



EFFECTIVE STRATEGIES FOR RAGAGEP APPLICATION

HOW TO MEET RAGAGEP COMPLIANCE FOR PSM & RMP

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SUMMARY

- What is RAGAGEP?
- Sources of RAGAGEP
- How do to meet RAGAGEP standards
- What's next?
- Questions



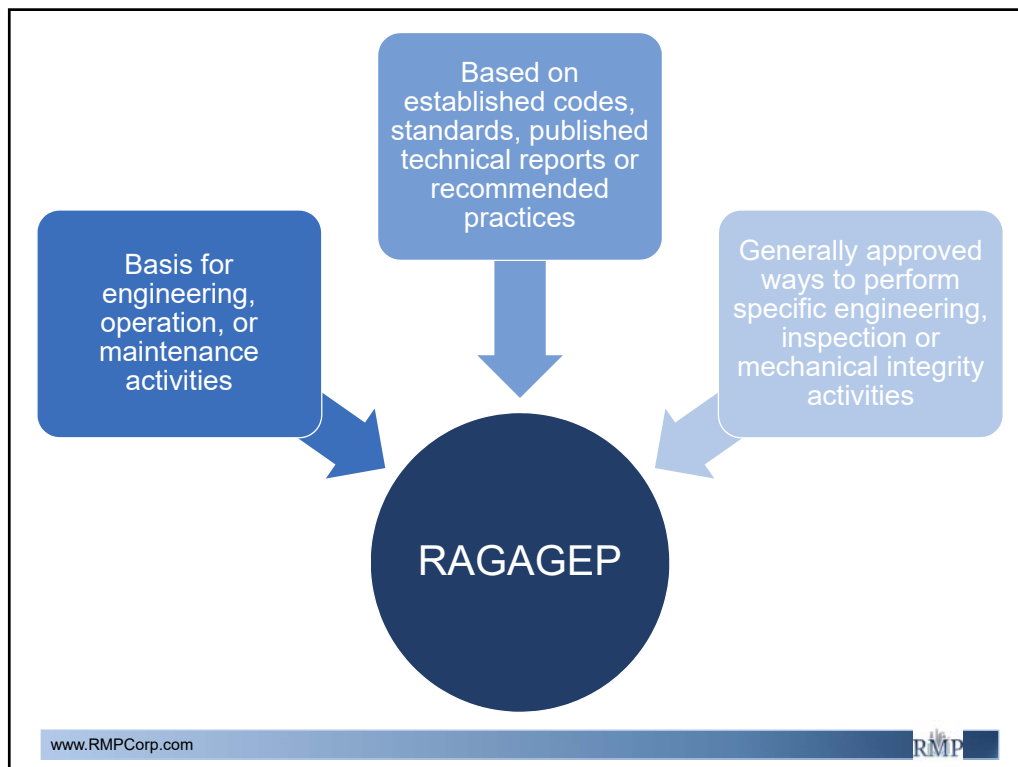
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WHAT IS RAGAGEP?

- RAGAGEP – Recognized and Generally Accepted Good Engineering Practices
- CCPS definition:
“Recognized And Generally Accepted Good Engineering Practices” (RAGAGEP) - are the basis for engineering, operation, or maintenance activities and are themselves based on established codes, standards, published technical reports or recommended practices (RP) or similar documents. RAGAGEP detail generally approved ways to perform specific engineering, inspection or mechanical integrity activities, such as fabricating a vessel, inspecting a storage tank, or servicing a relief valve.”

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SOURCES OF RAGAGEP

- Published and widely accepted codes
 - Federal, state, or municipal jurisdictions
 - E.g., NFPA, building codes, etc.
- Published consensus documents
 - Organization that demonstrates a diverse and broadly represented committee membership
 - E.g., ASME, ANSI, IIAR, etc.
 - **IIAR 9-201x**
 - **IIAR 6-201x (referenced in IIAR 9)**
- Published non-consensus documents
 - Smaller organizations and more industry-based
 - E.g., Chlorine Institute “pamphlets”, CCPS guidebooks, peer-reviewed technical articles, etc.

IIAR 9-201X

Notes:

IIAR 9-201x is undergoing approval. Some requirements may change, but overall the draft provides adequate standards to begin implementing at facilities in the near future.

