High-Performance Measure Details

Measure Name
Low-GWP Refrigerant Systems

Use Category
Other- Low-GWP Refrigerant Compressor Based Systems

Effective Date
May 11, 2026

Version
3.1

Measure Code
LM407

Measure Stage
Early Adoption & High Priority Data Collection

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Technology Summary

Low-GWP refrigerant systems use refrigerants with lower climate impact than legacy HFCs in heat pumps, chillers, heat pump water heaters, VRF/VRF-like systems, commercial refrigeration, and other HVAC&R equipment. For CEDA, this HPM supports electrification and decarbonization in new construction by addressing the refrigerant-related emissions that remain even when buildings move away from onsite fossil fuel use.

This matters in California because electrification depends heavily on vapor-compression equipment. If refrigerant charge, leakage, service practices, or equipment selection are poorly managed, refrigerant emissions can reduce the lifecycle carbon benefit of electrified systems. Low-GWP refrigerants also require practical design coordination, including equipment listing, code compliance, service access, pressure management for CO_2 systems, and safety considerations for mildly flammable or flammable refrigerants.

The most common performance gaps this HPM is designed to prevent include selecting refrigerants without confirming efficiency and capacity at design conditions; excessive refrigerant charge from long piping runs or system configuration; incomplete leak detection, labeling, or service access; poor charging, evacuation, start-up, or commissioning practices; weak coordination with safety requirements for A2L, A3, or CO_2 systems; and owner turnover that does not address refrigerant management or future maintenance needs.

Relevant standards/certifications include ANSI/ASHRAE Standard 34, ANSI/ASHRAE Standard 15, ANSI/ASHRAE Standard 15.2, UL/CSA 60335-2-40, AHRI 210/240, AHRI 340/360, AHRI 550/590, AHRI 1230, AHRI Directory Certification, ENERGY STAR, and NEEA Advanced Water Heater Specification.

Alignment with CEDA Program Goals

The CEDA program supports the implementation of energy efficiency measures that support Code Readiness's Long Term Tactical Plan (LTTP) to drive the goals of electrification, decarbonization, and load reduction.

Projects must meet one of the CEDA Inducement Requirements identified in the next section to receive an inducement on the equipment and will be evaluated for level of interest in metering to support Code Readiness Objectives.

This measure meets the CEDA program goals as follows:

- **Building partnerships with market stakeholders** by consulting on innovative technologies and best practices in energy efficiency, which can lead to the development of more effective solutions and accelerate the adoption of new technologies. As teams adopt the measure, this increases the volume of engineers able to design the equipment, contractors capable of installing the equipment, and owners able to operate the equipment.
- **Increasing the supply of high-performance measures and all-electric buildings** by combining electrification with energy efficiency that can result in projects implementing measures to achieve greater energy savings, reduced emissions, and overall improved building performance. As more buildings specify and install low-GWP-based systems, this helps to increase the overall supply of low-GWP refrigerants in the market for others to use, including beyond new construction.
- **Increasing the demand for high-performance measures and all-electric buildings** by pushing for electrification that drives the need for technological advancements, supporting economic growth opportunities through innovation, and raising awareness of the benefits of electrification to increase consumer adoption. As demand in the market increases for newer technologies, the long-term benefit is increased demand for manufacturers and suppliers to provide additional options available in the market.
- **Advancing new high-performance measure technology** by raising public awareness about new technologies and their benefits, helping build acceptance and demand through market support advocacy efforts that can influence stakeholder decisions that enable technological innovation.
- **Providing Codes & Standards with projects of interest** to collect metered data that will inform future California energy codes.

CEDA Inducement Requirements

This measure is intended to address a market and regulatory transition gap associated with the adoption of low-GWP refrigerants in building systems. While federal and state regulations are increasingly limiting the use of high-GWP refrigerants, adoption of low-GWP alternatives—such as CO_2, hydrocarbons, and emerging refrigerant blends—may require changes in equipment selection, system design, or safety considerations that can increase first cost or introduce additional implementation complexity.

Current Title 24 requirements do not explicitly regulate refrigerant GWP at the system level, and while CARB and EPA rules are driving phasedown of high-GWP refrigerants, there remains variability in how and when low-GWP systems are implemented across different end uses. This measure is designed to accelerate adoption of low-GWP refrigerant technologies by providing inducement support for projects that incorporate qualifying systems across HVAC, service water heating, and process load applications.

