, Cincinnati, OH, 2003 (published annually).

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Clayton, G.D. and F.E. Clayton, Eds., Patty's Industrial Hygiene and Toxicology, Wiley, 2000.

DiNardi, S.R., Ed. The Occupational Environment - Its evaluation and Control, AIHA Press, 1998.

Harrison, M.C. and S.C. Phillips. Final OEL for High Boiling Aromatic Oil (HBAO) Streams and Related Materials. October 31, 1997.

Lipton S., and J. Lynch, Health Hazard Control in the Chemical Process Industry. Wiley, 1987.

Patric, D.R., Toxic Air Pollution Handbook, Ed. Van Nostrand Reinhold, 1994.

Paustenbach, D.J. Occupational Exposure Limits, Pharmacokinetics, and Unusual Work Schedules. In Patty's Industrial Hygiene and Toxicology 2nd ed. Volume 3A, L.J. Cralley and L.V. Cralley, Eds. Wiley, New York (1985), pp 111-277.

Society of Tribologists and Lubrication Engineers, Guidelines for Meeting Emission Regulations for Rotating Machinery with Mechanical Seals, SP-30.

Society of Tribologists and Lubrication Engineers Guidelines for Meeting Emission Regulations for Compressors with Advanced Sealing Systems, SP-32.

Society of Tribologists and Lubrication Engineers Guidelines for Controlling Fugitive Emissions with Valve Stem Sealing Systems. SP-33.

U.S. Environmental Protection Agency. Compilation of Air Pollutant Emission Factors (Fourth Edition). EPA AP-42. US Government Printing Office, Washington, DC, 1980.

US EPA Method 21: Determination of Volatile Organic Compound Leaks 40 CFR 60 (Appendix A).

DEFINITIONS

Acute Effects - Sharp, having a rapid onset, with severe symptoms and a relatively short course. Refers to the development of symptoms soon after a single exposure to a substance.

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Acute Exposures - Toxicological reference to a single or repeated exposure within 24 hours exposure to an agent.

Chronic Effects - Effects associated with long-term exposures at relatively low dose levels.

Chronic Exposures - Exposures that occur over long time periods ranging from months to years.

Effect - The response produced due to exposure to a chemical or physical agent.

Exposure - Receiving a dose of a chemical substance or physical agent due to a contact with it.

Hazard - The inherent property of an agent which, if handled improperly, may result in damage to health or well-being.

Industrial Hygiene - The discipline devoted to the anticipation, recognition, evaluation and control of those environmental factors or stresses arising in or from the workplace that may cause sickness, impaired health and well-being, or significant discomfort and inefficiency among workers.

OEL - Occupational Exposure limit. A generic term which represents the allowable concentration for a specific length of exposure.

Response - The reaction of the body to a toxic agent.

Risk - The probability of an adverse effect. A function of the exposure level and potency of a toxic agent.

BACKGROUND

The Emissions Equipment Exposure (EEE) Review is typically conducted prior to release of basic design specifications and its recommendations are used for equipment selection during detailed design. In the review, Industrial Hygiene, Environmental, and Equipment specialists review the stream data including composition and temperature. After the applicable emission limits have been determined for each stream, the Review Coordinator combines all results to determine the strictest (lowest emissions) limit that will be used to control the stream. Designers use these recommendations when preparing basic design specifications.

Industrial Hygiene reviews are required on all new or modified units. These are normally requested by the respective process or design areas and are completed through the Environmental Division or through EMBSI. The EEE Review procedure minimizes the potential for differences in the equipment specified in the IH review, by the equipment specialists, and by the environmental specialists. Representatives from Environmental, Machinery, Mechanical, Instrumentation, and EMBSI have developed a procedure that better coordinates the required input from each technical area earlier.

There is a small cost for performing EEE Reviews. The total cost is about the same or less since the project would ultimately need to receive input from equipment and environmental and the EEE Review procedure eliminates most of the recycle. The EEE reviews eliminate a great deal of iterative effort by getting closure among the experts up front through review and resolution of any conflicting recommendations. Experience with projects is that this review is efficient in that it gets the appropriate technologies together at the same time and issues are resolved faster. In addition, a synergy occurs when a unit is evaluated based on the prior experiences with similar units. The end result is a product suitable to guide the designers in preparation of Design Specifications which contains detailed selection and/or selection guidance for equipment in environmentally sensitive or toxic service.

The review can be conducted as early as the design basis stage if a heat and material balance be available. It usually consists of the following steps:

1. Preliminary review by an industrial hygienist and a toxicologist to identify and classify all process streams in regard to their toxicity of its components. In addition, applicable workplace exposure limits are analyzed and incorporated into this review to insure compliance with pertinent governmental and ExxonMobil standards and guidelines.
2. Simultaneous preliminary review by the environmental contact to determine compliance issues with local regulations and company standards.