IIAR 9-201x establishes MINIMUM standards for existing systems. “Additional precautions may be necessary” mentioned in the foreword.

DEFINITIONS

- Prior to updated standards, some definitions were not provided / clear.
- IIAR 9-201x definitions
 - Change – “other than replacement in-kind”
 - Fault tree analysis
 - Layer of Protection Analysis (LOPA)
 - Replacement in-kind – “like for like”
 - Risk ranking method
- List of references provided

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SYSTEM DOCUMENTATION

- List of documentation that must be obtained, maintained, and on-file at the facility
 - P&IDs & BFDs
 - Electrical classification
 - Safety relief system design and basis
 - Machinery room ventilation design basis and calculations
 - Material energy balance (not under 10,000 lbs or built prior to 5/26/1992)
 - Maximum intended inventory

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SYSTEM DOCUMENTATION

- Equipment and Components
 - **Manufacturer data reports**
 - Specification sheets
 - Design information
 - **Materials of construction information**
 - As-built design drawings / specifications
 - Work orders with product specifications
 - **Manufacturer product information**
 - Owner's manuals
 - Design information

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INSPECTION, TESTING & MAINTENANCE

- IIAR 9-201x refers to IIAR 6-201x, which is still not finalized
- Improve procedures and/or training?
- Improvement on testing / inspections?
 - **Frequency**
 - **Detail**
 - **Checklist items**
 - **Updated manufacturer information**
- Accessibility of equipment
- Service valves present? Accessible?
- Improvement for addressing recommendations?

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GENERAL REQUIREMENTS

- Location of equipment similar to IIAR 2
- Refrigerant-grade NH3 must be used
- Allowances must be made for pressure-relieving devices
- Piping connected to a pressure vessel must be rated at least as high as the pressure vessel
- Specification on design pressures for various parts of the system
- Materials requirements similar to IIAR 2 for design of new systems

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GENERAL REQUIREMENTS

- Ability to purge non-condensable gases from system
- Ability to manage / remove oil
- If not intended for heat exchange, insulation must be used on piping and equipment surfaces where mitigation is needed
- Supports should minimize vibration and movement



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SERVICE PROVISIONS

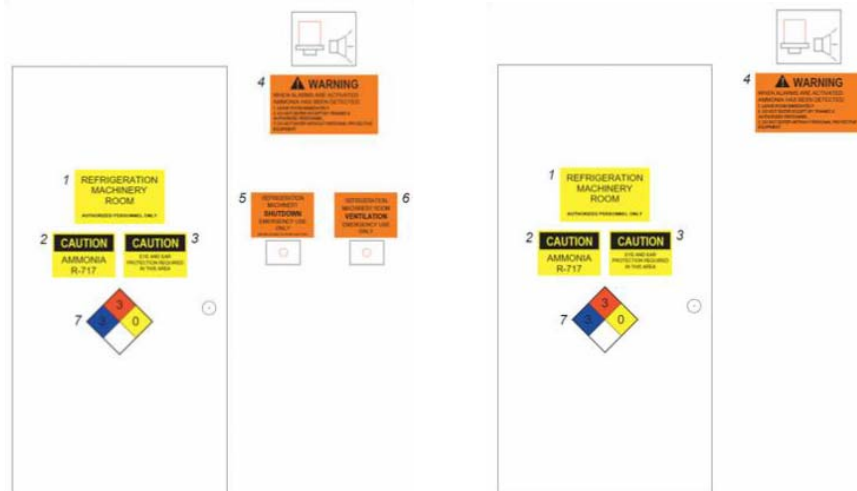
- Accessible piping and equipment for maintenance
- Charging connections shall be plugged or capped
- Pressure gauge at least 120% of the system-rated pressure on the high-side
- Manual isolation valves for serviceable equipment

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SIGNAGE

Principal Machinery Room Door Auxiliary Machinery Room Door



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PIPE MARKING

- Adequate labeling for equipment and piping
- Was ASME B&PVC, Section VIII, Division 1 consulted during design and installation?