Inducement eligibility is determined based on the refrigerant used in the qualifying mechanical equipment, not on secondary heat-transfer fluids, absorbents, or hydronic loop fluids across building systems, with higher inducement levels corresponding to broader application across major end-use categories. Projects must meet the applicable requirements below, with lower-level requirements satisfied prior to qualifying for higher-level inducement tiers.

System Design Requirements

1. **Essential level**: Targeted Low-GWP Adoption
   - 1.1. Provide one or more pieces of refrigerant-based equipment utilizing refrigerants with a GWP less than 250, serving any major building end-use category.
     - 1.1.1. Major end-use categories include HVAC, service/domestic hot water, and process load systems (if applicable).

2. **Advanced level**: End-Use Complete Low-GWP
   - 2.1. Provide refrigerant-based equipment serving at least one major building end-use category, where all refrigerant-based equipment serving that selected end-use category utilizes refrigerants with a GWP less than 250.
     - 2.1.1. Major end-use categories include HVAC, service/domestic hot water, and process load systems (if applicable).

3. **Premium level**: Whole-Building Low-GWP
   - 3.1. Provide refrigerant-based equipment serving all major building end-use categories, where all refrigerant-based equipment across each applicable end-use category utilizes refrigerants with a GWP less than 250.
     - 3.1.1. Major end-use categories include HVAC, service/domestic hot water, and process load systems (if applicable).

Supporting Documentation Requirements

For all of the above system design levels, the following documentation must be provided:

- Provide engineered, stamped, and permitted construction plans demonstrating that the project design fully complies with all state and local jurisdiction requirements and regulations.
- Provide equipment submittals stamped and approved by the responsible engineer of record.
- Provide equipment cost information.

Incremental Measure Cost

The Incremental Measure Cost (IMC) values presented below are intended for CEDA program planning and inducement calibration purposes only. These values represent normalized estimates of incremental first cost associated with implementing systems that utilize low-GWP refrigerants relative to conventional baseline systems using higher-GWP refrigerants.

This measure applies across multiple system types, including HVAC, domestic/service hot water (DHW/SHW), and process load applications. Because system configurations, refrigerant selections, and design requirements vary by application, IMC values are presented separately for each system category using appropriate normalization units.

Actual project costs may vary significantly based on system size, refrigerant type, safety requirements, operating pressures, and installation complexity. The values below are intended to reflect typical market conditions for new construction and are not representative of contractor bids or project-specific cost reconciliation.

HVAC Systems

Base Case

The HVAC Base Case is conventional refrigerant-based HVAC equipment serving the same heating and/or cooling load as the proposed system. This may include, but is not limited to, direct expansion (DX), variable refrigerant flow (VRF), packaged rooftop units, split systems, heat pumps, or chiller-based configurations using standard market refrigerants, safety classifications, operating pressures, and installation practices representative of current code-compliant market conditions.

Measure Case

The Measure Case replaces conventional refrigerants with low-GWP refrigerants with GWP < 250, including CO_2, hydrocarbons, and qualifying low-GWP A2L refrigerants where applicable. Systems are designed to meet the same thermal loads and performance requirements as the Base Case. Implementation of low-GWP refrigerants may require equipment redesign and additional system components due to refrigerant-specific characteristics, including:

- Flammability classifications (A2L/A3), requiring leak detection, ventilation, or charge limitations
- Higher operating pressures (e.g., CO2 systems), requiring pressure-rated components
- Modified system architecture, controls, and installation practices

IMC Values and Normalization

IMC values are normalized per ton of nominal cooling capacity served by qualifying HVAC equipment using refrigerants with a GWP less than 250. The values are intended for CEDA program planning and inducement calibration and are not project-specific cost estimates. Cost premiums may vary based on refrigerant type, equipment availability, safety classification, pressure requirements, charge limits, leak detection, ventilation requirements, controls integration, commissioning, and installation complexity.

