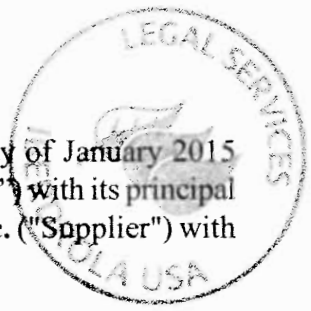
Agreement for Services



This AGREEMENT FOR SERVICES (this "Agreement") is made this 6th day of January 2015 between New York State Electric and Gas Corporation ("NYSEG" or "Customer") with its principal office located at 18 Link Drive, Binghamton, NY 13795 an[redacted]c. ("Supplier") with its principal office located at 1770 Sweets Corners Road, Fairport, NY 14450.

WHEREAS, Customer desires to procure certain services from Supplier, including the services described in Schedule A, attached hereto and made part hereof (the "Services"); and

WHEREAS, Supplier states that it is an established and well-known provider of the Services possessing the skills, qualifications, and experience necessary to perform and manage such Services in an efficient, cost-effective, and controlled manner, with a high degree of quality and responsiveness, and that it has successfully performed similar services for other customers and is willing to provide the Services to Customer in accordance with the terms and conditions of this Agreement; and

WHEREAS, in reliance upon such statements, Customer has selected the Supplier to provide the Services, which shall be procured and performed in accordance with this Agreement.

NOW THEREFORE, in consideration of the mutual covenants contained herein, and other good and valuable consideration, Customer and Supplier agree as follows:

1. Definitions.

1.1 "Affiliate" means, with respect to a person or entity, any individual, corporation, partnership, firm, joint venture, association, joint stock company, trust or other unincorporated organization, directly or indirectly controlling, controlled by, or under common control with, such person or entity. The term "control" shall mean the possession, directly or indirectly, of the power to direct the management or policies of a person or an entity. A voting interest of ten percent (10%) or more shall create a rebuttable presumption of control.

1.2 "Contract Documents" means this Agreement (including all Schedules, if any, attached or incorporated by reference), the Purchase Order (as defined below), the plans and specifications, and all addenda and change orders issued by Customer. Any reference to this Agreement shall be deemed a reference to all the Contract Documents.

1.3 "Effective Date" means the date this Agreement is executed by Customer and Supplier.

1.4 "Materials" means materials, supplies, equipment, machinery, tools, and all other items and facilities to be used, furnished, or delivered in connection with the Services.

1.5 "Services" means the services described in Schedule A, attached hereto and part hereof, including any design, engineering, installation, construction, modification, and or testing to be performed as part of the Services and includes the Materials necessary for the provision of the

Services.

1.6 "Purchase Order" means a purchase order issued by the Customer for the Services to be provided in accordance with this Agreement.

2. Scope

2.1 Scope of Services. Supplier shall perform the Services described herein and in Schedule A hereto. Supplier shall assign sufficient qualified employees or agents ("Personnel") to complete the Services in a timely manner, and complete the Services promptly and as specified herein. Supplier shall immediately bring to Customer's attention any errors, omissions, discrepancies or conflicts with respect to the Contract Documents or the Scope of Services.

2.2 Time. Supplier shall begin performance of the Services as soon as reasonably practical after the Effective Date. Time is of the essence in this Agreement. At Customer's request, Supplier shall promptly furnish a detailed schedule acceptable to Customer. If the Services falls behind schedule in whole or in part as the result of acts or omissions of Supplier, at its expense, Supplier shall take all steps necessary to return performance of the Services to the schedule, including (without limitation) the use of subcontractors, overtime, and shift work.

2.3 Subcontractors. Customer must give its written approval before Supplier uses any subcontractors in the performance of any Services. If Supplier shall cause any part of the Services to be performed by a sub-contractor, the provisions of this Agreement shall apply to such sub-contractor and its officers, agents or employees in all aspects as if they were employees of Supplier, and Supplier shall not thereby be discharged from any of its obligations and liability hereunder, but shall be liable hereunder for all acts and omissions of the sub-contractors. Nothing shall create any contractual relationship between Customer and any sub-subcontractor.

3. Term and Compensation.

3.1 Term. This Agreement shall be effective as of the Effective Date and shall last until 12/31/2015.

3.2 Compensation. In full consideration for the complete and satisfactory performance of the Services, Customer shall pay the amount set forth on the Purchase Order and as set forth on Schedule B attached hereto and incorporated herein. The price(s) charged by Supplier for all time and material Services shall be no more than Supplier's standard prices in effect for similar work.

3.3 Invoices. In accordance with the Purchase Order (including any milestones and retainages set forth therein), Supplier shall submit invoices prepared in such form and supported by such documentation as Customer may reasonably request. Customer shall pay undisputed amounts due within 30 days after invoice receipt. Additional payment terms may be set forth on the Purchase Order. The final invoice may be submitted after Customer accepts the Services.

3.4 Waiver. No inspection, approval, payment, or acceptance of the Services shall be construed as evidence of satisfactory performance of any Services not performed in accordance

with this Agreement, as a waiver of any of Customer's rights, or as relieving Supplier from its responsibility under this Agreement. Acceptance by Supplier of final payment shall constitute a waiver of all claims which Supplier may have against Customer.

