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INTERNAL RELIEF VALVES: DEFINING A REPLACEMENT INTERVAL

IIAR's research into internal relief valve replacement aims to improve safety and reduce downtime.

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Internal Relief Valves: Defining a Replacement Interval

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Internal Relief Valves: Defining a Replacement Interval

The testing or replacement interval for pressure relief valves that discharge back into an ammonia refrigeration system, commonly known as "internal relief valves," may be redefined based on a new IIAR research project that aims to collect the valves from members and test them.

The project, which is currently underway, is being managed by IIAR staff and members of the IIAR research committee and is being carried out by ioMosaic, a processsafety engineering firm that provides testing for the petrochemical and chemical industries.

Eric Smith, IIAR Vice President of Technology, Advocacy, Research and Publications, said the project is unique because it is a direct response to concerns voiced by federal regulators, who have challenged the concept that the valves will not ever fail to open, and because of IIAR staff's direct involvement in implementing the project.

Bill Greulich, IIAR's Research Committee Chair, said the project is necessary because IIAR-6 defines specifics for safety relief valves that discharge to atmosphere, but is essentially silent on relief valves that do not discharge to atmosphere, which generally means that the industry does not regularly replace them.

For many years, there has been no defined inspection or replacement interval because it has been assumed that these valves will always relieve overpressure because they are not exposed to oxygen and water and should not corrode internally. But recently OSHA inspectors began to raise the issue as a discrepancy they expect industry to address.

"OSHA has a point; forever [is probably not] an acceptable period of time," said Greulich. "This is a great example of a research problem that came in the door through the regulatory side of the industry and is being answered by this project."

Greulich added that IIAR staff member Matt Chojnacki has been managing the collection of donor valves internally on behalf of IIAR, which is a first for an IIAR research project.

"This is the first time we're using staff as a major player for the administration of a big project. It's a great model for us to follow moving forward," he said. "This is an example of our industry coming together to address a problem for regulators, and it improves our relationship with them because we're listening to them and interacting with them on this. The standard is silent where there is a perceived issue. Valves are safety devices and safety devices should likely have testing or replacement intervals, so this is a silence we can answer."

IIAR's staff leader for the project, Matt Chojnacki, IIAR's Technical Project Specialist, agreed with Greulich that the significance of the project extends beyond simply getting an answer on replacement intervals.

"This is a group effort to solve an important question, and it concerns nearly everyone," said Chojnacki. "Our industry has been getting questions on this subject, and regulators are looking for our support on this, essentially asking 'what's the requirement?' There's an opportunity for us to take the leadership role in answering."

IIAR's Smith said, "When OSHA regulators first approached us with this concern, we decided that rather than adopt some arbitrary interval or some interval from another industry, we should first study whether such valves fail or not, and if so, what the appropriate testing or replacement interval for the conditions unique to our industry should be."

"The IIAR Standards Committee recognizes that opening a system introduces some risk, so applying some testing and replacement interval that may or may not improve safety did not seem appropriate."

Smith recently met with federal officials to update them on the steps IIAR is taking to address their concerns and reported that they are pleased with the response and will patiently await results, Smith said. "This is a far better approach than either regulators fining the industry or IIAR adding arbitrary requirements."

Chojnacki said the research data generated by the project will help IIAR prove or disprove the industry's current approach to replacement intervals and may reveal that they should be defined in IIAR-6 along with those for valves that discharge to atmosphere.

ioMosaic's analysis will estimate failure rates of internal relief valves by examining a broad sample of valves donated by IIAR members. So far, nearly 100 valves have been collected. Chojnacki said that IIAR appreciates the participation of members so far, but the project still needs more donor internal relief valves to study, especially ones that have been in place longer and have more wear to examine. Both liquid and vapor donor valves are welcome and if members know of internal relief valves that will be replaced as a matter of routine maintenance, IIAR would like to have them for the project, said Chojnacki. The project seeks valves from all types of facilities and conditions, whether they are well maintained or not.

So far, the call for participation in the project is getting steady but minimal response from IIAR members, said Chojnacki. The collection process is slow precisely because of the problem the project is meant to study – IIAR doesn't specify a replacement interval, so there aren't many valves coming off systems in the first place.

Nevertheless, Chojnacki said he is confident the industry will step up to the challenge and help define the replacement interval problem as word of the project gets out. IIAR is offering a big incentive for participation – free registration to the IIAR Annual Conference (an approximate $800 value) for one (1) person from the donor facility, and one (1) person from the contractor who completes the valve replacement (if a contractor is used). IIAR is also covering the shipping costs to the research contractor.

"I want to call on anyone who can participate to send us their old internal relief valves," said Chojnacki. "Ultimately, the more data we can yield around this subject, the better it is for our industry. As a driver of this data, IIAR can go back to OSHA and EPA with more than just a gut feel or a disagreement. This is a chance to take it a little further and

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give them actual data points and proof in support of our stance, whatever that evolves into."

Every valve an IIAR member can contribute adds to the strength of our position with regulators, he said. "We need these data points, and it's up to IIAR members to pull through for each other and help us get them."

David Blake, senior consultant for ioMosaic, agreed with Chojnacki that the project still needs more input from the industry to be successful because of the way the valves are being measured.

"We want to try to determine how long a valve can survive and still be in good service so we [will] look at that data and develop standard deviations," said Blake.

"We're looking to try to define a corrosion rate. The problem will be that [for valves with limited years of service] we may not see enough corrosion to measure a difference. The primary data point we're looking for is failure rates," a data point that is easiest to collect in older valves.

For now, data collection may be slow going, but Greulich said IIAR understands the obstacles and will work methodically to overcome them.

"There's no really obvious solution for getting valves from people with no incentive to open up their systems, and that sort of encapsulates the broader issue," he said. "There are dangers and costs of replacement. Many of these valves were not installed with the idea of maintaining them as we do for external relief valves."

For that, there's no simple fix, and it may be the larger issue that the IIAR research project and ioMosaic can help solve on behalf of the industry, said Greulich, adding that ammonia refrigeration differs from most of the rest of the process safety world in the practice of putting internal valves in place and then leaving them there.

"We're different in that these valves are cheap and small, and we're used to leaving them in place, but that's not how other industries [that OSHA and EPA are used to regulating] do it."

"Now it's become a matter of aligning our industry with the expectations of our regulatory community," said Greulich. "Their expectations are formed in the broader process and chemical industry world. We need to get our heads wrapped around what our own data says about replacement frequency."

That means the success of the ioMosaic project will hinge on IIAR's ability to get more, older, internal relief valves to measure. "The key in my mind is to get more valves," he said. "This is a good and earnest thing for our industry to really come together on so that we can close up an open gap in our code."

Your Support of NRF Pays for Important Industry Research Projects

The ioMosaic internal relief valve project and others like it are funded by the Natural Refrigeration Foundation, which is supported in large part by the Foundation's Legacy 100 Club, a new way to contribute to the work of NRF.

The Foundation's Legacy 100 Fund is built by contributions of $100,000 each from companies or trustees who wish to induct one of 100 leaders of the refrigeration industry into the Club. The commitment can be funded by an individual, a company, or a foundation in the name of an individual, giving contributing companies a seat at the table in determining important industry research like the ioMosaic project.

"This is a good example of using NRF funds to solve a problem," said Eric Smith, IIAR Vice President of Technology, Advocacy, Research and Publications. "NRF is supporting the industry and its standards because they have been challenged. The ability to generate data to support our position on a topic is a key example of why the NRF exists."

In the case of the internal relief valve project, "the research is being conducted because the industry has been challenged to determine an appropriate time interval for replacement of pressure relief valves with outlets that are piped back into the system," said Chojnacki. "Unlike relief valves that discharge to atmosphere, valves that relieve back into the system are believed to be reliable for an indefinite period, because they are not subject to internal corrosion."

"With this research, we hope to establish that such valves will not fail and require no routine replacement, or to determine an appropriate interval for their recertification or replacement using predictive analysis engineering methods."

If you can contribute internal relief valves to the project and would like to participate, please contact:

Matt Chojnacki, matt_chojnacki@iiar.org,

or Eric Smith, eric.smith@iiar.org.

Everything You Ever Wanted to Know — IIAR Standards

To understand how far the industrial refrigeration industry has come in the last decade, and where it's headed, the best place to look is its standards.

The International Institute of All-Natural Refrigeration has nine standards, a suite of consensus-based, ANSI-approved guides covering everything from putting a system together to taking it out of service.

Jake Denison, Senior Product Manager at Evapco, and subcommittee Chair for IIAR-1, said the standard, Definitions and Terminology Used in IIAR Standards, can be a valuable starting point for anyone looking to learn about the industry or provide context for IIAR's suite of standards.

"Some people might gloss over the existence of IIAR-1, but it exists to help provide context and consistency across all our standards with a unified set of definitions," said Denison.

He added that IIAR-1 is unique from the rest of the IIAR standards in two key ways. First, the standard is free to the public, a feature that helps IIAR educate newcomers or people outside the industry on important terms and definitions. Second, the standard is not adopted by model codes because model codes do not recognize definitions as standards.

"IIAR-1 serves as a common thread; it's the backbone across all our standards," said Denison. "People have different backgrounds, so it's important to maintain consistency across all of our standards as they evolve and grow."

The first published copy of IIAR-1 contained 106 definitions in 2012, with the largest update in 2022 adding 50 new and 10 revised definitions. The next version of the standard will be published in mid-2027.

"IIAR-1 serves as a common thread; it's the backbone across all our standards," said Denison. "People have different backgrounds, so it's important to maintain consistency across all of our standards as they evolve and grow."

Meanwhile, one of the most well-known standards, IIAR-2: Standard for Design of Safe Closed-Circuit Ammonia Refrigeration Systems, provides the minimum design requirements for all new and modified ammonia systems.

IIAR-2's subcommittee Chair Mark Bazis, VP, Refrigeration Consultants Inc., said IIAR-2 is important because it establishes a uniform, nationally recognized design basis for ammonia systems that have been adopted into all U.S. model codes.

The original version of the standard, approved for the first time in 1978, has seen 11 published versions to date and now includes more detailed, and sometimes controversial, information, said Bazis.

"We now have safety showers, occupancy allowances and a relief piping formula instead of tables included," among other changes from the original version, he said.

Bazis added that "one of the most fascinating changes [from the original] IIAR-2 is dispersion. They gave an actual GPM for water so you could discharge your emergency ventilation into a water spray to take the ammonia out. We took all that out [of IIAR-2]. The current version has a velocity requirement, spark-resistant construction, and motors out of the air stream. All that stuff we added in there to make the engine room safer."

IIAR standards also cover growing markets for non-ammonia systems, like CO2, as is the case with IIAR's CO2 standard, IIAR CO2, which covers safe design, installation, inspection, testing and maintenance and the full lifecycle of CO2 systems, said John Collins, CO2 subcommittee Chair and Director of Industrial Sales at Zero Zone.

Collins said beyond the basics of CO2 systems, IIAR's standard touches on stationary closed systems, systems using CO2 as a secondary coolant, cascade systems and any system providing refrigeration that is operating part-time or full-time with a transcritical cycle.