Qualifying HVAC Equipment Capacity	IMC Values
Small / distributed HVAC systems: < 50 tons	**$400/ton**
Medium / large HVAC systems: 50 – 299 tons	**$300/ton**
Large central plant / chiller systems: ≥ 300 tons	**$250/ton**

For CO_2, R-290, or other higher-complexity low-GWP HVAC systems, CEDA may apply project-specific cost review or an additional complexity adder where the project demonstrates incremental cost impacts associated with high-pressure components, A3 refrigerant safety requirements, specialized ventilation, leak detection, or nonstandard installation requirements.

Sources

- Heschong Mahone Group (CalMAC) – IMC White Paper
- CPUC CEDARS Deemed Measure Guidance
- U.S. EPA – AIM Act & Refrigerant Transition Rules
- California Air Resources Board (CARB) – Refrigerant Regulations
- ASHRAE Standard 15 & 34 (Safety + classification)
- A2L Refrigerant Transition White Paper
- A2L Refrigerant Transition Overview
- Low GWP Refrigerant Transition (R-32, etc.)
- ACEEE – Emerging HVAC & Refrigerant Trends

Domestic / Service Hot Water (HPWH Systems)

Base Case

The Base Case is a conventional domestic or service hot water system designed to meet the same hot water load using standard market equipment and refrigerants representative of current code-compliant practice. Depending on project type and system configuration, the Base Case may include unitary, packaged, or split heat pump water heaters; central or semi-central heat pump water heater systems; or other standard domestic/service hot water equipment serving the same load.

Where a project is already receiving credit or inducement through another deemed measure or CEDA HPM for the same HPWH equipment or system scope, the IMC under this Low-GWP Refrigerant Systems HPM shall be limited to the separable low-GWP refrigerant/equipment premium only and shall not double count costs already captured elsewhere.

Measure Case

The Measure Case consists of qualifying domestic/service heat pump water heating equipment using refrigerants with a GWP less than 250, such as CO_2-based HPWH equipment or other eligible low-GWP HPWH technologies. The Measure Case must serve the same domestic/service hot water load and delivery requirements as the Base Case.

Eligible configurations may include unitary, packaged, or split HPWHs in the 45–120 gallon product class, as well as central or semi-central HPWH systems serving multifamily, high-rise multifamily, lodging, residential care, commercial, public, agricultural, or industrial buildings. Low-GWP HPWH systems may require specialized equipment or design coordination relative to conventional systems, including higher-pressure components for CO_2 systems, refrigerant-specific compressor and heat exchanger designs, modified controls, start-up and commissioning coordination, and integration with storage and temperature maintenance strategies.

IMC Values and Normalization

Incremental Measure Costs for domestic/service HPWH systems are normalized using the metric that best reflects the qualifying equipment scope:

Unitary Packaged or Split HPWH System(s), 45 thru 120 gallons

For unitary packaged or split HPWHs:

> **Estimated IMC** = Number of qualifying HPWH units × Applicable $/unit IMC value

- **45-55 gal**: $1,000 per unit
- **56-65 gal**: $1,500 per unit
- **66-75 gal**: $2,000 per unit
- **76-120 gal**: $2,500 per unit

Central or Semi-Central HPWH System(s), >200 gal primary storage

For centralized or semi-centralized HPWH systems:

> **Total Qualifying HPWH Heating Capacity** = Number of qualifying HPWH units or modules × Nominal heating capacity (kBtu/h) per unit or module
>
> **Estimated IMC** = Total Qualifying HPWH Heating Capacity (kBtu/h) × Applicable $ per kBtu/h IMC value

Qualifying DHW Equipment Capacity	IMC Values
Total HPWH system heating capacity: < 100 kBtu/h	**$300 per kBtu/h**
Total HPWH system heating capacity: 100 – 299 kBtu/h	**$250 per kBtu/h**
Total HPWH system heating capacity: ≥ 300 kBtu/h	**$200 per kBtu/h**

For unitary, packaged, or split HPWH systems, the IMC shall be applied to the number of qualifying HPWH units using refrigerants with a GWP less than 250. This approach is appropriate where the incremental cost is primarily driven by discrete equipment selection within a defined storage-capacity product class.

For central and semi-central HPWH systems, the IMC shall be applied to the total qualifying HPWH heating capacity, expressed in kBtu/h of nominal heating output. This approach better aligns the IMC with the actual quantity and capacity of low-GWP refrigerant-based equipment installed, rather than static project metrics such as dwelling units or gross floor area.