3.5 Withholding. Customer may withhold payment to the extent reasonably necessary to protect Customer from (without limitation) defective Services, damage to Customer or a third party, failure to carry out the Services in accordance with this Agreement, potential claims of a third party(ies), and reasonable doubt that the Services can be completed for the balance due or on time.

4. Certain Obligations of Supplier.

4.1 Examination. Supplier represents that it has examined the site where the Services shall be performed and has investigated and considered the conditions affecting the performance of the Services and hereby waives all claims against Customer on account of any such conditions.

4.2 Warranty. Supplier represents and warrants that all services shall be performed and completed using its best efforts and skills. The Services shall be of high quality; performed in accordance with sound, generally accepted professional practices and by fully experienced, equipped, organized, and properly qualified individuals; free from defaults and defects in workmanship, title and Materials; and in compliance with applicable specifications and fit for its intended purpose. All Materials shall be new, free from defects and workmanship, material, and title, and approved by or acceptable to Customer. Supplier shall be solely responsible for all means, methods, techniques, sequences, and for coordinating all portions of the Services. The Services shall not be deemed completed until all applicable drawings and other documents, if any, have been completed, delivered, and accepted by Customer. Customer will rely upon the accuracy, competence, and completeness of the Services. Supplier shall comply with all applicable laws, rules and regulations, including (without limitation) corporate policies of Customer. Except as otherwise expressly specified, Supplier shall procure, pay for and comply with the terms and conditions of all applicable permits, licenses and inspections.

4.3 Remedy. If the Services do not comply with the foregoing warranties for up to one year after final acceptance of the Services, Supplier shall reperform, repair or replace the Services, including modifications or additions as may be reasonably necessary to correct any defect or failure. The choice of repair or replacement will be made by Customer. Reperformed, repaired or replaced Services shall be subject to the same terms and warranties as provided for the original Services. If Supplier cannot reperform the defective Services within a reasonable period of time, considering Customer circumstances, Customer may elect to remedy the defect and bill Supplier therefore. If Customer determines that reperformance is no longer feasible, Supplier shall refund any compensation paid to it for such Services and reimburse Customer for actual damages incurred and damages which may be foreseeably incurred to the extent they are attributable to acts or omissions of Supplier.

4.4 Protection. Supplier shall take all necessary steps to protect and prevent damage or injury to the Services, persons, or property of Customer and others, including (without limitation) if applicable the responsibility for the security of the Services and site. Supplier shall

perform the Services, including storage of Materials, so as not to interfere with the progress of the Services, Customer's normal operations, or the activities of others.

4.5 Inspection. Supplier shall permit and facilitate inspection of the Services by Customer and its agent's at all reasonable times.

5. Insurance. Supplier shall maintain insurance in accordance with the requirements as set forth in Schedule [C]. Supplier must maintain applicable insurance. An insurance certificate must be mailed to Customer prior to starting Services.

6. Audit. For all Services not performed on a fixed-price basis, Supplier shall keep accurate records and accounts showing all direct and indirect charges, disbursements, costs or expenses incurred by Supplier in the performance of the Services. Upon reasonable notice, Customer shall have the right to audit Supplier's records and accounts up to two years after payment of the final invoice for the Services. Supplier shall also allow Customer to audit or inspect Supplier's facilities and books and records to determine Supplier's compliance with this Agreement, including (without limitation) quality assurance, project management, and other standards.

7. Changes. At any time, Customer may make changes ("Changes") in the Services, as it deems necessary or appropriate. Changes include (without limitation) additions to or omissions from the Services, schedule changes, or a temporary suspension of all or part of the Services. Within three days after any Change proposal from Customer, Supplier shall notify Customer of any additional time or compensation which will be necessitated by the Change. The resulting time to complete the Services and/or the cost or credit to Customer shall be equitably and mutually determined by Customer and Supplier. No additional time or compensation shall be due to the extent a Change results from the fault or negligence of Supplier. No Change shall be binding unless made in a subsequent Customer Purchase Order.

8. Proprietary Information. Data or information generated or acquired during this Agreement relating to Customer which is not otherwise publicly available, shall belong to and be proprietary to Customer and shall be kept secret by Supplier, although Supplier may use it to the extent necessary to perform the Services. Drawings, specifications, calculations, reports, Services in process, models, or other work product, if any, prepared by Supplier shall become the property of Customer when prepared and shall be delivered to Customer upon request and, in any event, upon the termination of this Agreement for any reason. Supplier may keep copies or samples thereof for its internal use (but not disclosure to others), but Customer shall retain all intellectual property therein. Supplier hereby irrevocably assigns to Customer all right, title and interest in such items, and, at Customer's option and expense, shall execute any documents reasonably requested by Customer for the assignment, registration, or other protection of any related proprietary right.