IIAR CO2 does not cover: replacement of equipment or piping with functionally identical equivalents; all parts of refrigeration systems or heat pumps that do not contain CO2; factory built systems, or systems that existed before the effective legal date of the standard.

The current edition of the standard, IIAR CO2: 2021, has been adopted by model codes in the U.S., and a review is currently underway for the next version, said Collins.

IIAR recently announced the completion of ANSI/IIAR CO2-2021, Addendum A-2026. This addendum revises Chapter 11 of the original publication and introduces a new set of criteria for determining the capacity of pressure relief valves.

While some standards, like IIAR CO2, aim to include as much different information as possible, others, like IIAR-7 Operating Procedures for Closed Circuit Ammonia Refrigeration Systems, are intentionally streamlined to address the basics of a subject.

"IIAR-7 is our standard for operating procedures," said Lesley Schafer, IIAR-7subcommittee Chair and Senior Manager, Corporate Refrigeration, for C&S Wholesale Grocers. "This standard lays out what you need in an operating procedure, not how you should write it."

Schafer said the standard is especially useful for end users, manufacturers and contractors. "We think we know this stuff,

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but if you don't stop and think about it once in a while, it's easy to forget," she said, adding that the subcommittee's latest effort on IIAR-7 was to reduce the word count.

"The new thing we did in 2025 was to try to decrease the words in the normative sections, that's the part [of the standard] that could be enforceable," she said.

Schafer, who is also the subcommittee chair of IIAR-8: Decommissioning of Closed-Circuit Ammonia Refrigeration Systems, said the work on this standard is a bit more obscure.

"This is our standard for decommissioning, so one of the things our team found ourselves shaking our heads at was . . . what does that mean exactly?" she said. "This is one case where IIAR-1 is going to have to update with our new definition because we really tried to clarify what we mean by decommissioning."

"Our main goal with IIAR-8 is to make sure you have a safe sendoff [at decommissioning] so you don't leave a hazardous situation in a system."

Finally, IIAR 9: Standard for Minimum System Safety Requirements for Existing Closed-Circuit Ammonia Refrigeration Systems is the standard for the evaluation of existing ammonia refrigeration systems, said Eric Johnston, IIAR-9 subcommittee Chair and Director of Process Safety Management, American Foods Group.

This standard provides the minimum safety requirements for existing ammonia refrigeration systems that are already in operation and may have been built before applicable codes and standards were modified and updated.

"The primary purpose is to offer a structured evaluation methodology so facilities can systematically identify gaps compared to modern expectations," said Johnston. "IIAR-9 does not replace design standards. Instead, it creates a consistent baseline so that existing systems can be evaluated fairly and without retroactively applying modern requirements unless that's truly necessary."

Johnston added that the standard is a good example of how IIAR responds to regulatory pressure via standards. "IIAR-9 was developed in response to lots of end users having ongoing challenges between industry and regulators," he said. "Agencies frequently attempted to apply other industries' standards, and they really didn't apply to our systems."

While IIAR-9 was written to respond to a specific regulatory problem, it's also a good example of how IIAR's standards change as industry needs change.

"Now there's a lengthy conversation on what the future of IIAR-9 should be," said Johnston. "With changes in the regulatory landscape, is there really a need for IIAR-9 to remain a standard, or is it better for it to be transitioned into a guideline?"

"We're ultimately looking to answer that question, and it will be up to the board of directors to give that guidance."

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Standards: IIAR Answers Member Questions

Often, the timeliest issues in the industry — from IIAR-2's relief calculation formula to hot work permits for sulfur sticks — are being discussed in standards subcommittee meetings.

This year, at the IIAR Natural Refrigeration Conference & Expo, March 15-18, IIAR standards subcommittee leaders convened to give IIAR members a chance to ask their own questions. The Q&A format illuminated some of the biggest issues the industry is working on with regulators and settled some common misconceptions around standards.

Q: *Safety showers are regulated by an ANSI standard and OSHA, so why are they in IIAR-2?*

A: "The ANSI standard Z358.1 for safety showers is not adopted in the mechanical code. It's a suggestion; honestly, until it's adopted, we put it in IIAR-2 so it would be adopted. If you read that [ANSI] standard, it's pretty vague where they want the showers to go. They don't specify or state if a shower goes in this room or that room; they just give some suggestions. So that's the reason we put it in IIAR-2, so that it's adopted in the model code." — Mark Bazis, IIAR-2 Subcommittee Chair

Q: *Do sulfur sticks need a hot work permit?*

A: The safety committee is looking at this issue and how to respond.

"There is an OSHA interpretation that says sulfur sticks require a hot work permit, but we don't agree with this interpretation. This is something we're going to have to take up with OSHA." — Eric Smith, IIAR, Vice President of Technology, Advocacy, Research, Publications

Q: *In IIAR-2, why was the formula for relief calculations changed, wasn't the old formula easier?*

A: "It's not always about being easier. There were a lot of gaps in the old formula. In the old formula, it was for technically just the discharge of the relief valve up to the header. The new formula really cleaned that up, and now we do the pressure loss calculations all the way back to each relief valve." — Mark Bazis, IIAR-2 Subcommittee Chair

Q: *Is IIAR-1 [Definitions and Terminology Used in IIAR Standards] only for use in standards or is it intended to be useful on its own?*

A: "On its own, IIAR-1 is not [adopted by model codes. But when used in conjunction with other standards, the definitions provide the necessary baseline for the standard's enforcement.] [The standard is also] useful to look at and understand where this industry is focused. The definitions that are given are certainly a valuable investment of time to look at from an educational standpoint." — Jake Denison, IIAR-1 Subcommittee Chair

Q: *Once the new requirements come out for ventilation [in IIAR-2], will we have to update our rooms?*

A: "Usually every mechanical code has a statement in there that says that if your system is being operated safely, you don't have to update to the current mechanical code. Of course, every AHJ, or Authority Having Jurisdiction, has the option to require you to update to the most current mechanical code. So the short answer is no, but you would probably have to have a reason why you wouldn't. And this applies to any standards that are adopted by the mechanical code in your AHJ. Anytime anyone puts in a new system, they have to follow the latest mechanical code in their area." — Mark Bazis, IIAR-2 Subcommittee Chair

> "This is similar to risk ranking and your PHA's. IIAR-9 provides you with a path to not close a gap. You can do a risk ranking, and if [there is sufficient justification], it allows you not to close [the gap]."

Q: *What are the areas to be considered in the next version [of the CO2 Standard] with what has been learned with the increased use of small and medium-size systems? Is there a ballpark number estimate of the number of systems that exist that are using IIAR-CO2?*

A: "Yes, we've seen a tremendous growth of CO2 systems being installed. In the last 20 years, we've gone from what might be counted in the dozens here in the U.S. to tens of thousands across the world. What we've learned is that there are certain areas where [that growth] has complicated things. The industry is looking for better direction and guidance on [several things]. I touched on reliefs as one of the primary needs; that's an immediate area of focus for standards. Some of the other areas aren't necessarily related to small and medium systems, but are general, safety and basic requirements." — John Collins, CO2 Subcommittee Chair

Q: *When is the CO2 standard expected to become enforceable?*

A: "It is in the model codes in the U.S.;" IIAR-CO2 is enforceable now. "An addendum will be published this year." — John Collins, CO2 Subcommittee Chair

Q: *Referring to IIAR-8 [Decommissioning of Closed-Circuit Ammonia Refrigeration Systems], when is it recommended to decommission an ammonia plant? Is this decision based on the lifetime of the components or more related to safety?*

A: "In my experience, this has been a business decision. Our subcommittee team has had other experiences where a system was dormant, or it wasn't used for a long time, and that decision was made by a regulatory agency. So that just depends on the situation." — Lesley Schafer, IIAR-7Subcommittee Chair

Q: *In IIAR-8, the standard mentions removal; what is the approach for removing contaminated oil?*

A: "We do include provisions for removal. Basically, the standard, the way it is written, says 'you need to figure out how to do this.' A lot of the things in IIAR-8 have to do with what you have to do to dispose of chemicals. There are local and government requirements we have to follow. What's included in the standard is what [you have to do], not how [you have to do it]." – Lesley Schafer, IIAR-8Subcommittee Chair

Q: *In IIAR-9, what is the timeframe to remedy a found gap?*

A: "This is similar to risk ranking and your PHA's. IIAR-9 provides you with a path to not close a gap. You can do a risk ranking, and if [there is sufficient justification], it allows you not to [close the gap]." – Eric Johnston, IIAR-9 Subcommittee Chair

Q: *Please point me to a provision where IIAR-9 is more restrictive than IIAR-2 2014 or IIAR-2 2021.*

A: "Right now, IIAR-9 requires that you have a cover over your vent switch in your machine room, and IIAR-2 does not require that. There are a lot [of examples]. One of the issues we run into is that IIAR-2 is constantly changing. IIAR-9 is always meant to be a minimum safety requirement; it shouldn't have to change. When we originally developed IIAR-9, we looked all the way back to the early 90's and chose the least restrictive things we could find." – Mark Bazis, IIAR-2 Subcommittee Chair

GOVERNMENT RELATIONS

BY LOWELL RANDEL, IIAR GOVERNMENT RELATIONS DIRECTOR

Trump Administration Publishes Updated Regulatory Agenda

On July 4th, 2026, the Trump Administration released its updated Unified Regulatory Agenda for 2026. The Regulatory Flexibility Act requires federal regulatory agencies to publish their regulatory plans on a semi-annual basis. The target dates for release are April and October, but historically administrations have not always followed that timeline. The July 2026 release appears that it will cover all of 2026 and be the only update provided this year. The Regulatory agenda lists all "active", "completed" and "long-term" regulatory actions within an agency.

In addition to the regulatory agenda, the Administration also published an accounting of deregulatory actions taken in fiscal year 2025 carried out under Executive Order (EO) 14192. The order requires federal departments and agencies to: (1) issue 10 deregulatory actions for each new regulatory action; and (2) not exceed a regulatory cost allowance. For fiscal year 2025, agencies were directed to ensure that the total incremental cost of all new regulations finalized is significantly less than zero. According to the Administration, agencies have far exceeded the 10 for 1 requirement in 2025. The report indicates that the ratio in 2025 was 129 to 1. Agencies issued 646 deregulatory actions and 5 significant regulatory actions. Within these results, Agencies issued 218 deregulatory actions that delete, modify, or otherwise refine the Code of Federal Regulations, which reflects a 43 to 1 ratio. The report further states that regulations eliminated in 2025 will save about $211.8 billion in present and future regulatory costs across the government.

The 2026 Unified Regulatory Agenda contains 3,954 agency actions across the federal government including 2,518 active actions, 628 completed actions, and 808 long-term actions. A total of 1,119 actions were published in the Unified Agenda for the first time, a majority of which are considered deregulatory in nature.