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3. Generation of a preliminary report including an equipment matrix to satisfy the requirements of environmental regulations and toxicity issues.
4. Review by experts in the areas of rotating equipment, mechanical, instrumentation, safety, offsites to identify issues with equipment selection in the preliminary matrix as regards cost, complexity, applicability to specific needs of this project, unnecessary conservatism or risk, etc.
5. A draft report is prepared incorporating the results of this review to ensure there are no overlooked project issues.
6. Final issues are resolved by the work group and a preliminary report for customer review is issued.
7. Customer reviews and provides any required changes or comments.
8. Report is revised and issued.

For smaller projects, some of the above steps may be modified or skipped.

The following sections describe the parts of the EEE Review (exposure/emission/safety).

1. Exposure Review Procedure

The exposure review is similar to what is called a Industrial Hygiene or IH review. ExxonMobil Biomedical Services (EMBSI) conducts the exposure review. The human exposure limit for each stream is established and then each stream is categorized as R1, R2, R3 or R4 where each "R" level (Respiratory Exposure Class) is associated with a pre-defined exposure limit. Piping system hardware (valve packings, pump seals, etc.) are specified based on the Respiratory Exposure Class.

2. Environmental (Emissions Regulations) Limit Procedure

From an environmental perspective, specialists review local and federal regulations to determine what limit(s) are placed on the release of specific compounds. These limits can apply to VOC's (Volatile Organic Compounds), VHAP's (Volatile Hazardous Air Pollutants) and other substances that are not regulated from an exposure and emission perspective. The outcome of the environmental review is the specific equipment hardware or performance required for each process stream.

3. Combining Reviews and Selecting the Sealing Hardware

- a. When the exposure and emissions reviews are completed the coordinator will determine which limit is the strictest and this will be the project requirement.
- b. At this point additional input from Area Specialists and/or the Owner is needed to ensure consistency with project limitations / requirements and hardware design issues.

EXPOSURE REVIEW PROCEDURES

The exposure review is similar to what was previously called the Industrial Hygiene or IH review. Exposure Sciences and Human Factors Section of ExxonMobil Biomedical Services, Inc. (EMBSI) conducts the exposure review. The worker inhalation exposure limit for each stream is established based on stream composition and allowable exposure limits, and each stream is classified as to the degree of hazard it poses via respiratory exposure (i.e., R1, R2, R3 or R4). In an *Equipment Selection Matrix*, each "R" class is associated with pre-defined type of emissions control equipment.

EMISSIONS REGULATION LIMIT PROCEDURE

From an environmental perspective, specialists review the local and federal regulations to determine what regulatory limits are placed on the release of specific compounds which can impact equipment selection. These limits can apply to VOC's (Volatile Organic Compounds), VHAP's (Volatile Hazardous Air Pollutants) and other substances. The outcome of the emissions review is the specific emission limit assigned to each stream or the required control equipment.

COMBINING REVIEWS AND SELECTING THE SEALING HARDWARE

When the exposure, emissions and equipment reviews are complete, the Review Coordinator will determine which limit is the strictest. Either the exposure "R" level, or a specific regulatory emission limit will govern each stream. Input from the technical specialists and the Owner is needed and should be collected during the Definitive Planning phase of the project. Owner preferences or requirements for the sealing hardware should be identified and incorporated into the EEER recommendations. The technical or environmental specialist can work with the Owner to



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define site specific requirements. The end result is a product suitable to guide the designers in preparation of basic design specifications.

EEE REVIEW WORK PROCESS

The EEE Review is typically conducted during Definitive Planning. A heat and material balance is a necessary pre-requisite of this review. [Figure 1](#) contains a work process flow plan describing the steps, and the EEE Review integration with the broader ISHER (Inherent Safety, Health, and Environmental Review). Clarification of the steps illustrated in [Figure 1](#) are provided below.

The EEE Review Coordinator is typically from the Environmental, Safety, Civil and Marine Division. This person coordinates the process and can also conduct some or all of the environmental reviews noted in Steps III-A and III-B. Environmental engineers review the need for specific controls required to meet local environmental regulations. This is based on contact with the ExxonMobil Engineering Single Point of Contact (SPOC), knowledge of the site, and possible site contact.

Simultaneous review by an industrial hygienist (often assisted by a toxicologist) to classify all process streams into respiratory exposure hazard ("R-") classes. An **Equipment Selection Matrix** identifies equipment selection based on the "R" class of each stream. EMBSI Report MR.19.DQ.93, "Equipment Selection for Industrial Hygiene Design Review," is the reference document used. Design Practice XVIII-B contains further discussion of the IH review considerations. (Step III-B)

A preliminary report that reflects the most conservative (lowest emissions/most stringent) controls from both the industrial hygiene and environmental reviews (Steps IV and V) is compiled by the Review Coordinator. Other items identified as part of the Environmental Review in Step III-A may be documented in this report or separately. The preliminary draft report is reviewed by the project/process design requestor and, in some cases (e.g. large projects), by the equipment specialists. The report is modified if required. (Steps VI and VII)

The modified report is reviewed by the site and any changes are made prior to issuing the final report (Final reports are included in the GII for large projects where applicable.) (Steps VIII and IX)