9. Confidentiality. Supplier, its employees and agents, shall treat any information, (including any technical information, experience or data) regarding Customer or its Affiliates plans, programs, plants, processes, costs, equipment, operations, or customers, which may be disclosed to, or come within the knowledge of, Supplier its employees and agents in the performance of this Agreement, as confidential, and will not use or disclose this information to others, during the term of this Agreement, and for three (3) years thereafter, except as is necessary to perform the Services hereunder, without Customer's prior written consent. The provisions of this Article shall not apply

to any information referred to in this Section which (i) has been published and has become part of the public knowledge through no effort by Supplier, its employees, or agents, (ii) has been furnished or made known to Supplier or Supplier's Affiliates by third parties (other than those acting directly or indirectly for or on behalf of Customer or Customer Affiliate) as a matter of legal right and without restriction on disclosure, (iii) was in Supplier's possession prior to disclosure by Customer or its Affiliates and was not acquired by Supplier or Supplier's Affiliates, its employees and agents directly or indirectly from Customer or its Affiliates or, (iv) is required by law or by any other governmental regulatory authority to be disclosed.

Any information, which is supplied by the Supplier to Customer or a Customer Affiliate under this Agreement, will be similarly restricted. Customer and Customer Affiliate will not disclose such information to others or publish it in any form at any time; provided, however, that notwithstanding the foregoing, Customer may disclose any such information to its Affiliates, employees, and consultants, to any regulatory agencies or instrumentality's when such disclosure is necessary, or otherwise required by law. Customer will cooperate with the Supplier in an effort to minimize the amount of such information, which will be disclosed in any such case, and to make reasonable efforts to secure confidential treatment of such information.

In no event shall Customer's or its Affiliates' names and/or logo or the name and/or logo of it's parent company be used, whether written or verbal, duplicated, reproduced by any means whatsoever without the prior written permission of the Customer.

All inquiries by any governmental, business, or other entity, including media, regarding any Services performed or to be performed by Supplier for Customer shall be directed by Supplier to Customer for response.

10. Force Majeure. Neither party shall be liable for its failure to perform hereunder to the extent circumstances arise which are beyond its reasonable control and which could not have been avoided by the exercise of due diligence and foresight. The party prevented from performance shall diligently take all steps reasonably available to overcome the cause of such inability to perform and shall resume its performance as soon as practicable.

11. Indemnification.

11.1 Generally. Supplier will fully indemnify, defend at its expense and hold harmless the Customer and its Affiliates, directors, officers, employees, and agents (the "Indemnitee") from and against any and all claims, demands, suits, losses, costs, fees, damages or expenses it may suffer, or for which it may be held liable, whether including, without limitation, reasonable expenses and attorneys fees incurred in the connection therewith, by reason of (A) any patent, trademark, or copyright infringement claim, or any design, device, process or procedure used, installed or provided by the Supplier or its agents or subcontractors under this Agreement; (B) any work-related accident or injury affecting an employee, agent or subcontractor of the Supplier, arising in connection with Service performed under this Agreement; (C) any claim by an agency or instrumentality of the federal, state or any local government, or by an employee, agent or subcontractor of the Supplier alleging that (i) the Indemnitee is required to maintain worker's compensation or unemployment or any other type of insurance upon any employee, agent or subcontractor of the Supplier; (ii) the Indemnitee is liable for tax payments or withholding with

respect to any employee, agent or subcontractor of the Supplier; (iii) any employee, agent or subcontractor of the Supplier is entitled to receive employee benefits from the Indemnitee, including, without limitation, vacation, deferred compensation, medical, pension, 401(k) or any other benefit available to the Indemnitee's employees; and (iv) the Indemnitee is liable to any party, for any reason, due to the negligent performance of Services or omissions by an employee, agent or subcontractor of the Supplier; (D) bodily injury, including death, to any person or persons due to the negligent, reckless or willful actions or omissions of the Supplier or its agents or subcontractors; (E) damage to or destruction of any property, including loss of use thereof, due to the negligent, reckless or willful actions or omissions of the Supplier, or its agents or subcontractors. Individual employees, agents and subcontractors of the Supplier who are performing Services for the Indemnitee under this Agreement shall be considered to be employees, agents or subcontractors of the Supplier for all purposes under this Agreement, notwithstanding any judicial or administrative determination that such employees, agents or subcontractors of the other party should be regarded as employees under applicable law. All actions of the employees, agents and subcontractors of the Supplier under this Agreement shall be deemed to be actions of the Supplier under these indemnities and this Agreement. In furtherance of the foregoing indemnification and not by way of limitation thereof, the Supplier hereby waives any defense or immunity it might otherwise have under applicable worker's compensation laws or any other statute or judicial decision (including, for Services to be conducted in Maine, without limitation, Diamond International Corp. v Sullivan & Merritt, Inc. 493 A2d. 1043 (Me 1985)) disallowing or limiting such indemnification, and the Supplier consents to a cause of action for indemnity.

11.2 Taxes. Supplier similarly agrees to fully indemnify, defend and hold Customer harmless against liability or expense on account of all contributions, assessments, and taxes now or hereafter imposed by any governmental authority with respect to the compensation of Supplier. Supplier warrants that all sales, use, gross receipts, and other similar taxes, if any, imposed in connection with the Services or Materials are included in the price for the Services and shall not be billed as an extra unless Customer expressly gives its permission in writing.