Below is a summary of selected Regulatory Agenda items for the Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA) that could impact IIAR members:

EPA Agenda Items

Title: Accidental Release Prevention Requirements: Risk Management Programs Under the Clean Air Act; Common Sense Approach to Chemical Accident Prevention

Abstract: The EPA is undertaking a rulemaking to amend its Risk Management Program (RMP) regulations by making several proposed changes to the 2024 Safer Communities by Chemical Accident Prevention rule. The proposed amendments will seek to improve chemical process safety by avoiding duplicative requirements, realigning RMP requirements with Occupational Safety and Health Administration (OSHA) Process Safety Management requirements, and eliminating unnecessary burdens placed on facilities where there is not specific data available to show that the current RMP standards would reduce or have reduced the number of accidental releases.

Status: The Proposed Rule was published on February 24, 2026. The public comment period ended May 11, 2026. IIAR provide both oral and written comments. The target date for publishing a Final Rule is in September 2026.

Title: Risk Management Program, CAA section 112(r)(7)(Section 610 Review)

Abstract: EPA is initiating a review of the 2017 Risk Management Program (RMP) final rule (82 FR 4594) pursuant to section 610 of the Regulatory Flexibility Act (RFA, 5 U.S.C. 610). Since 2017, the Agency has published two additional final rules for the Risk Management Program on December 19, 2019 (84 FR 69834) and March 11, 2024 (89 FR 17622). Section 610 of the RFA requires that federal agencies review each rule that may have a significant economic impact on a substantial number of small entities within ten years of publication of the final rule. EPA initiates a Section 610 review to determine if the provisions of a rule that are related to small entities should be continued without change, rescinded, or amended to minimize adverse economic impacts on small entities. Section 610 review of the 2017 rule is unrelated to the rulemaking entitled Accidental Release Prevention Requirements: Risk Management Programs Under the Clean Air Act; Common Sense Approach to Chemical Accident Prevention.

Status: EPA initiated its review in July 2026 and it is targeted for completion in early 2027.

OSHA AGENDA ITEMS

Title: Lock-Out/Tag-Out Update

Abstract: Recent technological advancements that employ computer-based controls of hazardous energy (e.g., mechanical, electrical, pneumatic, chemical, and radiation) conflict with the Occupational Safety and Health Administration's (OSHA) existing lock-

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 (continued from page 13)

out/tag-out (LOTO) standard. The use of these computer-based controls has become more prevalent as equipment manufacturers modernize their designs to increase productivity. Additionally, National Consensus Standards have evolved, and international approaches to the use of computer-based controls are increasingly recognized. In light of these advancements, there is a need to modernize United States regulations to better align with current technologies, ensuring improved safety effectiveness and, indirectly, potential benefits such as increased operational efficiency. OSHA issued a Request for Information (RFI) in May 2019 to understand the strengths and limitations of this new technology, as well as potential impacts on worker safety.

Status: A Notice of Proposed Rulemaking is targeted for release in November 2026.

Title: Emergency Response

Abstract: OSHA currently regulates aspects of emergency response and preparedness; some of these standards were promulgated decades ago, and none were designed as comprehensive emergency response standards. Consequently, they do not address the full range of hazards or concerns currently facing emergency responders and other workers providing skilled support, nor do they reflect major changes in performance specifications for protective clothing and equipment. The agency acknowledges that current OSHA standards also do not reflect all the major developments in safety and health practices that have already been accepted by the emergency response community and incorporated into industry consensus standards.

The regulatory effort began in 2007 with a Request for Information (RFI). In July 2014, OSHA hosted two stakeholder meetings with participants representing a broad range of emergency responders as well as allied stakeholders such as State Plan representatives, skilled support workers, and law enforcement. Given the broad support and interest seen during the stakeholder meetings, OSHA decided to move forward with a comprehensive proposed standard for emergency response. In September 2015, OSHA requested, and NACOSH designated, a subcommittee made up of major stakeholders and charged with developing proposed regulatory text. In October 2021, a Small Business Advocacy Review (SBAR) panel was assembled, as required by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA); SBREFA was concluded in December 2021. OSHA published a Notice of Proposed Rulemaking (NPRM) in February 2024.

To encourage and increase stakeholder feedback regarding the proposed rule, OSHA twice extended the original 90-day public comment period. The agency also held informal public hearings. OSHA is currently making revisions based on the analysis of the testimony and evidence provided during this public hearing and post-hearing comment period.

Status: Publication of a Final Rule is targeted for April 2027.

Based on the Trump Unified Regulatory Agenda for 2026, it appears that agencies like EPA and OSHA will continue to consider deregulatory actions. IIAR is actively monitoring these developments and engaging with agency officials to advance the interests of the natural refrigerants industry.

Given the broad support and interest seen during the stakeholder meetings, OSHA decided to move forward with a comprehensive proposed standard for emergency response.

State Regulations, PFAS, Cause Uncertainty for Synthetic Refrigerants

When the U.S. Environmental Protection Agency finalized its Reconsideration of the Technology Transitions Rule in May 2026, it introduced extended compliance dates, relaxed interim GWP limits, and installation flexibility for several subsectors including cold storage. While many in commercial refrigeration saw the reconsideration as a reprieve, it may have introduced unanticipated regulatory challenges from several states.

Now, three months after the rule went into effect, a patchwork of more stringent state regulations –some even more restrictive than the original rule – are taking effect. New York, California and Washington have all passed their own equivalents of the TT Rule, and other states may follow suit.

Meanwhile, growing concern over trifluoroacetic acid, the polluting PFAS component of synthetic refrigerants, could mean that states nationwide, led by eight states that already have PFAS restrictions, may enact anti-PFAS legislation adding to state-level pressure on HFO's.

Adam Shorey, Vice President of Therm Solutions and Chairman of IIAR's Responsible Refrigerants Committee, said the TT extension offered some relief from uncertainty for end users now that it has been re-ruled. "But it really is just kicking the can down the road, which is a setback," he said, adding that the net effect for IIAR is that "we'll have to wait a little longer for this transition [to natural refrigerants] to happen."

"Unfortunately, there are just a lot of end users who wanted to continue to use [cheaper] synthetics. Our hope was that the original rule would push people towards IIAR and naturals, and that may not happen as readily," he said.

Nevertheless, synthetic refrigerant users planning to comply with the extended 2023 deadline will still need to consider that new phasedown limits will push them towards refrigerants with A2L fire ratings, which come with more stringent regulatory requirements than traditional HFC's.

"With the application of the TT Rule that provides for 150 GWP thresholds, people who still want to use freon would have to apply the system a little differently," said Reed Portney, Sales Manager for Packaged Systems at Evapco. "In the past, they could get away with bypassing [safety measures] we consider standard in ammonia refrigeration. They now have to apply some of those things based on the flammability ratings of their new refrigerants."

Part of the AIM Act is to promote natural refrigerants, said Portney. "Once that 150 GWP limit is enacted, it becomes more difficult to see regulatory limitations as a deterrent for ammonia. In the past, customers might have said ammonia systems are overly burdensome from a regulatory standpoint compared to synthetics, but now they will be in line with each other a little bit more."

While the new A2L flammability requirements may eliminate discrepancies in regulatory burdens around the use of HFO's and natural refrigerants, the bigger issue for commercial end users may be the development of a patchwork of regulations at the state level created by the delay of the TT Rule.

For manufacturers, shifting timelines can certainly create some challenges. Product development, capacity planning, inventory management, and customer investment decisions are all tied to regulatory expectations. When implementation dates change, it can create uncertainty in the market and we much prefer certainty from the federal level than a patchwork of state and local regulation," said Lauren MacGowens, Director of Transformation & Sustainability for Vilter.

Nevertheless, now that the TT Rule has been extended from 2026 to 2032, the delay may not turn out to be as much of a positive as that industry was hoping. That's because states are beginning to roll back the extension on their own, creating a patchwork of local regulations that may complicate compliance for end users with facilities across different regions.

"The back and forth over the rule extension should be over now, but the uncertainty and the revocation of the rule has now left the door open for states to do things like introduce their own versions," said Shorey. "I think states are looking at this as a situation where they were moving towards this rule and now it's not a rule anymore, but this preparation for the original rule has already happened – and many of them are going to go ahead and enact either the original requirements or something close to them."

After EPA finalized its 2026 reconsideration of the Technology Transitions Rule, New York moved quickly to adopt its own version of the rule, restoring the original, more aggressive timelines. The state's Department of Environmental Conservation made clear that the federal rollback conflicted with New York's climate mandates under the Climate Leadership and Community Protection Act, which requires steep reductions in greenhouse gas emissions across all sectors.

New York's rule effectively reinstates the original Technology Transitions deadlines and GWP caps, rejecting EPA's extensions for supermarket systems, cold storage warehouses, industrial process refrigeration, and other categories.

Where EPA now allows interim GWP limits of 700 or 1,400 through 2032, New York maintains the 150/300 GWP thresholds and the earlier installation cutoffs, keeping the state aligned with California, Washington, and other jurisdictions that have chosen not to follow the federal delay.

"New York has moved aggressively here," said Shorey. "They've gone above and beyond even the TT Rule. My guess is that more and more states will do their own thing like New York, and this causes complexity because now you have to comply with one set of regulations for one state and another for another."

Evapco's Portney agreed with Shorey that the extension of the TT Rule may initially result in a slower transition to naturals, and even an uptick in freon in the near term, but that the net effect of the AIM Act, and factors beyond it, like the emerging state regulation of PFAS polluting HFO's will eventually push end users towards natural refrigerants.

"I expect there to be an uptick in freon for a few years in different sectors across the AIM Act, because some end users will be trying to push through certain refrigerants for certain applications before these limits take effect in 2032," said Portney. "But a large number of customers already use ammonia, so for the industrial process market, that will continue to be dominated by the ammonia refrigeration industry."

For those still deciding between a long-term commitment to HFOs or naturals, there are already plenty of end users trending toward ammonia, and that may have more to do with emerging PFAS regulations at the state level than the AIM Act, said Portney.

Several U.S. states have begun moving directly into PFAS restrictions, even though no state has yet enacted a refrigerantspecific PFAS ban. Instead, states are regulating PFAS as a class across broad product categories. The result is a regulatory environment where PFAScontaining substances like HFO's may face future bans.

The states with the broadest PFAS phaseouts are Maine, Minnesota, Colorado, Vermont, California, Connecticut, Washington, and New York, all of which have active PFAS restrictions or reporting requirements. Several states, including Maine, Minnesota, and Colorado, have enacted frameworks that phase out PFAS across all product categories by 2032 unless a use is deemed unavoidable.

"States are starting to implement their own restrictions around PFAS, and because of that, end users are starting to look at all of these state-specific and region-specific limitations, not just the ones that address the TT Rule," said Portney.

"We recommend looking at what the AIM Act has to say, then look at what the state and local jurisdictions have to say, then look at the holistic picture to decide what's best, and once you figure that out, you figure out what you can and can't do for the future."

"Plenty of people are going to come to the conclusion that they should choose ammonia or CO2," said Portney. "Even outside of the states where more stringent AIM Act policies exist, a certain subset of facility owners are going to come to the conclusion that natural refrigerants are the best choices for the future."