These values are intended for CEDA program planning and inducement calibration only. They are not contractor bid estimates, project reconciliation values, or final accounting benchmarks. Actual project costs may vary based on equipment manufacturer, refrigerant type, tank size, heating capacity, system configuration, storage and temperature maintenance design, electrical infrastructure, controls integration, commissioning requirements, local labor conditions, and project-specific installation constraints.

Sources

- DOE / NREL – Heat Pump Water Heater Cost Studies
- ENERGY STAR HPWH Resources
- Updated Costs and Benefits Analysis
- 2024 State of the Heat Pump Water Heater Market Report
- Heat Pump Water Heaters Costs—Here's How Much Homeowners Are Paying in 2023
- ET22SWE0017 Commercial and Multifamily CO2 Heat Pump Water Heater Final Report
- Central Heat Pump Water Heating Systems for Decarbonizing Multifamily Buildings: Market Assessment, Energy Performance and Cost Impact Analysis

Process / Refrigeration Systems

Base Case

The Base Case consists of conventional process cooling, process refrigeration, or process heat-pump systems designed to meet the same process loads using standard market refrigerants and typical code-compliant system configurations. These systems may include centralized or distributed refrigeration equipment serving cold storage, production, industrial, agricultural, or other eligible process applications.

Measure Case

The Measure Case replaces conventional higher-GWP refrigerants with qualifying low-GWP refrigerants with a GWP less than 250, while maintaining the same process load, temperature requirements, and operational function as the Base Case. Eligible systems may include standard low-GWP refrigeration configurations, CO_2-based systems, transcritical CO_2 systems, or other qualifying low-GWP process refrigeration technologies.

Incremental costs for this category vary based on load profile, temperature level, refrigerant selection, system architecture, equipment availability, and installation complexity. Typical cost drivers include high-pressure components for CO_2 systems, refrigerant safety requirements, enhanced controls, specialized installation practices, commissioning, and custom engineering or integration.

IMC Values and Normalization

IMC values for process and refrigeration systems are normalized by refrigeration capacity and are intended as order-of-magnitude program calibration inputs, not fixed deemed values or project-specific cost estimates. Project-specific cost data may be used to refine the IMC where available and approved by CEDA.

- **$400/ton** — process refrigeration systems using qualifying low-GWP refrigerants (non-CO_2/transcritical)
- **$500/ton** — CO_2/transcritical or other higher-complexity low-GWP process refrigeration systems

Apply the IMC only to the refrigeration capacity served by the qualifying low-GWP system. For systems serving multiple process loads or temperature levels, capacity should be allocated to the applicable low-GWP equipment scope to avoid double-counting.

Sources

- CO_2 Refrigeration Systems
- CO_2 as Refrigerant (transcritical systems)
- The Future of Cooling

Code Readiness Objectives

This measure supports CEDA's Code Readiness efforts by collecting market, cost, and implementation data to inform future policy and code development related to low-GWP refrigerants in building systems. While federal and state regulations are driving the phasedown of high-GWP refrigerants, current Title 24 requirements do not explicitly address refrigerant selection or establish GWP-based performance criteria at the system level. As a result, adoption of low-GWP refrigerants remains inconsistent across building types, system applications, and end-use categories.

The data gathered through this measure will help identify cost-effective, scalable pathways for integrating low-GWP refrigerants across HVAC, service water heating, and process load systems, while maintaining system performance, safety, and reliability. These insights will support the development of future code language and program strategies that align refrigerant selection with California's broader decarbonization and climate goals.

The objectives include the following:

- **Characterize adoption pathways for low-GWP refrigerants across major end-use categories (HVAC, service water heating, and process loads)**, including system types, refrigerant selections, and design approaches used in real-world projects.
- **Quantify incremental costs and cost drivers associated with low-GWP refrigerant systems**, including equipment cost differences, safety requirements, installation complexity, and design coordination.
- **Assess system performance and operational impacts**, including efficiency, reliability, and maintenance considerations associated with alternative refrigerants and system configurations.
- **Evaluate implementation barriers and market readiness**, including contractor familiarity, product availability, code compliance challenges, and permitting considerations associated with low-GWP refrigerants.
- **Identify safety and design considerations associated with low-GWP refrigerants**, including high-pressure systems (e.g., CO_2) and mildly flammable refrigerants (e.g., A2L and hydrocarbons), and their implications for system design and installation.
- **Support development of future code and regulatory frameworks**, including potential GWP thresholds, prescriptive pathways, or performance-based approaches for refrigerant selection in building systems.