12. Termination.

12.1 Cause. Customer, reserving to itself the right to receive such other damages and remedies as it may have pursuant to this Agreement or at law or in equity, has the right to terminate this Agreement, by giving written notice of termination to Supplier of the occurrence of any of the following:

(a) Supplier defaults in the observance or performance of any covenant, agreement or condition contained in this Agreement if within ten (10) days after the giving of written notice to Supplier of such failure of performance, Supplier has not cured such failure or if such failure of performance cannot be cured in ten (10) days, if Supplier has not commenced curing such failure of performance promptly and within such ten (10) day period is not effectuating such cure with haste and does not cure such failure of performance within a reasonable time, not to exceed, thirty (30) days from receipt of the notice specified herein.

(b) In the event that Supplier is declared to be bankrupt or insolvent, Supplier makes an assignment for the benefit of creditors, Supplier shall file a voluntary

petition in bankruptcy or insolvency or an involuntary petition is filed against Supplier, or a receiver shall be appointed for Supplier and such appointment or bankruptcy or insolvency proceedings, petition, declaration or assignment is not set aside within thirty (30) days.

(c) There has been a material adverse change in the financial condition of Supplier that affects the ability of Supplier to perform.

12.2 Convenience. Customer may terminate this Agreement for any reason at any time ("Termination for Convenience") or Customer may similarly terminate any specific portion of the Services for any reason and at any time. Termination for Convenience shall take place five (5) days from issuance of written notice by Customer. In the event the Supplier has not defaulted, Customer agrees to pay for all Services rendered to the termination date pursuant to this Agreement, provided, however, that such payment shall not result in total payment(s) to the Supplier exceeding the maximum amount payable under the terms of the applicable Purchase Order. This provision shall not be deemed to limit or otherwise affect Customer's right to terminate this Agreement for breach or default by the Supplier.

13. Employee Solicitation. During the term of this Agreement and for a period of one (1) year thereafter, except with the prior written consent of Iberdrola USA Management Corporation, Supplier shall not offer employment to, or employ, any employee of Iberdrola USA Management Corporation or Iberdrola USA Management Corporation's current or future Affiliates, and Supplier shall not induce or attempt to induce, directly or through an agent or third party, any such employee to leave the employ of Iberdrola USA Management Corporation or Iberdrola USA Management Corporation's current or future Affiliates.

14. Miscellaneous. This Agreement and the contract documents as defined herein constitute the entire agreement between the parties and supersede all prior or contemporaneous communications or agreements, written or oral, with respect to the Services. Any reference to Supplier shall be deemed a reference to Supplier, its employees and subcontractors and those under their direction and control. Supplier shall not assign this Agreement (or any monies due hereunder) nor subcontract its obligations without the prior written consent of Customer. Any such attempted assignment or other transfer without such consent shall be void. This Agreement may be amended only by a writing signed by the parties. The failure of either party to enforce any provision of this Agreement shall not constitute a waiver thereof nor of the right to seek any other remedy. No waiver shall be valid unless in writing signed by the waiving party. Addresses for notice shall be as set forth in the preamble or as changed by notice. This Agreement shall be governed by the laws of the state of New York without regard to conflict of law principles. Any dispute shall be resolved in courts located in the state of New York, and Supplier consents to their personal jurisdiction. All sections or provisions of this Agreement with terms containing obligations or duties which by their nature are to be or may be performed beyond any termination hereof, shall survive the termination of this Agreement without regard to the reason for termination, including, without limitation, Sections 3, 4, 5, 6, 8, 9, 11, 13, and14.

15. Iberdrola S.A. Code of Ethics and Iberdrola USA Annex. Supplier shall comply with the Iberdrola Suppliers' Code of Ethics ("Suppliers' Code of Ethics") in connection with its performance under this Agreement. The Suppliers' Code of Ethics can be found at the Iberdrola USA website (www.iberdrolausa.com).

16. Performance Monitoring. Customer will evaluate Suppliers performance by utilizing Supplier Corrective Action Reports and Supplier Performance Evaluation Reports. The Supplier must provide upon request the OSHA incident rate and Experience Modification Rate for Customer's review. The Customer will evaluate the Supplier's performance upon the conclusion of the Services by completing the specified report. The Customer will continuously monitor the Supplier's performance.

17. Continuous Improvement. Continuous improvement is the foundation of this Agreement. Supplier will use its best efforts to improve continuously its performance in all areas. In particular, Supplier will evaluate opportunities for cost/price reductions on items and services ordered and to be ordered and communicate them promptly to Customer.

18. No Dispute. Supplier covenants that it is not aware of any pending billing dispute or other contractual dispute (pursuant to current contracts or contracts no longer in effect) or any pending or threatened litigation between Supplier and/or any of Supplier's Affiliates and Customer and/or and of Customer's Affiliates.

19. Supplier Security Requirements. Supplier shall comply with Customer's Supplier Security Requirements in their performance of Services for Customer under this agreement.