Portney cited the emerging state-level PFAS regulations as the next biggest cause of regulatory uncertainty for end users.

"There are already many states examining the PFAS issue, and plenty of designers and engineers have seen enough of this over the years with HFC's and HFO's. I think they are increasingly concluding that natural refrigerants might be best for their applications," he said.

"Now [with the state-level TT Rules] we have a precedent for what might happen with PFAS. HFC's are being phased out, even with a delay, and there are these issues surrounding HFO's, so there are a number of people now who would rather move on from synthetics and look at other options like natural refrigerants."

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IIAR STANDARDS UPDATE

BY TONY LUNDELL, SENIOR TECHNICAL ADVISOR – STANDARDS, PUBLICATIONS, & EDUCATION

Understanding the Importance of Passivation

In recent years, the quality of the circulated water in evaporative condensers and cooling towers has declined as air and water pollution has increased. As regulations limit the use of many corrosion inhibitors for the hot dip galvanizing process, such as chromates, the passivation process for protection has become even more critical.

Passivation is a treatment process that forms a very thin protective layer that reduces chemical activity with air and water or other material that comes into contact with a surface. The passivation process varies depending on the type of material to be protected and the substances with which they contact. The most common circumstance in industrial refrigeration is passivation for coils and casings for evaporative condensers and cooling towers. Passivation provides maximum protection from corrosion on newly installed evaporative condensers and cooling towers that have hot dipped galvanized steel tube coil surfaces. Hot dip galvanizing produces a coating of zinc-iron intermetallic alloy layers on steel with the outer layer being purely zinc. The zinc provides cathodic (sacrificial) protection and physical barrier protection. Passivation helps prevent the development of corrosion that could result in rapid penetration through the zinc coating to the steel. If the corrosion makes it entirely through the protective coating to the carbon steel condenser tubes, they will rapidly corrode. Note that fouling material, such as scale or white rust on the tubes can hide corrosion on the surface of the tubes. Corrosion control of galvanized steel depends on forming and maintaining a stable and passive oxide layer on the surface of the galvanized steel during the installation of the equipment.

Passivation is a chemical process that forms a metal oxide bond that enhances the original corrosion resistant, hot dipped galvanized surface by forming a thin transparent oxide coating. It dissolves any embedded or slightly rubbed in iron pick-up on the surface, and reduces the transport of corrosive elements to the underlying metal surfaces. Passivation service providers will typically state that the chemicals they use are proprietary. In general, these are the chemicals used:

- Sodium Hydroxide: Used for cleaning and preparing surfaces before passivation.
- Citric Acid: A mild acid that effectively cleans and passivates metal surfaces.
- Surfactants: An aid in removing oils and contaminants from the coil surface.
- Sodium Nitrite: Acts as a corrosion inhibitor, especially in cooling water systems.
- Phosphoric Acid: Helps remove rust and scale while promoting corrosion resistance.

It is important that proper precautions are planned and taken for passivation when a new condenser or tower with hot dip galvanized tubes is installed. The passivation must take place prior to start up and before a full refrigeration system heat load occurs. The full refrigeration system heat load should be avoided during passivation since water evaporation can concentrate corrosive ions and increase the pH and fouling potential. A new evaporative condenser can be delivered after fabrication and set in a parking lot, an open area near the machinery room, or mounted in its designed position. Once set, a portable chemical treatment process can be arranged and it can be passivated before being connected to the closed-circuit refrigeration system.

Water quality varies by location, so passivation must be performed on site and cannot be done at the factory. Many contractors will not accept responsibility for passivation because water treatment is an ongoing process that is the responsibility of the owner. It is important to develop a schedule, early in the startup process, that includes time to involve a qualified water treatment provider to minimize problems and optimize the investment. The passivation process can take weeks or months (typically 6 to 8 weeks or even more in some locations). For a quality assurance check on your water treatment service provider, have the company provide references for which equipment they have successfully passivated and have them provide and explain the passivation process they will use to service your equipment. Hold the company accountable as the expert to provide the passivation process, even if they have to get the process details from the manufacturer. Make sure they have enough insurance in case an unfortunate situation occurs while your equipment is in their hands. Passivation must extend the life of the galvanized protective coating on the tubes and not damage it in any way. If an onsite water treatment provider is currently servicing existing similar equipment at your facility, it is best if they provide a proven passivation process for your new equipment.

It is also important to have a good preventive maintenance program for existing equipment that checks the conditions of the tubes early enough to consider enhanced water treatment, such as passivation, or the scheduling of equipment replacement before it becomes a risk for a refrigerant release. Typically, condenser or cooling tower replacement projects need to start at least six months in advance to insure the involvement of a qualified water treatment company. If the project schedule gets too crunched, the passivation process is at risk of elimination because the new unit will need to be on line as quickly as possible. A sign that the passivation process is successful and completed is when the new shiny zinc coating on the tube surfaces turns to a dull gray color.

The target life expectancy of a newly installed condenser should be minimum of fifteen years with a stretch target of up to twenty-five years. It is noteworthy that some condensers are still in operation after more than forty years. When originally purchased, these condensers likely had chromate corrosion inhibitors applied as part of the hot dipped galvanizing process and the galvanizing itself was likely thicker. If a new condenser is installed without passivation, the tubes may only last from five to fifteen years. This quickly identifies passivation as a great investment to optimize your equipment's life expectancy.

Where Are You?

BY KEM RUSSELL

Is it helpful, sometimes even really important to know how things are going? The answer is yes! If you don't audit, check, measure, and/or observe what's happening you may end up with results you didn't expect or want. A correction might take a significant effort depending on what is happening and how much time passes between your observations.

Here is a recent personal example where I should have done a better job of auditing my progress. I planned to do a day hike on a loop canyon trail. Starting elevation was about 5,690 feet; high point was about 7,831 feet; total trail distance of the loop was about 7 miles.

From the trailhead parking area, I walked up a forest road for about half a mile to the actual trail, which then snaked its way up the forested canyon to the ridge. The hike was somewhat steep, but I finally broke out of the deciduous trees and fir trees to large, flowered meadows with aspen tree groves. It was beautiful!

I had been verifying my location and progress using a mapping app and my phone's GPS. The map showed that once I reached the ridge the trail would intersect a jeep road.

When the path intersected the jeep road I turned left to follow the road to the next intersection with the trail for the downhill portion of the loop. I walked for about 15 minutes, and the road came to a dead-end. "Hmmm?" I didn't remember the road coming to a dead-end on the map. Looking at my GPS position, I saw that I was well off course and should have gone to the right when the trail intersected the jeep road. I should have verified which direction I was supposed to go on the road. Now I had to backtrack. Well, lesson learned, I needed to verify my position more often.

I hiked back to where I had first intersected the road and then correctly followed it to an intersection with another jeep road. I turned left at the intersection and continued on for about 10 minutes then verified I was going the right way. The intersection with the last half of the loop trail was further along the road.

It was a beautiful day; the scenery was breathtaking. I was confident I would see the trail intersection, so I didn't check my GPS location. I walked maybe three fourths of a mile and had a gut feeling I should have gotten to the trail intersection by then. I got a present GPS location; I was way beyond the trail intersection! "Grrrr!" I turned around, mentally kicking myself for not monitoring my position more often and not really learning a lesson from my first mistake. As it was this seven mile hike turned into a nine-plus mile hike. If I had just monitored my progress more often I would have saved about two miles of extra hiking.

It is important to verify whatever you are doing, observing and auditing is what is supposed to be happening. This applies personally or when working as a team, and/or as a company. You should do this often enough that you don't end up off track from what you want or expect.

You can likely think of many examples of the need to verify things to make sure they are going correctly. I want to briefly focus on areas of ammonia refrigeration systems where this can be beneficial.

For any refrigeration system that contains 10,000 lbs. or more anhydrous ammonia the owners and operators of that system have to adhere to both OSHA's Process Safety Management (PSM) and EPA's Risk Management Program (RMP). One of the sections in these two federal programs where we are seeing that the programs are working as they should is "Compliance Audit".

The audit verifies that all elements currently in place for a "specific" system meet the requirements for the PSM Standard and RMP Rule. The audit results are to be documented. The PSM Standard and RMP Rule both state that an audit must be done every three years.

If deficiencies are found by the auditors then corrections are to be made to bring the element(s) into compliance. How long corrections take to be completed will vary depending on the particular deficiencies found. It would be best to make corrections as soon as reasonable, not to take the full three years until the next audit. You should always try to have an active, fully functioning PSM/RMP. This could mean that in some cases elements may need to be audited more frequently until you feel comfortable that requirements are being met for the PSM Standard and RMP rule. It is not a good idea to wait as something might go further off course.

I have many times been asked by companies to review the status of their programs. What I first do is an audit of all of the elements. That audit helps both the company and I have a much better idea of how much effort may be needed to bring various elements up to a condition where they meet the requirements.

IIAR has a guideline to help companies meet the standards and rules for the PSM/RMP.

It is important to verify whatever you are doing, observing and auditing is what is supposed to be happening.

The guideline includes a chapter on how to do a "Compliance Audit".

What about facilities that have refrigeration systems that have less than 10,000 lbs. of anhydrous ammonia?

These systems, or processes, must also have a program in place to fulfill the "General Duty Clause." In 1990, Congress amended the Clean Air Act and added Section 112(r)(1) which defines what the General Duty Clause involves. Among other things, the facilities are responsible for:

- Knowing the hazards posed by the chemicals and assessing the impact of possible releases;
- Designing and maintaining a safe facility to prevent accidental releases;
- Minimizing the consequences of accidental releases that do occur.

To help understand how to fulfill the above responsibilities the EPA, in May 2005, produced a document titled: "Guidance for Implementation of the General Duty Clause Clean Air Act Section 112(r)(1)".

It is important to understand that the General Duty Clause is not a regulation, but it does require companies to have a program in place to address at least the three bullets listed above. In April 2020 the EPA issued a document that listed some things that could be done. Those are:

- Adopt or follow any relevant industry codes, practices or consensus standards (for the process or facility as a whole as well as for particular chemicals or pieces of equipment);
- Be aware of unique circumstances of your facility which may require a tailored accident prevention program;
- Be aware of accidents and other incidents in your industry that indicate potential hazards.

If your system has less than 10,000 lbs. of anhydrous ammonia you should audit what is in place, if anything, to see that you are fulfilling the General Duty Clause. If you do have a program in place you should audit how the program is doing and if any modifications or improvements should be made. If you don't have a program in place you should start developing one as soon as possible.

IIAR has developed codes and standards, as well as other guidelines to help companies design, construct, start-up, maintain, etc. system(s). As mentioned earlier there are IIAR guidelines for PSM/RMP. There is also a guideline to help smaller ammonia systems develop a program. This guideline is called "Ammonia Refrigeration Management" or "ARM".

It can be very beneficial to know that your system is operating in a safe and efficient manner. Also, to audit how your facility programs are working and that they meet Federal and State requirements for your specific system. It is important to monitor your system(s) and audit your programs at a frequency that not only meets Federal and State requirements but also works for a particular system. Don't end up off course or completely lost.