By linking real-world project data with cost, performance, and market insights, this measure advances the development of coordinated policies and code pathways that support widespread adoption of low-GWP refrigerants across the building sector.

Code Readiness Site Monitoring

If selected for Code Readiness monitoring, equipment energy consumption and mechanical system performance may be monitored on-site for a period of up to 24 months. To support performance evaluation and data collection, projects shall provide reasonable access for the installation and operation of metering, sensors, and communication equipment.

Projects equipped with a Building Automation System (BAS), Energy Management System (EMS), or equivalent platform should enable integration of advanced metering devices through the existing system to facilitate data collection and remote access. For projects without a BAS or EMS, the Code Readiness team may install temporary stand-alone data loggers, sensors, and communication equipment as needed to monitor system performance for the duration of the monitoring period.

Instrumentation may be installed or supplemented, where necessary, to measure key system and equipment parameters sufficient to evaluate system performance and operational characteristics. All monitoring equipment will be temporary and installed in a manner that minimizes disruption to normal building operations.

Data Benefits

Collected data will help support the following:

- The data obtained from this measure provides insights that can inform and enhance future regulations. These revised regulations could promote the reduction of high-GWP refrigerants. By doing so, there is potential to decrease the environmental impact of HVAC and refrigeration systems.
- The data collected through this measure will directly help the Codes and Standards Advocacy Team support the adoption of more stringent criteria for refrigerants in the commercial and industrial sectors.

Code Reference

California Title 24, Part 6 does not currently establish system-level refrigerant GWP thresholds by equipment type or application. The Energy Code regulates building energy performance, equipment efficiency, and applicable system requirements, while refrigerant selection is primarily addressed through federal and state refrigerant regulations. The 2025 Energy Code applies to projects with permit applications on or after January 1, 2026.

At the federal level, the U.S. EPA's AIM Act Technology Transitions Program restricts the use of higher-GWP HFCs in specific refrigeration, air-conditioning, and heat pump sectors and subsectors. Beginning January 1, 2025, certain new products and systems are prohibited from using restricted HFCs or HFC blends, with limits varying by equipment category.

At the state level, CARB regulates high-GWP refrigerants through the Refrigerant Management Program and HFC reduction measures. CARB's Refrigerant Management Program applies to stationary refrigeration systems containing more than 50 pounds of high-GWP refrigerant and includes requirements for registration, leak inspection, leak repair, reporting, and recordkeeping. CARB has also adopted prohibitions and GWP limits for certain HFCs in stationary refrigeration, air-conditioning, chillers, and related end uses.

For this HPM, refrigerant eligibility is based on the refrigerant used in qualifying mechanical equipment, not on secondary fluids, absorbents, hydronic loop fluids, or heat-transfer media. Projects must comply with all applicable Title 24, EPA, CARB, California Mechanical Code, fire/life-safety, and local jurisdiction requirements. The HPM is intended to support adoption of low-GWP refrigerant systems that go beyond standard practice or applicable minimum regulatory requirements.

Eligible Climate Zones, Building Types, & Project Scopes

Eligible Climate Zones

This high-performance measure applies statewide in **California Climate Zones 1-16** (Title 24). Applicants must identify the project's climate zone in the submittal.

Eligible Building Types

This high-performance measure applies to:

- **High-Rise Multifamily**: Buildings with **four (4) or more habitable stories above grade.**
- **Nonresidential: Commercial, public, agricultural, and industrial** facilities (e.g., offices, retail, lodging, education, healthcare, food service, warehouses, manufacturing, civic buildings).

Eligible Project Scopes

This high-performance measure applies to:

- **New construction**, **additions**, and **major alterations/retrofits** to systems served by the measure.

This high-performance measure does not apply to (not in scope):

- **Low-rise residential** (single-family and multifamily ≤3 habitable stories above grade).