Supplier shall be familiar with and shall comply with the requirements of the NERC CIP- 004 for projects or services at or relating to critical cyber assets and critical company operating facilities ("Critical Infrastructure"). The specific CIP Standard follows:

> CIP-004 Excerpt:
> R3. Personnel Risk Assessment --The Supplier shall have a documented personnel risk assessment program, in accordance with federal, state, provincial, and local laws, and subject to existing collective bargaining unit agreements, for personnel having authorized cyber or authorized unescorted physical access. A personnel risk assessment shall be conducted pursuant to that program prior to such personnel being granted such access except in specified circumstances such as an emergency. The personnel risk assessment program shall at a minimum include:
>
> R3.1. The Supplier shall ensure that each assessment conducted include, at least, identity verification (e.g., Social Security Number verification in the U.S.) and seven- year criminal check. The Supplier may conduct more detailed reviews, as permitted by law and subject to existing collective bargaining unit agreements, depending upon the criticality of the position.
>
> R3.2. The Supplier shall update each personnel risk assessment at least every seven years after the initial personnel risk assessment or for cause.
>
> R3.3. The Supplier shall document the results of personnel risk assessments of its personnel having authorized cyber or authorized unescorted physical access to Critical Cyber Assets, and that personnel risk assessments of contractor and service vendor personnel with such access are conducted pursuant to Standard CIP-004.

20. Utilization of Small Business Concern. Supplier and subcontractors of all tiers must comply with section 52.219-8 of the Federal Acquisition Regulation. This policy requires that small business concerns, veteran-owned small business concerns, service-disabled veteran-owned small business concerns, HUBZone small business concerns, small disadvantaged business concerns, and women-owned small business concerns shall have the maximum practicable opportunity to participate in the performance of Services.

21. Small Business Subcontracting Plan. In accordance with section 19.702(a) (1) and (2) of the Federal Acquisition Regulation, each Supplier (except small business concerns) whose contract is expected to excee[redacted] for construction) and has subcontracting possibilities is required to submit an acceptable subcontracting plan to the Customer. The plan shall include spending goals with businesses that are defined by the U.S. Small Business Administration as small, women-owned small, veteran-owned small, service-disabled veteran-owned small, HUBZone, small disadvantaged (SDB), and minority-owned; as defined by the National Minority Supplier Development Council. If the Supplier fails to submit a plan within the time limit prescribed by the Customer, Customer may terminate this Agreement.

The Supplier assures that the clause entitled "Small Business Subcontracting Plan" will be included in all subcontracts, that offer further subcontracting opportunities, and all subcontractors (except small business concerns) who receive subcontracts in excess o[redacted] for construction) will be required to adopt a plan similar to this plan.

22. Notices. Along with all other correspondence requirements included in this Agreement, any notice, request, approval or other document required or permitted to be given under this Agreement shall be in writing and shall be deemed to have been sufficiently given when delivered in person or deposited in the U.S. Mail, postage prepaid, return receipt requested, addressed as specified herein or to such other address or addresses as may be specified from time to time in a written notice given by such party. The parties shall acknowledge in writing the receipt of any such notice delivered in person.

All communications to Iberdrola USA Management Corporation shall be directed to:

Iberdrola USA Management Corporation
Contract Administration
89 East Avenue
Rochester, NY 14649
Phone: 585-724-8028
Fax: 585-771-2820

All communications to Supplier shall be directed to:

Supplier Name	[redacted].
Contact Name	William P. Flood
Title	President
Email Address	felsonenergy@gmail.com
Street Address	1770 Sweets Corners Road
City, St, Zip	Fairport, NY 14450
Phone	(585) 315-1307

IN WITNESS WHEREOF, Customer and Supplier have each caused this Agreement to be signed and delivered by it's duly authorized representative as of the date first given above.

New York State Electric and Gas Corporation

Signature

Kevin E. Walker

Print Name

COO

Title

3-5-15

Date

[redacted]C.

William P. Flood

Signature

William P. Flood

Print Name

President

Title

2/24/15

Date

New York State Electric and Gas Corporation

Signature

Jose Maria Torres

Print Name

CFO

Title

3/6/15

Date

SCHEDULES:

Schedule A: Scope of Services
Schedule B: Pricing Terms
Schedule C: Insurance Requirements
Schedule D: Special Conditions
Schedule E: Plan and Schedule of Work
Schedule F: Host Customer Approval Form

ATTACHMENTS:

Exhibit A-1: Savings Template
Signed Commissioning Plan
Compressed Air System Investigation For Diesel Plant - Corning
HB Blower Engineering Data
Ingersoll Rand Information
Compressor Data Sheets

Schedule A

Scope of Services

Any changes to the Scope of Work herein found or made in the field from the conditions noted on the herein referenced spreadsheets must be pre-approved by the Customer for the purposes of receiving a block bid payment. Any adjustments to the payments in Schedule B will be made, accordingly.

Corning, Inc. - Diesel Plant

The Corning Diesel plant, located at 890 Addison Road in Painted Post, NY is part of the Environmental and Life Sciences division of Corning, Inc. that manufactures ceramic substrates and particulate filters. When coated with a catalyst, the ceramic substrate converts noxious exhaust gases into harmless gases and water. This industrial manufacturing plant is in the forefront of technology to control and mitigate diesel emissions from transportation, industrial, mining, construction and agricultural engine applications.