I have many times been asked by companies to review the status of their programs. What I first do is an audit of all of the elements. That audit helps both the company and I have a much better idea of how much effort may be needed to bring various elements up to a condition where they meet the requirements.

Costa Rica Eyes National Standards

A set of Costa Rican refrigeration standards based on IIAR's Suite of Standards is poised to become law in the country, paving the way for other countries in the region to follow suit.

In Costa Rica, the National Fire Protection Association, NFPA, codes already incorporate IIAR standards for anything to do with refrigeration, creating a deference to IIAR standards. However, the new national standards will represent the first time Costa Rica has implemented its own set of standards and codified them into law.

"We're waiting on the new national standards in Costa Rica that are based on IIAR standards to become law. IIAR standards are actually Costa Rica's standards, and have been for several years now, with their own names and designations. What is new is their codification into national law, which is (hopefully) soon becoming a reality," said Yesenia Rector, IIAR Vice President – Education, Outreach and Events.

The effort to institute IIAR standards in Costa Rica has been years long, said Rector, culminating recently in the realization that the country had already informally adopted IIAR's standards through its fire code.

That realization came when IIAR's new Costa Rica Chapter Chair, Catalina Aragón, took over the IIAR Costa Rica Chapter's standards efforts and pointed out that IIAR's standards were already formally in use in the country. Aragón said that discovery will help in the effort to get Costa Rica's own version of the standards codified into law.

"The key in this relationship was Catalina coming on board," said Rector. "Before her arrival, there was good work being done such that IIAR's standards could be adopted as national standards. This was accomplished through the IIAR chapter there, but in a voluntary manner. None of us had put two and two together, but Catalina realized that IIAR's standards were already required through NFPA."

"This accelerated the whole process. We saw that they could become law [faster] because they're already incorporated by reference into a required (by law) NFPA code."

Aragón agreed with Rector, adding that "It would be very difficult to prove the need" for the Costa Rican government to formally adopt a Costa Rican version of IIAR's standards "without IIAR's resources."

"Here we have to prove a need for changes [in law] especially in construction," said Aragón. "Without the standards from IIAR already being in use through the fire code, we'd have to start from zero.

"This has been a powerful tool for us. We can go full-handed to the government and demonstrate that we are doing something important for safety in this industry and we're protecting not just the health but the investment of the industry in the country."

While Costa Rica's government has not yet formally incorporated the industry's new standards, Aragón said the law that will accomplish that is already written and awaiting approval.

In the meantime, the natural refrigeration industry in the country is preparing by moving ahead with training and education.

Federico Alarcon Lopez, IIAR Latin America Programs Manager, said IIAR's local chapter will partner with the Colegio de Ingenieros Electricistas, Mecánicos e Industriales, the professional national organization that represents and regulates electrical, mechanical, and industrial engineers in the country, to provide training on Costa Rica's new standards.

"While our government figures out when they're going to make our new standards into law, we're paving the way for our professional community to be ready to apply them," said Aragón.

The relationship between CIEMI and IIAR's Costa Rica chapter is especially valuable because CIEMI runs the national certification program that certifies engineers to work in the country in specialized areas like natural refrigeration.

"Before we can work in this industry, we'll have to go through a three-year program to get certification to show that we can apply these standards," said Aragón, adding that IIAR and CIEMI's ability to proactively start the process of training professionals on the new standards is part of why they're being adopted.

"This has really helped the government make their decision," she said. "They don't have to wait for the engineers who are building these systems or the inspectors inspecting them to come up to speed. We can say we're already doing that; there's no reason to delay the standards."

IIAR's Alarcon Lopez said the educational collaboration with CIEMI will produce contractors and manufacturers who are better positioned to implement Costa Rica's new standards. "This grows the security of our industry. The principal goal of IIAR in the region is the education of end users."

"Our chapter mission is to provide information and education for everyone."

While Costa Rica's government has not yet formally incorporated the industry's new standards, Aragón said the law that will accomplish that is already written and awaiting approval.

Don't Overlook Mechanical Integrity

Smaller facilities are starting to pay more attention to mechanical integrity, as it remains one of the most cited violation types. Adding to the pressure on facilities to renew focus on mechanical integrity, IIAR 62019: Inspection, Testing, and Maintenance of ClosedCircuit Ammonia Refrigeration Systems was adopted into the 2024 edition of model codes as the minimum requirement for ITM (Inspection, Testing, and Maintenance) standard for ammonia refrigeration systems, regardless of the system charge.

The standard states that owners must comply once it is adopted by the local authority having jurisdiction, AHJ. So what can facility owners do to make sure their programs are up to speed? Develop and implement a mechanical integrity plan that incorporates the ITMs outlined in IIAR-6, said Doug Reindl, founding Director of the Industrial Refrigeration Consortium.

"For any system built in 2024 or later, the model codes reference IIAR-6 as a requirement," said Reindl. "And for facilities that are not under PSM, the model code adopted by the AHJ still applies."

"In cases where we have data on OSHA's national emphasis program, mechanical integrity is either the number one or number two most cited element year over year. Why? OSHA field inspectors continue to find gaps," said Reindl.

For most facilities, the factors within mechanical integrity that people miss the most include not having a written program that guides a facility's mechanical integrity efforts or not doing inspections or tests at specified intervals.

"It's hard once you get behind because of staff turnovers or transitions, but time keeps moving ahead," said Reindl. He added that having a plan to keep up with mechanical integrity, for example, by accounting for variation in staff resources, is another way facilities can keep up.

Aside from avoiding regulatory enforcement activity, businesses have a compelling case for focusing on mechanical integrity. "If facilities are diligent about doing inspections and tests and they retire their equipment before it fails, the reliability of their ammonia refrigeration systems improve and that avoids unplanned outages. Avoiding equipment failure helps protect people on-site, the off-site public, and the environment while delivering continuity in business operations."

Learning mechanical integrity for ammonia refrigeration systems also makes facility personnel more acutely aware of the warning signs of degradation.

"Facilities should ask . . . what are the specific mechanisms that degrade ammonia refrigeration infrastructure specifically? And they should use that information to do inspections and targeted testing as-required and replace that equipment before the end of its life," said Reindl.

Mechanical integrity as a subject may not get as much focus as other areas, but for facilities, keeping a close eye on it can ensure the business is doing everything it needs to do for the safety of its systems.

Often that starts with simple familiarity and awareness.

"One of the biggest factors that degrades mechanical integrity is the external corrosion of piping and vessels, something that's easy to see occurring on uninsulated piping and vessels," said Reindl. "If you see ammonia refrigeration piping or vessels visibly corroding and ignore it, the wall thickness will continue to be reduced and the potential for an uncontrolled release increases."

"With insulated equipment, corrosion under insulation is a concern so additional techniques are needed to gauge the condition of the piping or vessel," he said. "A critical part of protecting the [mechanical integrity] of this equipment is ensuring the external surfaces of all insulated piping and vessels are properly coated before insulating."

Reindl said the last part of the process – following up – is often the easiest to forgo. "Checking in and looking at maintenance over the life of the equipment so you can monitor and truth test to make sure there's no activity under the insulation, in terms of corrosion, is important."

IIAR members can access Doug Reindl's ANR course focused on mechanical integrity via their IIAR member portal.

"One of the main goals for this course is to get attendees to understand the sorts of tests that their routine maintenance requires so they don't have unplanned failures," said Reindl. "Particularly those that could cause an unplanned release."

IIAR Reduces Student Membership Rate

Membership in IIAR, the industrial refrigeration technical association of record, has changed since its inception nearly four decades ago. What began as a small standards-creation effort led by a group of engineers has ballooned into a community of contractors, end users, manufacturers, students and even regulators.

To keep pace with the needs of a rapidly diversifying membership, IIAR changed its membership structure in 2022, added to its member benefits in 2024, and continues to make small changes to make membership more accessible than ever.

Mike Chapman, Vice President – Operations for IIAR, said people tend to think of membership as a means to get discounted conference registration, but there is much more to it. "People aren't completely aware of all of the benefits on offer," he explained. "There are a lot of resources to help our members grow professionally from a development standpoint."

One of the biggest changes this year is the student pricing fee structure, which went from $100 to $30 to make membership more affordable for students, said Lisa Berryman, Senior Operations Services Manager. She added that other member benefit additions include IIAR's certificate course for IIAR-6 2025 in Spanish and the IIAR job board, which is intended to connect IIAR members with candidates for entry-level jobs across the industry.

IIAR member benefits have grown so much in recent years, it might be tempting to pay attention to just the new benefits without exploring everything that is being offered, said Berryman.

"The biggest points are the free course offerings. A lot of people are interested in that as a benefit because the value you get for membership outweighs buying them one at a time as a nonmember," she said. "Other benefits are free registration to our monthly webinars, access to recorded technical content from past conferences, access to all of the IIAR standards and our library of materials published in the past like IIAR bulletins."

Berryman said IIAR's library of superseded standards is especially valuable for members looking for context on how their technology has evolved. "Being able to tap into that knowledge base if you're an IIAR member" is important.

Beyond benefits, IIAR's recent membership structure change is still paying off for people who find the new process more streamlined.

"The group company membership has the best value when it comes to companies that need more than one person to have access to their benefits," said Berryman. "We've recently had a lot more individual members upgrade."

Ben Dawes, IIAR's Advocacy and Digital Marketing Manager, agreed with Berryman. "Ever since our revamp of membership – to put one company administrator in charge of managing membership for each member company – that change alone has made things much simpler," said Dawes. "The main point is that we have one single company administrator now who can manage member changes, upgrades and other things on behalf of the company."

Dawes said this and other changes, like offering a job board as a member benefit, are ways to encourage people's interest in the industry by making participation easier.

"We've wanted to get people in the door [by streamlining membership] and at the same time, we wanted to highlight jobs that can get people interested for the first time [in their career]. The idea is to create an easy pathway to get people into the industry."

That growing interest is visible in the scholarship program run by the Natural Refrigeration Foundation, where scholarship applications are substantially higher this year than in previous years, an outcome Dayna Martinez, IIAR Education Programs Manager, attributes to a growing awareness of IIAR.

"There's been an increase in interest from our student population thanks to our university engagement team and all the outreach they do. There's definitely an increased awareness of the future this industry has to offer students," she said.

MEMBERSHIP PRICING

IIAR has created several different membership tiers to meet a wide range of needs. Individual Company membership is a single membership where a member is registered under their company of employment.

If additional employees from the company would like to join, companies can upgrade to a Group Membership, which includes up to 25 members. If companies would like to add more than 25 employees, they can do so at a significantly discounted rate. "If they have dozens of technicians or a lot of people in the plant that can use training, the value proposition is the significant benefits for the lower cost," Chapman said.

IIAR also offers special membership at a discounted rate to affiliates, such as regulators and first responders, academics, students, and retirees.

Beyond benefits, IIAR's recent membership structure change is still paying off for people who find the new process more streamlined.

IIAR Eyes AHJ's to Replace Federal Enforcement

A new picture of how regulatory activities might function in the future is emerging, thanks to efforts by the International Institute of All-Natural Refrigeration's "NH3 Overdue Regulation Modernization," or NORM, task force.