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EMERGENCY REQUIREMENTS

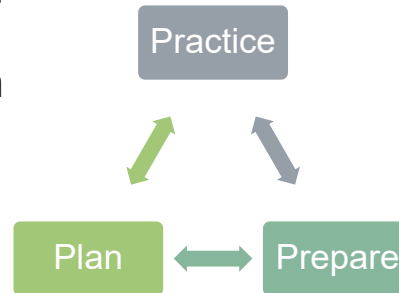
- Emergency shutdown valves shall be clearly and uniquely identified at the valve and on schematics
- Wind indicator shall be provided in accordance with emergency planning documentation and requirements
- Emergency shutdown direction must be readily accessible to trained refrigeration system staff and trained emergency responders

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EMERGENCY PLANNING & RESPONSE

- Any additional emergencies to address?
- Coordination with local responder adequate? Improvement areas?
- Are drills or table-top exercises needed?
- Is Injury & Illness Prevention Program adequate?



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GENERAL REQUIREMENTS

- Enclosures must be suitable for location and provide protection against physical and environmental damage
- Guarding or barricading may be required on some equipment
- Screens or guards shall protect exposed moving parts
- Ammonia is to be stored in cylinders or vessels designed for ammonia containment

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GENERAL REQUIREMENTS

- Means of egress shall comply with Building Code
- Refrigerant piping with an external surface temperature of 140°F or greater and within 7.25 feet of walkways, landings, aisles, etc. shall be protected with caution signs, insulation, or guards



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MACHINERY ROOMS

- Tight-fitting constructions with minimum 1-hour fire-resistance rating
- Piping supports shall carry weight of piping, contents, and insulation
- Supports and foundations shall prevent movement and vibration
- Airflow from occupied spaces shall be protected against ammonia leakage
- Combustible materials cannot be stored in machinery room unless in fire-rated storage containers

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MACHINERY ROOMS

- Equipment installation must allow egress from any part of the room in an emergency
- Manually operated valves inaccessible from floor level shall be operable from portable platforms, fixed platforms, ladders, or chain operated
- Manually operated emergency valves shall be directly operable from the floor or chain operated
- Access to machinery room shall be restricted to authorized personnel

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MACHINERY ROOMS

- Fuel-burning equipment permitted only under specific conditions listed in IIAR 9
- Pipe penetrations through machinery room shall be sealed to walls, ceiling, or floor
- Ammonia cylinders shall only be connected to the system if ammonia is in the process of being transferred by authorized personnel



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EYEWASH STATIONS & SAFETY SHOWERS

- Minimum of 2 eyewash / shower units
 - 1 inside machinery room
 - 1 outside primary egress of machinery room
- No more than 55-ft path of travel to nearest station
- Path of travel shall be unobstructed
- Meets ANSI/ISEA Z358.1 requirements



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ELECTRICAL SAFETY / HOT WORK

- Electrical equipment / wiring must be installed in accordance with Electrical Code
- Machinery room classified as Ordinary Location, where emergency ventilation and ammonia detection meets IIAR 9 standards
- Hot Work
 - Improvements to process / procedures?
 - Appropriate training?
 - Additional training needed?

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DRAINS & ENTRANCES / EXITS

- Drains
 - Means shall be provided to dispose of liquid
 - Contaminant control on drains shall be provided where oil, secondary coolants, or other liquids may be spilled
 - Means shall be provided to limit the spread of liquid ammonia into drainage
- Entrances / Exits
 - Rooms greater than 1,000 ft² shall have at least 2 exit doors
 - Doors shall be within 150 ft of any point of the room (exception: Building Code)
 - Self-closing and tight-fitting construction

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LIGHTING & EMERGENCY CONTROL

- Lighting
 - Machinery rooms must have at least 30 foot-candles at the working level
- Emergency Control
 - ESD switch shall be located outside and adjacent to the designated principal machinery room door
 - Emergency ventilation switch shall be located outside and adjacent to the designated principal machinery room door