The Scope of Work for this comprehensive compressed air energy efficiency upgrade project will consist of replacing 4 existing, single-stage 300HP compressors (Model# EPE300-W125), with 4 new 300HP compressors----2 of which will be two-stage compressors (Model# EPE300-A125), and 2 will be two-stage, VSD compressors (Model# R225NE-W100). In addition, we will be replacing 2 existing heatless regenerative desiccant air dryers with 2 new heated-blower desiccant dryers (Model Numbers HB3000 and HB6000). Further, automated compressor controls will be installed in order to optimize pressure and control flow efficiently. Along with the controls an air amplifier will be installed to serve dedicated higher pressure loads, allowing pressure at the compressors and throughout the rest of the plant.

The Compressed Air System Investigation for Corning Diesel Plant, an engineering study performed by Ingersoll Rand dated April 2013, and the bidder developed Exhibit D (Corning Diesel Plant Calculations Workbook), both of which were submitted with the bid proposal for RFP #14228, are included herein by reference, and contain the locations, existing conditions and post-project conditions, as submitted by the Supplier in the Block Bidding process, and validated by the Customer, to support the descriptions and detail the work to be performed under the Scope of Work.

Pursuant to, and in addition to, the terms and requirements of Schedule D Special Conditions of this Agreement, this Scope of Work shall include the following:

Commissioning Plan and Functional Test Procedures

[redacted] shall has submitted a detailed and robust Commissioning Plan and Functional Test Procedures document with step-by-step procedures and tests designed to demonstrate that the operation of the equipment installed under the Scope of Work is in compliance with requirements of this Agreement and verifies that such equipment, sensors and control devices perform as a system consistent with the proposal submitted by [redacted] for the Block Bidding RFP #14228. These procedures and tests shall further serve to provide reasonable demonstration that the energy savings proposed by [redacted] in the RFP will be delivered. The Commissioning Plan and Functional Test Procedures documents is subject to approval by NYSEG and are attached to this Agreement.

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[1]NOTE: To the extent, if any, that the energy savings and utility cost (block bid amount) noted in the attached spreadsheets referenced herein conflict with the provisions of Schedule B of this Agreement, the Schedule B of this Agreement shall take precedence and govern.

Schedule B

Pricing Terms

SCHEDULE B

Pricing Terms

The rates listed in this Schedule B shall be in effect for the Term of the Agreement, unless otherwise modified pursuant to the terms of Schedule A.

Payment terms are defined as follows:
1) Upon completion of the Scope of Work for each Host/Project Location as described in Schedule A of this Agreement, the Supplier shall submit to the Customer the supporting documentation, as described in Schedule D of this Agreement, to demonstrate that the Scope of Work has been completed as contracted.
2) The Customer will require up to thirty (30) days to review the documentation, complete any post-installation inspection, as appropriate, and confirm that the Scope of Work has been satisfactorily completed as contracted. Any delay by the Supplier in providing the Customer with acceptable completed documentation, as determined by the Customer, may cause a delay in the Customer's review beyond the 30 days noted herein.
3) Upon confirmation by the Customer that the Scope of Work has been satisfactorily completed, the Customer will notify and authorize the Supplier to Invoice the Customer for the Contracted Utility Contribution noted in this Schedule B.
4) Upon receipt of an approved Invoice from the Supplier, the Customer shall make payment, Net 30 Days, for the Contracted Utility Contribution.

Host/Project Location	Customer (OpCo)	Contracted Energy Savings (kWh)	Contracted Utility Contribution
Corning, Inc. (Diesel Plant)	NYSEG	2,914,399	$ [redacted]
[redacted] Total		2,914,399	$ [redacted]

Schedule C

Insurance Requirements

Before commencing Services, the Supplier shall procure and maintain at its own expense for a period of two years beyond completion of the Services, the insurance types, limits, terms, and conditions listed in Section 1 below. The amounts as specified are minimums only. The actual amounts above the minimums shall be determined by the Supplier. In addition, for any Services that are authorized to be subcontracted, the supplier shall require each subcontractor to procure and maintain all insurance as outlined in section one.

IF YOU DO NOT HAVE A CURRENT CERTIFICATE ON FILE WITH CUSTOMER prior to commencement of Services, Certificates of Insurance evidencing supplier's and/or subcontractor's possession of insurance as outlined in Section 1 shall be filed with Customer for its review.

Certificates of Insurance should be mailed to the Procurement Department at the following address:

Iberdrola USA Management Corporation
Procurement Department/Insurance Cert.
89 East Avenue
Rochester, NY 14649-0001

1. **Required Insurance Coverage's and Minimum Amounts**

Each insurance policy shall be placed with an insurance company licensed to write insurance in the State where the Services are to be performed and shall have an A.M. Best's Rating of not less than "B+" and a policyholder surplus of at least [redacted].

Each insurance policy, except Workers' Compensation and Employers' Liability, shall be endorsed to add Customer as an additional insured. All insurance where Customer is an additional insured must contain provisions which state that the policy will respond to claims or suits by Customer against the Supplier/Consultant/ Labor supplier/etc. In addition, Customer should be notified of any reduction in the aggregate policy limits.