The task force is currently asking regulators to remove PSM/ RMP requirements that duplicate across agencies or defer to IIAR standards where the standards and regulations overlap. Once it gets federal buy-in for IIAR standards, the committee hopes to convince OSHA and EPA to find a way to shift resources to local enforcement bodies outfitted with IIAR standards.

"The concept is that if facilities are following, implementing and conforming to IIAR standards, then they are doing everything that needs to be done to satisfy federal regulatory requirements," said IIAR Vice President of Operations Mike Chapman.

"The second part of this plan is IIAR's effort to get funds from federal or state governments to train local enforcement teams. Because this concept is a state and local program, building relationships between the enforcement folks and the facilities is key," said Chapman. "Optimally, this is a way to build amicable relationships with regulators with the main focus on prevention."

"This is the fundamental second step," said Kurt Liebendorfer, Vice President of Evapco and chair of the NORM task force, once regulatory duplication has been addressed. "We'll develop a business plan that proposes moving more funding to the states so [regulatory activities] can be enforced at a local level rather than the federal level."

> "There's a reduced emergency response cost, and the community is in a better place because better communication means lower friction between industry and the community."

The plan would advocate for an ideological shift from isolated enforcement activities on the federal level to ongoing local enforcement activities built on closer connections between Authorities Having Jurisdiction, or AHJ's, and the facilities in their jurisdiction.

Under the plan, federal money would be shifted to AHJs to bolster education and outreach and build a more holistic approach to enforcement, which could help facilities correct course before major risks have a chance to build.

"Why wouldn't we push to work with regulators more amicably if it's more likely that we can accomplish this goal at the local [rather than federal] level?" said IIAR President Gary Schrift. "When you move the enforcement authority and funding to the local level, those are the people in the same community who can educate each other and stay in communication."

Giving AHJ's – like a local code inspector or emergency personnel like a fire chief – more regulatory responsibility would require that they also be given more resources so they can fund extra time, focus and education at the local level, added Schrift. The idea isn't new and is already used for specialized enforcement niches across the country.

Closer interaction with the local responder community has also been a long-term initiative for the EPA that is underfunded.

Evapco's Liebendorfer agreed, adding that "The federal government already allocates a large portion of funds that are funneled from the federal [enforcement budget] to some states for these things. We want to map out this idea . . . how do we shift more of this money to the local level where it can be more effective in advancing best practices?"

Many of the safety efforts of local AHJ's are currently underfunded or overlooked, said Liebendorfer, and IIAR's plan could be a template for the federal government to use to create funding pipelines to local communities. "This makes sense because there are already many emergency response communities that are begging for more money."

District Fire Chief for the City of San Antonio, Mark Trevino, who runs a 54-person hazardous materials team and writes most of the department's grant proposals, said federal regulators could look at a funding shift as a way to build close ties between emergency managers and the facility teams they work with, a crucial step in reducing the possibility that big risks develop in the first place.

"Nothing we do proactively is going to hurt anybody," said Trevino. "If we can get in there and develop relationships first, then when it comes time to go check on a company, and there's a violation, we can look at it together and say, 'that's not a great idea' and then come back to follow up later."

Trevino compared the ongoing safety monitoring that would be possible in the local community under IIAR's plan to the concept of regulating normalization of deviance.

"The further you drift away from what you know you should be doing, the more trouble you'll be in later," he said. "It starts with these little violations, and before you know it, you're drifting away from the standards you know you should be following."

"Developing these local relationships and giving AHJ's the resources to do that work helps build the structure that prevents normalization of deviance from happening – because frequent visits and communication uphold that framework [of standards]," said Trevino. "The closer you get to the people, the bigger impact you're going to make."

IIAR's Chapman said that IIAR's plan could also help the federal government harness the efficiencies AHJ's are well positioned to provide, by driving enforcement to the local level where an environment of frequent contact and communication can support it.

Emergency management "is where coordination is the most important, where the resources are best spent, and where relationships are best served," said Chapman. "Any preparedness and response activities occur at the local level. Rarely, if ever, do any incidents rise to the level of federal or even state response."

This environment – where preparedness and response happen locally, but

IIAR EYES AHJ'S (continued from page 25)

enforcement happens at the state or federal level – could be a big factor contributing to the duplication and cost of the current regulatory environment, said Chapman.

"If local implementation [of enforcement] can get a better response from industry and from AHJ's, why not?" said Chapman. "There's a reduced emergency response cost, and the community is in a better place because better communication means lower friction between industry and the community."

Local implementation is also the best use for IIAR codes and standards, said Chapman, adding that IIAR's concept would make IIAR standards the foundation of a local enforcement plan, where they can be the most effective.

Giving local AHJ's enforcement authority and funding will naturally create a closer collaboration with industry, said Chapman, leading to a situation where "industry not only helped create the standards everyone has to follow, but there's a natural consensus and buy-in for these standards."

"That's the nature of industry best practices. When you have a consensus around best practices for standards, you can't get anything better from a safety and enforcement standpoint. Because these tools are created by the people who make and use the technology."

Meanwhile, Mike Gray, Fire Prevention Captain for the San Antonio Fire Department, who oversees the Hazmat activities for San Antonio, said his team is exceptionally prepared to meet the challenges of local emergency response; additional federal resources for education, training and enforcement would go a long way in helping his jurisdiction proactively manage safety.

Two large ammonia facilities are currently being built in San Antonio, and the team isn't funded well enough to do more than educate themselves and prepare as much as possible, said Capt. Gray.

"If we could carry out enforcement, that would be fantastic," he said, adding that "right now if we were to find a problem at one of these facilities, there's not a lot we can do. And if I can't [proactively] address issues from my side, all I can do is prepare our guys to respond."

Three Questions to Consider for a Good Inspection Plan

In an age of proliferating diagnostic tools, visual inspections are still needed, and equally important, an inspection plan a facility can follow. And while IIAR – 6 Inspection, Testing, and Maintenance of ClosedCircuit Ammonia Refrigeration Systems provides a starting point, system owners must develop a complete plan.

"There are no Cliff Notes for IIAR-6, though there is a huge opportunity for teams that lean on the standard – it is a tool in their quiver," said Suzy Vohsen Bos, Director, Marketing and Client Services of Gamma Graphics Services and the instructor of IIAR's latest webinar, The Nitty Gritty of Visual Inspections.

Vohsen Bos added that most people reasonably assume IIAR – 6 will lay out the exact parameters of a Mechanical Integrity (MI) evaluation without realizing that the standard only gets you part of the way. "This is why we have so many people attending this webinar; you really have to dig into this," she said.

Nevertheless, Vohsen Bos cautioned that visual inspections do have limitations and should not be treated as the only safety measure, especially now that so many diagnostic tools are available.

"For years, we lacked the technology to get clear answers about the fitness of each component of the system, so everything hinged on visual inspections," she said. "You watched for anything you could see, hear, or smell — signals to dig deeper, repair, or replace. Now we have the tools to deliver quantitative data, whereas visual inspections only offer qualitative suggestions. "While there are plenty of opportunities to specify the diagnostic technology that might be needed for follow-up, formulating a plan specific to a facility is still the first step.

To do that, said Vohsen Bos, she recommends using three questions to set goals and expectations and then write the plan.

"The first two questions set the parameters an organization will need to create their plan and focus them in on being honest about what they can do."

"When this is done correctly, it really helps to streamline everything," she said. "If the facility decision-making process is considered, that makes it much easier to follow the plan. Your ideal plan will tell you everything you need to know about making decisions once those requirements are set."

Vohsen Bos leads webinar attendees through three questions to help them get familiar with the process required to formulate a good visual inspection plan:

1) Ask . . . Why am I performing evaluations? For example: Is it safety? Mechanical integrity? To check the regulatory box? The answer to this question will set the framework for how aggressive and thorough you're going to be.

2) Ask . . . What is the corporate culture? For example: Is everybody on board? Do I have inspection and testing designated in the budget? What are my limitations? How often do I perform in-house testing? What are the testing limitations?

3) Ask . . . What are the minimum operating components for the system? For example: What are [the maintenance limitations] I'm going to decide for each component?

The third question, said Vohsen Bos, is where a facility can really start to build out its plan. "Start with your minimum requirements to answer: what is the lowest operating threshold I'm willing to tolerate for every component of my system? Then ask: what happens when I reach that minimum? What happens when I approach it?"

Finally, said Vohsen Bos, do not forget to follow through because that's where most citations end up happening.

"The first two questions in this list protect you from mapping out an unrealistic plan. Corporate culture ultimately defines what's possible and drives decisionmaking," said Vohsen Bos. "You have to make sure this is something your facility can follow. A good evaluation action plan presents a very strong position for PSM and RMP, but if you create a guide and don't follow it, that's a really good way to get cited."

2026 TECHNICAL PAPER #8

CASE HISTORY:

The Reverse Piston Design: Taking the Load Off High-Pressure Refrigeration and Sustainability Challenges

MICHAEL GERSMEYER

ABSTRACT

The industrial refrigeration and heating industries are increasingly affected by the transition to low–global warming potential (GWP) refrigerants and decarbonization initiatives. Consequently, industrial refrigeration and heating applications now often require high suction pressures due to their use of low-GWP refrigerants such as NH3 or CO2. To address this challenge, new compressor designs must be used to extend bearing life and increase the intervals between maintenance downtimes. This paper presents a novel design that reduces bearing loads,prolongs compressor life, and improves system uptime while reducing maintenance costs.

Introduction

Industry Trends and Background

With the transition to low-global warming potential (GWP) refrigerants and the increasing emphasis on decarbonization, the industrial refrigeration and heating industries have been actively seeking solutions that utilize environmentally friendly refrigerants. CO_2 is one example of such a refrigerant; however, CO_2 systems require relatively high working pressures, and, in many applications, require high suction pressures compared to conventional refrigerants.

Problem

High suction pressures in refrigeration compressors can impose a significant load on compressor components, including bearings. Specifically, high suction pressure can generate significant axial loads in screw compressors, leading to accelerated wear in thrust bearings, reducing their service life; in some scenarios, this reduction can be significant. Severe bearing wear can lead to the shutdown of refrigeration systems for maintenance in order to replace or repair damaged bearings. Such shutdowns are costly due to labor required to perform maintenance, the cost of replacement parts, and the loss of production during the downtime.

For several decades, various methods have been used to mitigate high axial loads on bearings in screw compressors. These methods include larger bearings, specialty bearings, additional bearings, and balance pistons; however, these solutions are often complex or costly.

For example, the use of larger or additional bearings is not always feasible: this solution requires physical space that may not be available within the housing of compact machine designs. Specialty bearings can be employed, but are often costly.

Although these methods can increase the service life of bearings, they do not address the root cause of the problem, the high axial loads. Consequently, acceptable bearing life may still not be achieved when employing these methods.