Measure Exclusions

This high-performance measure excludes the following:

- Low-rise residential buildings, including single-family homes and multifamily buildings with three or fewer habitable stories above grade.
- Equipment or systems using refrigerants with a GWP greater than or equal to 250.
- Systems that do not use an eligible refrigerant-based mechanical cooling, heating, heat pump, or refrigeration cycle.
- Absorption or adsorption chillers, chiller-heaters, or refrigeration systems, including water/lithium bromide, ammonia/water, silica gel/water, or similar working-fluid pairs. Water used as the refrigerant in an absorption cycle does not qualify for this HPM, and LiBr or similar materials are absorbents, not refrigerants.
- Gas-fired absorption chillers, gas-fired chiller-heaters, engine-driven chillers, boilers, electric resistance equipment, evaporative coolers, cooling towers, fluid coolers, dry coolers, heat exchangers, desiccant systems, or other equipment without an eligible refrigerant circuit.
- Hydronic, chilled-water, hot-water, condenser-water, glycol, brine, thermal storage, or process-fluid loops where the claim is based on a secondary heat-transfer fluid rather than the refrigerant contained in the mechanical equipment.
- Refrigerant management, service, or conversion activities alone, including leak detection, refrigerant recovery, reclamation, recharge, top-off, or drop-in refrigerant replacement without installation of qualifying equipment.
- New construction supermarket or grocery store refrigeration systems.
- R-717 ammonia systems in commercial or industrial refrigerated warehouses, cold-storage facilities, chillers, or other applications where ammonia is already standard practice or required by regulation.

- Systems installed solely to comply with already-applicable federal, state, local, CARB, or EPA refrigerant requirements, where no above-standard low-GWP refrigerant selection is demonstrated.
- Equipment receiving another CEDA HPM inducement for the same incremental cost scope, unless the low-GWP refrigerant premium is clearly separated and approved by CEDA.
- Portable, temporary, transport, vehicle-mounted, plug-load, or standalone equipment not serving a qualifying building HVAC, service/domestic hot water, or process load end use.
- Projects that cannot provide sufficient documentation to verify refrigerant type, refrigerant GWP, equipment scope, served end use, and applicable cost basis.

Reviewer Checklist

HPM Review Checklist: LM407 – Low-GWP Refrigerant Systems – V3.1

Checklist Description: This checklist captures the elements that must be present in the project design to be eligible for the high-performance measure inducement or consideration for additional site metering.

Project Name: _____ **Review Date:** _____

Assessment:

- ☐ Approved
- ☐ Not approved

Notes:

Reviewer: _____ **Signature:** _____

Essential Level Inducement Requirements	Comments
☐ Did the project provide one or more pieces of equipment utilizing low-GWP refrigerants with a GWP of less than 250 serving the HVAC, domestic/service hot water, and/or process loads of a commercial, industrial, public, agricultural, or high-rise multi-family building?	

Advanced Level Inducement Requirements	Comments
☐ Did the project provide refrigerant-based equipment in at least one of the building's major end-use categories, being HVAC, service/domestic hot water, or process load systems (if applicable), all utilizing low-GWP refrigerants with a GWP of less than 250?	

Premium Level Inducement Requirements	Comments
☐ Did the project provide refrigerant-based equipment in all the building's major end-use categories, being HVAC, service/domestic hot water, and process load systems (if applicable), all utilizing low-GWP refrigerants with a GWP of less than 250?	

Supporting Documentation Requirements (applies to all levels)	Comments
☐ Were engineered, stamped, and permitted construction plans provided?	
☐ Were equipment submittals stamped and approved by the responsible engineer of record provided?	
☐ Was equipment-cost information provided?	

Site Metering Prerequisite	Comments
☐ Did the project install a Building Automation System (BAS), Energy Management System (EMS), or similar building management system so that advanced metering devices can be installed?	

Version History Log

Version	Effective Date	End Date	Change Description
1	October 24, 2023	December 31, 2023	Low-GWP threshold at < 750 GWP
2	January 1, 2024	March 30, 2025	Updated low-GWP threshold to < 500 GWP, added exclusions under “Measure Exclusions”
3	March 31, 2025	May 10, 2026	Updated format, requirements, checklist, updated low-GWP threshold to < 250 GWP
3.1	May 11, 2026	Active	Updated measure to the current CEDA HPM format, added IMC section, updated narratives, and revised reviewer checklist

The version identified as 'Active' is the current published version and remains in effect until superseded by a subsequent published version. CEDA may update, replace, or retire High-Performance Measures without prior notice. End dates are assigned to prior versions once superseded.