Each policy shall be endorsed to provide a minimum of thirty (30) days prior written notice of cancellation, intent not to renew, or material change in coverage.

Each policy shall be endorsed to provide a breach of warranty clause.

In the event Supplier and/or Subcontractor has a policy(ies) written on a "claims-made" basis, such insurance shall provide for a retroactive date not later than the commencement of Services under this agreement. In addition, the Supplier and/or Subcontractor will guarantee future coverage for claims arising out of events occurring during the course of this

agreement.

All of the insurance required hereunder will be primary to any or all other insurance coverage in effect for Customer.

1.1 Workers' Compensation and Employers' Liability Insurance in accordance with the statutory requirements of the State of New York. For Services that are conducted outside of New York State, the minimum limit for Employers' Liability Insurance should be [redacted] each accident, [redacted] disease-policy limit, [redacted] disease-each employee.

1.2 Automobile Liability insuring any auto, all owned autos, hired autos, and non-owned autos with a bodily injury and property damage combined single limit of [redacted] per occurrence.

1.3 General Liability (Comprehensive or Commercial Form), including coverage for Premises/Operations, Underground/ Explosion & Collapse Hazard, Products/Completed Operations, Contractual Liability specifically insuring the attached Indemnity Agreement, Independent Contractors, Broad Form Property Damage, and Personal Injury, in the amount of [redacted] per occurrence and [redacted] aggregate.

The amount of insurance may be satisfied by purchasing primary coverage in the minimum (or greater) amounts specified or by purchasing a separate excess Umbrella Liability policy together with lower limit primary coverage.

Each General and/or Umbrella Liability Insurance policy shall be endorsed with the following Cross Liability clause: In the event of claims being made by reason of personal and/or bodily injuries suffered by any employee or employees of one insured hereunder for which another insured hereunder is or may be liable, then this policy shall cover such insured against whom a claim is made or may be made in the same manner as if separate policies had been issued to each insured hereunder, except with respect to limits of insurance. In the event of claims being made by reason of damage to property belonging to any insured hereunder for which another insured is or may be liable, then this policy shall cover such insured against whom a claim is made or may be made in the same manner as if separate policies had been issued to each insured hereunder, except with respect to the limits of insurance.

None of the requirements contained herein as to types, limits and approval of insurance coverage to be maintained by Supplier or Subcontractors are intended to, nor shall they in any manner limit or qualify the liabilities and obligations assumed by Supplier or Subcontractor under this agreement.

Schedule D

Special Conditions

I. The execution of this Agreement shall serve as the Supplier's certification that the selected bid and/or measures have not and will not receive funding from NYSERDA or any other energy efficiency program funded by the New York State System Benefit Charge (SBC).

II. Supplier shall provide with the execution of this Agreement, updated Plan & Schedule of Work dates for each Host Customer project. A Plan & Schedule of Work for updating is attached as Schedule E.

III. Supplier shall provide updated Host Customer Approval Form(s), as needed, with the execution of this Agreement. Updated Forms are required if the original Forms submitted with the Request for Proposal ("RFP") contained any Host Customer exceptions. Updated Forms shall not contain any Host Customer exceptions. A clean copy of the Host Customer Approval form is attached as Schedule F. If the original Host Customer Approval Form, Exhibit E of the RFP, does not contain any Host Customer exceptions, it is included here in this Agreement by reference to memorialize the Host Customer's commitments.

IV. Customer is responsible for monitoring, overseeing, and coordinating their energy efficiency programs, individually and collectively. The Customer will determine Supplier compliance with performance expectations; maintain accounts and pay invoices; conduct field inspections for quality assurance purposes as necessary; carry out pre- and post-installation inspections; conduct all program evaluations; ensure appropriate data management; respond to Commission discovery requests; and produce monthly, quarterly, and annual PSC reports.

V. In cooperation and support of these Customer' responsibilities, Suppliers shall do the following:

1. Comply with the terms and conditions of the Service Agreement
2. Produce data for the Customer to produce interim performance reports to the PSC.
3. Document all achieved savings and the completion of the Scope of Work. This shall include, at a minimum, RFP Exhibit D files with as-built conditions and documentation confirming the operating assumptions/conditions for the energy savings equipment.[1]
4. Comply with confidentiality requirements for handling Host Customer energy consumption data and require Host Customers to agree to cooperate with program evaluation related activities[1].
5. Provide before and after digital pictures of all work.
6. Document in electronic format what every picture represents.
7. Provide invoices documenting the purchase of the equipment installed.
8. Provide Self Certification of the actual Total Project Costs for the completed project.
9. Provide a copy of the Supplier's invoice to the Host Customer, which confirms the Host Customer's contribution towards the project.

10. Comply with all Block Bidding Program quality assurance and evaluation requirements; including, but not necessarily limited to, follow-up interviews and on-site verification by the Customer's program evaluation contractor.
11. Cooperate with the Customer to respond to Commission discovery requests and produce PSC reports[2].
12. Deliver energy savings as contracted.
13. Resolve any Host Customer complaints.