Traditional balance pistons often have a rotating piston that is attached to the end of the rotor. The piston fits within a cylinder sleeve that guides the piston and forms a pressurized cavity. High-pressure oil is supplied to the piston, producing a force that opposes the axial load on the rotors, thereby eliminating some of the axial load applied to the thrust bearing. In twin screw compressors, balance pistons can be used on the male rotor, female rotor, or both.

However, suction pressures can decrease dramatically when compressors are unloaded. Under such conditions, the bearings may become overloaded by the high-pressure oil. To prevent this, the high-pressure oil must be regulated by a set of valves, orifices, and in some cases, electronic closed-loop controls. These control methods can be complex and costly.

Consequently, a simple solution was required to significantly increase bearing life.

Proposed Solution and Description

Single-screw compressors are designed such that the compression forces are balanced. This can be seen in Figure 1, where the forces *F comp 1* and *F comp 2* are equal and opposite along the axis of the screw rotor. Therefore, these forces cancel each other out. There are other forces created by the compression cycle in the axial direction. However, these axial forces due to compression are negligible and will therefore be considered zero for this paper.

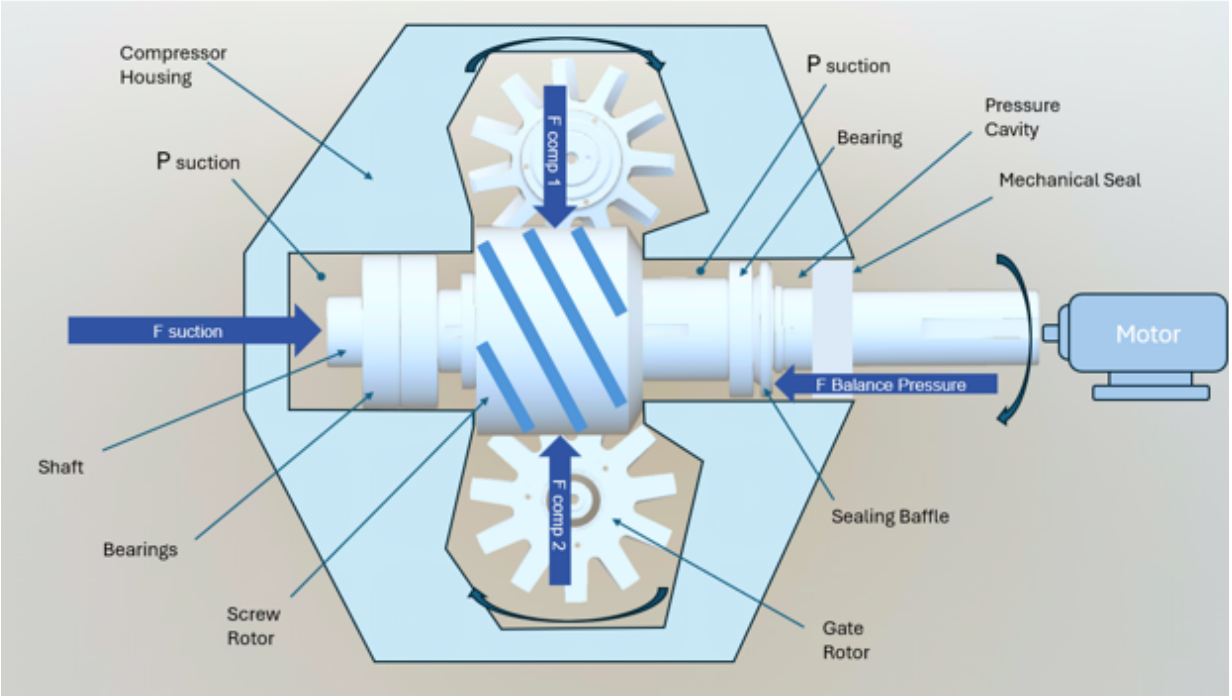

Figure 1. Single-screw compressor free-body diagram.

The remaining axial force acting on the assembly is generated by the suction pressure, labeled as *P suction* in Figure 1. Note that *P suction* acts on the end of the shaft opposite the motor. The opposite end of the *shaft* extends through the *compressor housing*, where it is coupled to the motor. Consequently, the only force generated by the suction pressure in the axial direction is *F suction*, which acts on the leftmost end of the shaft.

In contrast, the reverse piston design offsets *F suction* by employing a *sealing baffle* that creates a *pressure cavity*. The sealing baffle is keyed to the *screw rotor shaft* of the single screw compressor, causing it to rotate with the *screw rotor*. The pressure cavity fills with oil that is used to lubricate the *bearings* and the *mechanical seal*. A labyrinth seal on the sealing baffle holds the oil within the *pressure cavity*.

When *F suction* increases due to increasing suction pressure, the *F balance pressure* also increases. The *F balance pressure* opposes F suction such that the axial loads experienced by the *bearings* are significantly reduced.

Examples of Bearing Life Increase

The following calculations and scenarios illustrate the effect of suction pressure on bearing life. The axial force generated by suction pressure is the product of the cross-sectional area of the shaft multiplied by the suction pressure. For a shaft with a diameter of 2.5" operating at a suction pressure of 300 psi:

$$F_{suction} = A_s \times P_s, \text{ where } A_s \text{ is the Shaft area and } P_s \text{ is the suction pressure}$$

$$F_{suction} = \pi * (2.5"/2)^2 * 300\ psi = 1{,}472 \text{ lbs}$$

An axial force of 1,472 lb represents a significant load that can lead to reduced bearing life when the compressor is operating continuously.

Table 1 presents a few feasible scenarios and the resulting increase in bearing life.

Scenario	Standard L10 bearing life in years	L10 bearing life in years with reverse load	Reverse load force in lbs
#1	7	12	450
#2	7	20	910
#3	5	14	910
#4	16	50	682
#5	5	29	1364

Table 1. Feasible scenarios and resulting increase in bearing life.

Table 1 shows that a load of 1472 lb. can be substantially counteracted by the reverse load generated by the reverse piston design.

Examples of Designs That Increase Bearing Life

Bearing life has long been a concern in screw compressors. This section provides a description of several designs used in the industry to increase bearing life. The intent of this section is not to present a complete technical description of each design, but rather to provide some context on recent developments in the industry.

Balance Mechanism with Slide Bearing

The following configuration was designed by Takaki et al. (2015), which uses a thrust plate located at the end of the rotor shaft to limit the thrust force transmitted to the bearing. This component is represented by item 46 in Figure 2. The amount of thrust can be adjusted depending on the pressure differential between the suction and discharge pressures. The adjustment is carried out by a control unit that is comprised of pressure sensors and a control unit, represented by item 80 in Figure 3.

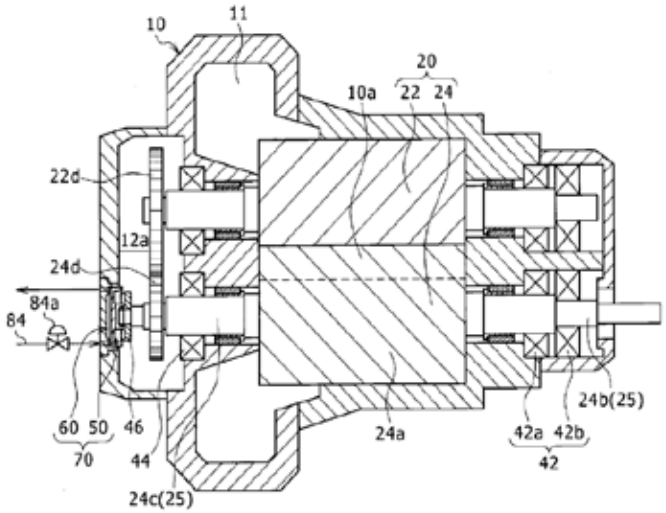

Figure 2. Compressor section view.

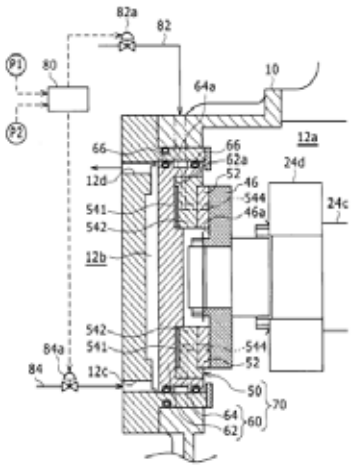

Figure 3. Detailed view.

Bilaterally Symmetric Screw Compressor

This configuration was designed by Hossain et al. (2015) and comprises a single screw rotor with two sets of grooves. Inlet ports are located near both ends of the rotor, while the discharge ports are positioned near the center. This symmetrical design balances the axial forces on the rotor, reducing the load imparted onto the bearings. However, this approach requires additional machining and gate rotors, increasing the overall cost of this design.

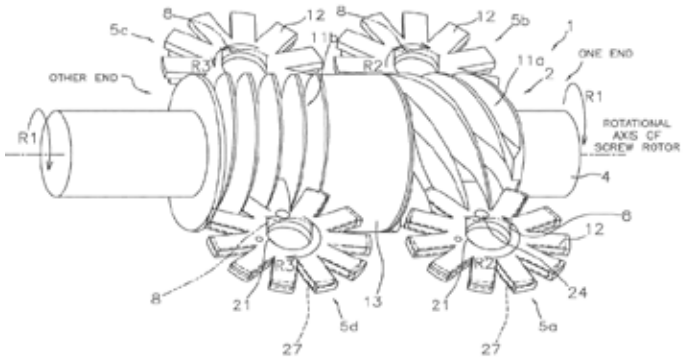

Figure 4

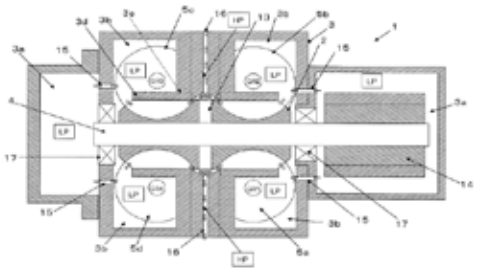

Figure 5: Block diagram showing pressures

Balance Piston for Twin-Screw Compressors

This approach uses control panels to monitor pressure and adjust the oil pressure as needed to ensure that the bearings are not overloaded (Johnson Controls, 2022). This design requires multiple balance pistons, while the control system can be complex and costly.

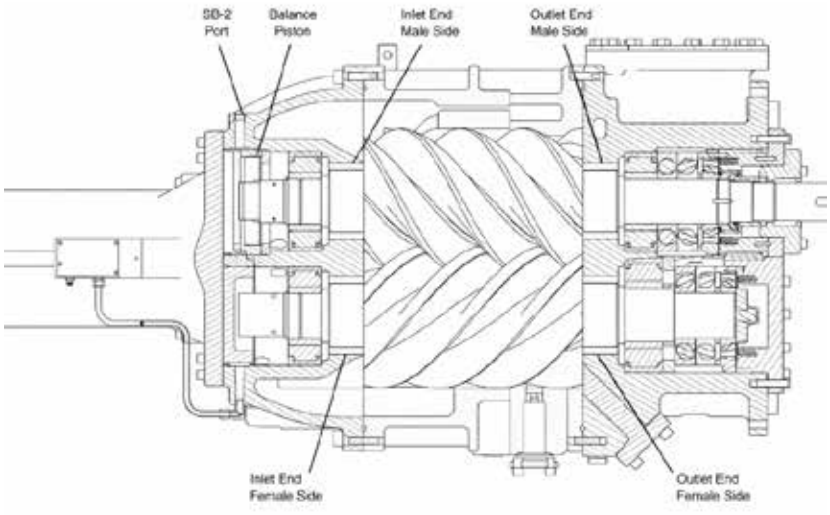

Figure 6

Compressor With Balance Piston Using Slide Valve Position to Adjust Balance Pressure

In this design, a fluid source provides pressure to the balance piston (Nemit, 2014). However, the equipment to regulate the pressure may include a controller, solenoid valves, algorithms, a pressure transducer, and a feedback mechanism. This apparatus can be complicated and expensive.