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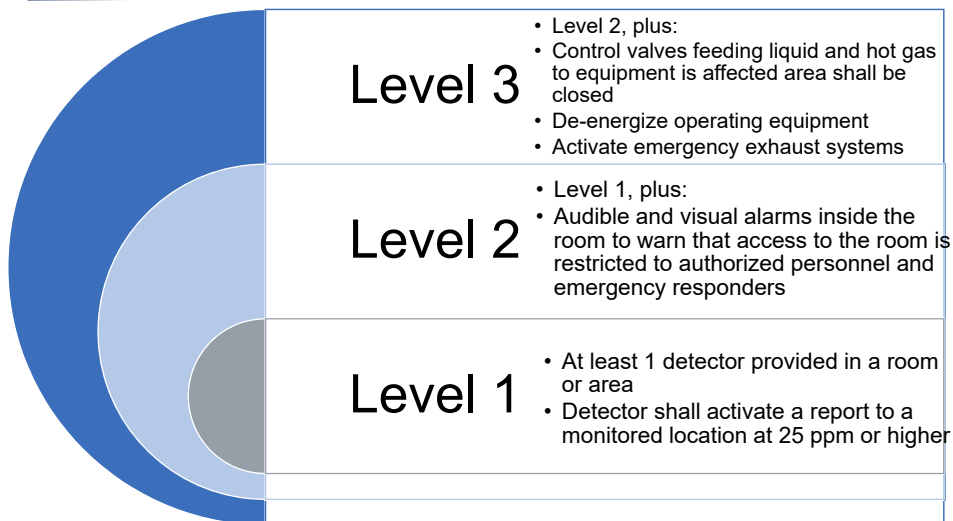
DETECTION & ALARMS

- At least 1 detector inside machinery room
- Detector shall alarm and report to monitored location
- Audible and visual alarms shall be provided inside the room and outside each entrance
- Alarm to a monitored location at a concentration no higher than 50 ppm
- Activated emergency ventilation at a concentration no higher than 1000 ppm
- Automatic de-energize equipment at a concentration no higher than 40,000 ppm

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DETECTION & ALARMS (IIAR 2)



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DETECTION & ALARMS

- Power supply shall be on a dedicated branch circuit
- Shall remain on when other power is lost
- Power failure trouble signal shall be sent to a monitored location of dedicated circuit loses power
- Detector shall be mounted where ammonia is expected to accumulate
- Must be accessible for maintenance testing



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VENTILATION

- Occupied conditions: greater than 0.2 cfm/ft² of the machinery room area or 20 cfm per occupant
- Exhaust ventilation
 - Automatically activated during ammonia leak detection
 - Produce at least the temperature control ventilation rate
 - Air ducts shall only serve the machinery room
 - Exhaust shall discharge vertically upward
 - Exhaust fans shall utilize non-sparking blades
 - Exhaust fan motors shall be totally enclosed type

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VENTILATION

- Inlet air
 - Make-up air shall replace air being exhausted
 - Air supply shall prevent short-circuiting
 - Use corrosion-resistant screens
 - Intakes shall draw in uncontaminated air
 - Intakes shall only serve machinery room
 - Louvers shall fail open during power loss
- Temperature control ventilation
 - Must maintain temperature no higher than 104°F in the machinery room
 - Shall be continuous or activated by thermostat

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EMERGENCY VENTILATION

- Design and design basis shall be documented
- Shall be activated upon detection and manually according to IIAR 9
- Shall be powered independently and continue to operate regardless of emergency shutdown controls
- Monitored location shall be notified upon loss of power or failure of the system

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PRESSURE RELIEF DEVICES

- Certified in accordance with ASME
- Hydrostatic relief where liquid ammonia can be trapped
- Dual PRDs on 3-way valve is pretty standard
- IIAR 2 guidance:
 - Location of discharge must be > 15 feet above grade and > 20 feet from windows, ventilation intakes, or exits
 - Termination of discharge shall be directed upward and arranged to avoid spraying NH₃ on persons in the vicinity



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COMPRESSORS

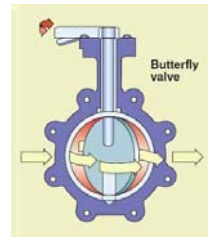
- Install necessary check valves or isolation valves
- If high NH₃ liquid level in the vessel and vessel is directly connected to compressor suction, automatically controlled shutdown of the compressors
- High-discharge-pressure limiting device shall be installed to shut down compressors