The complexity of this design can be reduced by regulating the pressure acting on the balance piston (item 145, Figure 7) using the position of the capacity slide valve. When the compressor is unloaded, the fluid pressure applied to the balance piston is reduced, thus reducing the force of the balance piston and the load on the bearings during unloaded operations.

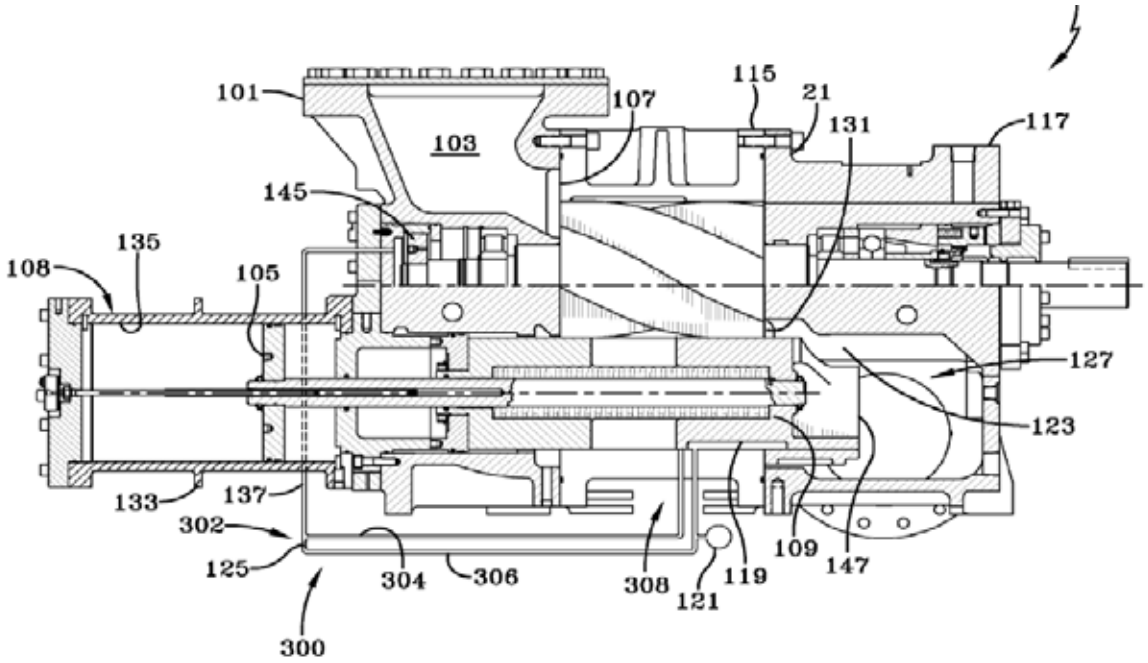

Figure 7

Balancing Piston Device

This design uses balancing pistons (item 67, Figure 8) that exert a biasing force on screw rotors (Schibbye et al., 1976). The force is generated by oil pressure entering at location 69 and the pressurizing cavity at location 62 (Figure 8). The oil is supplied from the lubricating system.

The oil pressure in this system must be regulated to ensure that the rotors are not overbalanced or underbalanced. Therefore, a regulation system would need to be used (not shown in this figure). The regulation system can be controlled using valves, orifices, or closed-loop electronic controls.

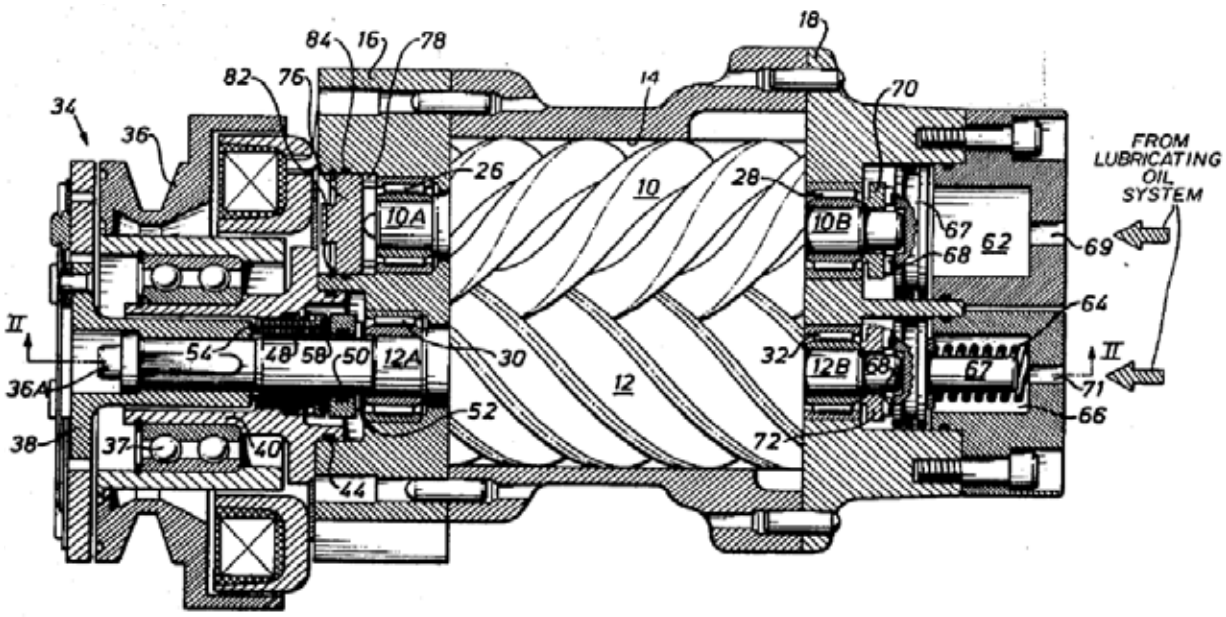

Figure 8

Conclusion

Higher working pressures in compressors can generate substantial bearing loads, thereby significantly reducing bearing life. The reverse piston design attempts to mitigate this issue, leading to significantly increased bearing life. This is accomplished by pressurizing a cavity with oil pressure that is already supplied by the compressor system. The pressure cavity generates a reverse load that counteracts much, and in many cases nearly all, of the load imparted by the suction pressure acting on the main rotor shaft. By offsetting the force generated by the high suction pressures, the bearing load is reduced and bearing life extended. The implementation of this design can lead to reduced maintenance costs for industrial refrigeration and heating operators that aim to utilize low-GWP refrigerants such as CO_2.

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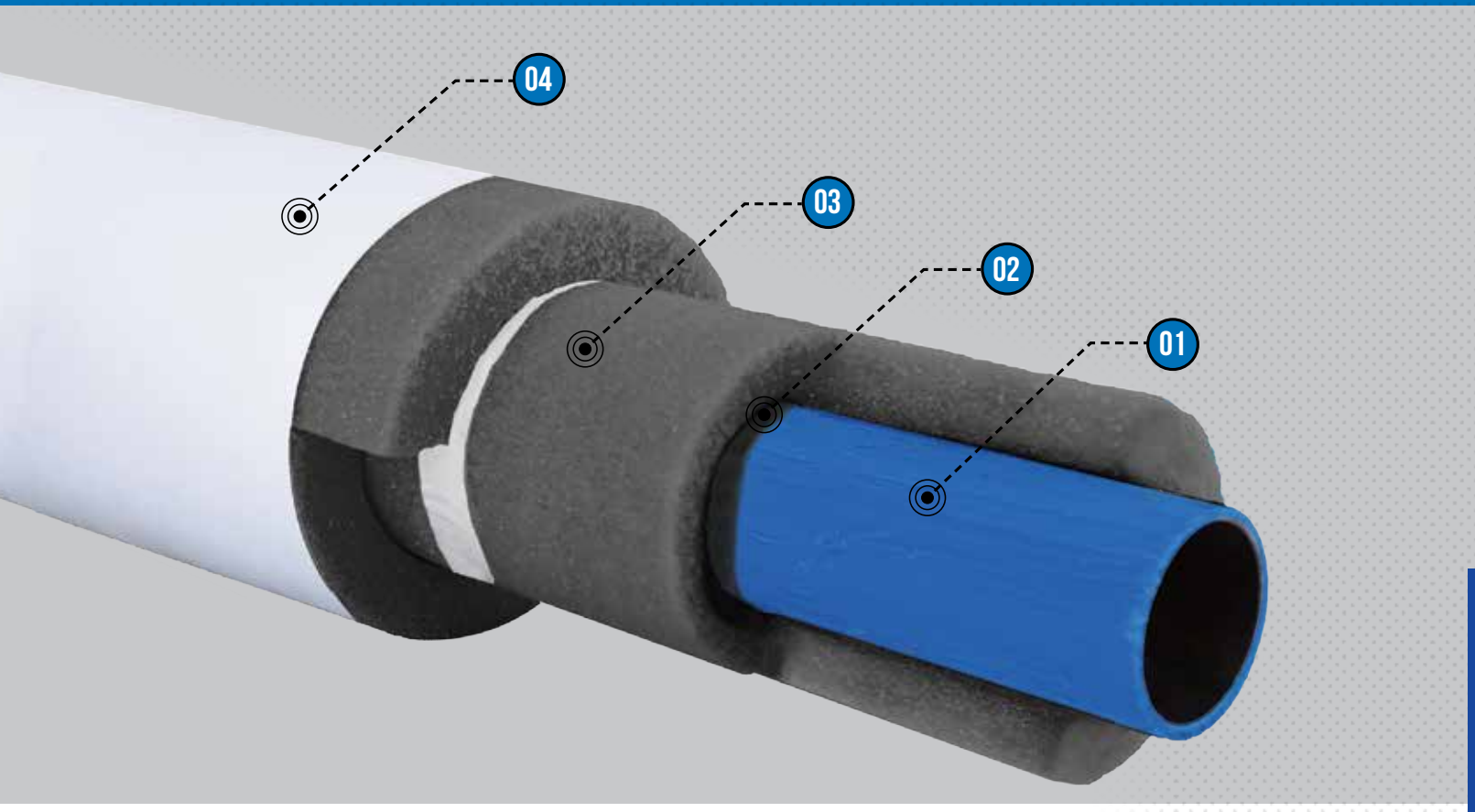

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