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SHUTOFF VALVES

- Proper materials and connections
- Valve placement and orientation
 - Inlet & outlet of positive-displacement type compressor, compressor unit, or condensing unit
 - Main feed inlets and outlets of individual refrigeration equipment loads
 - Refrigerant inlet and outlet of a pressure vessel greater than 3 ft³



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LOCATION OF PIPING

- Shall not obstruct means of egress
- Shall not be placed in elevator shaft, dumbwaiter, shaft, or other shaft containing moving object
- Shall not be installed in a stair, landing, or means of egress that is enclosed and accessible to the public
- Shall be protected from corrosion
- If installed in concrete floors, shall be encased in pipe duct

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INSTRUMENTATION & CONTROLS

- Must have the ability to manually or automatically control the starting, stopping, and operating of the system or equipment
- Must have means to monitor the concentration of an ammonia release in the event of power failure
- Changing safety settings shall be limited to authorized personnel only

VISUAL LIQUID LEVEL INDICATORS

- Shall not be installed where risk of hydraulic shock exists
- Shall have protection from physical damage
- Shall be fitted with internal check-type shut-off valves
- Compatible with the use of NH₃

RAGAGEP EVALUATION

- Owner's (or designated representative) responsibility to conduct regular evaluations and document RAGAGEP compliance
- Methodology (2 options)
 - Evaluate using IIAR 9 standard
 - Evaluate using IIAR 2, codes, and standards adopted by local Authority Having Jurisdiction
- Evaluation shall be conducted by person(s) knowledgeable in the specific RAGAGEP identified

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RAGAGEP EVALUATION

- RAGAGEP evaluation shall
 - Review system documentation
 - Review applicable RAGAGEP
 - Conduct physical inspections of the ammonia refrigeration system as necessary
- Results shall be documented (example provided in Appendix D)
- Documentation shall specify action(s) taken to address gap(s) by one of the following
 - Close the gap(s) to meet RAGAGEP requirement(s) in a timely manner, or
 - Provide justification for declining to close an identified gap by approved method

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RAGAGEP EVALUATION

- Frequency
 - Initial evaluation shall be conducted in conjunction with the next PHA revalidation or HR
 - Shall be revalidated at least every 5 years
 - Revalidation may be incorporated into the PHA revalidation process

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PROCESS HAZARD ANALYSIS

- Better methodology for PHA?
 - HAZOP?
 - LOPA?
 - DMR?
- Re-evaluating the hazards and safeguards
- Re-evaluating controls
- Address facility siting
- Address human factors
- Improvements to team makeup?
- Better method for managing recommendations?
- Consider overpressure scenarios

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OPERATING PROCEDURES & CONTRACTORS

- SOPs
 - More detail in SOPs needed?
 - Additional SOPs needed?
 - Improvements on training
 - Improve tracking method for updates / revisions
- Contractors
 - Improvements for keeping track of contractor safety and training records?
 - Method to evaluate contractor performance?

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TRAINING

- Improve topics for refresher training
- Add HAZWOPER or other safety training to required trainings?
- Improve tracking method for training sessions
- Change frequency of training
 - Annual
 - Quarterly with rotated topics

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MANAGEMENT OF CHANGE / PRE- STARTUP SAFETY REVIEW

- Reviewing and confirming changes are in accordance with the newest design specs
- During the process, is there any other equipment that needs to be upgraded?
- Improvement areas for MOC / PSSR process for next time?
- Is the correct technical basis being applied and does it apply to another portion of the facility?

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INCIDENT INVESTIGATION & EMPLOYEE PARTICIPATION

- Incident Investigation
 - Drills and/or practice scenarios for training?
 - Forms and procedures up-to-date?
 - Any additional information needed?
- Employee Participation
 - Adequate participation?
 - Improvement areas?
 - Written plan in-place is adequate?

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WHAT'S NEXT?

- IIAR Standard 9 should be in the final stages of approval
- IIAR Standard 6 (public review period until August 20, 2018)
- Other things to consider:
 - IIAR 9 is MINIMUM requirements
 - RAGAGEP means striving for safer practice and operations
 - Look for improvements on safety for the design and/or operation of the system
 - Provide feedback on IIAR 9 during the public comment period
 - Involve all employees/personnel at the facility for input on the site's individual program

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QUESTIONS?

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