[1] NOTE: For complex projects where savings cannot be readily determined by simple site inspection, the Customer, at the Customer's discretion, may require additional validation to ensure that the installed energy savings measure(s) operate as proposed and will deliver the proposed energy savings. This validation will follow the International Performance Measurement & Verification Protocol (IPMVP) which could include, but not necessarily limited to, metering of equipment, visual inspection and read-out of control equipment and operational logs. If additional validation is required, it will be at the Suppliers expense.

VI. The Customer will conduct pre- and/or post-installation physical site inspections at a sample of host sites. Suppliers shall notify the Customer at least 30 days in advance of the start of each project in the Supplier's Scope of Work, to provide the Customer with the opportunity to schedule a pre-installation inspection.

VII. Suppliers shall provide the Customer with sufficient documentation to verify that the Scope of Work has been completed as contracted. Such documentation shall include, at a minimum: (a) confirmation of pre- and post-installation inspection requirements, if applicable; (b) provide digital pictures of each measure prior to beginning implementation of the savings measures; (c) provide post implementation digital pictures of each measure; (d) an Excel spreadsheet (the original Scope of Work spreadsheets) with columns added for as-found and as-installed conditions and for picture numbers matching before- and after-pictures to the Scope of Work; (e) invoices from the procurement of the energy savings measure equipment marked-up with sufficient identification matching the equipment on the invoice to the original Scope of Work spreadsheets and host customer location(s); (f) documentation to support Total Project Costs; and (g) copies of invoice(s) to the Host Customer for their contribution to the project. Such documentation shall be completed and submitted to the Customer upon completion of the Scope of Work, as described in SCHEDULE B.

VIII. Supplier must complete Scope of Work no later than **12 months** from the Effective Date of this Agreement.

IX. Failure to deliver the Contracted Energy Savings[3] or to deliver the Contracted Energy Savings at the prescribed program delivery dates may be grounds for the Customer, at their sole discretion, to reduce the Contracted Utility Contribution and/or Contracted Energy Savings or to terminate this Agreement.

[1] New York State Department of Public Service, Office of Energy Efficiency and the Environment letter dated June 12, 2009 regarding Customer Data Guidelines and evaluating energy efficiency programs, included herein by reference and available in Appendix A of the Information Reporting Manual referenced in footnote [ii] below.

[2] The data fields specified in the PSC scorecard and evaluation reporting requirements are included in *New York Department of Public Service Energy Efficiency Program Information Reporting Manual* (June 29, 2009), included herein by reference and available on the New York State Department of Public Service website at http://www.dps.state.ny.us/Reporting_Manual_6-30-09.pdf , plus other specific management and operational reports as required by the Companies.

[3] All energy savings shall be calculated in accordance with the NYS Energy Efficiency Portfolio Standards proceedings, which includes, but is not necessarily limited to, the following:

a) *New York Standard Approach for Estimation Energy Savings From Energy Efficiency Programs - Residential, Multi-Family, and Commercial/Industrial Measures*, October 15, 2010. ("NY Tech Manual") available on NYSEG, RG&E and NYSDPS websites, or through the following link: https://docs.google.com/viewer?url=http%3A%2F%2Fwww.dps.state.ny.us%2FTechManualNYRevised10-15-10.pdf

b) "Appendix M" to the NY Tech Manual issued May 5, 2011, available as a separate document on the NYS Department of Public Service website at: http://www3.dps.state.ny.us/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/06f2fee55575bd8a852576e4006f9af7/$FILE/Appendix%20M%20final%205-05-2011.pdf

c) *Order Approving Modifications to the Technical Manual*, July 18, 2011, available on the NYSDPS website at: http://documents.dps.state.ny.us/public/Common/ViewDoc.aspx?DocRefId={207D90AD-22A3-486B-861F-115DCC235F7B}

Schedule E

Plan & Schedule of Work

SCHEDULE E Plan & Schedule of Work			
Block Bidding Program			
Installation Schedule for Proposed Projects			
Date: 2-24-15			
Prepared by: William R Floyd			
Supplier: [redacted]			
Project Name	**Proposed Start Date**	**Proposed Completion Date**	**Project Description**
Corning, Inc. – Diesel Plant	4/1/15	8/1/15	Compressed Air System Upgrade

Schedule F

Host Customer Approval Form

APPROVAL AND COMMITMENT FOR INCLUSION IN BLOCK BIDDING

By signing below, the Host Company agrees to the following:

(i) To be included in the Block Bidding proposal presented to NYSEG by the Supplier Company;

(ii) That the proposed project is genuine and that the Host Company is committed to implementing the project, if selected;

(iii) That the Customer Contribution for the project is consistent and valid with the terms between the Host Company and Supplier;

(iv) If such proposal is accepted by NYSEG, the Host Company agrees to allow NYSEG to mention the Host Customer's name (no project details) in a NYSEG press release or media announcement announcing the successful bidders;

(v) To cooperate with NYSEG's program evaluation contractor in requests for program evaluation interviews and on-site verification activities; and

(vi) That the proposed energy saving measures have not, and will not, receive funding from NYSERDA or any other energy efficiency program funded by the New York State System Benefit Charge (SBC).

CORNING INCORPORATED Host Company Name	Felson Energy, Inc. Supplier Company Name
DAVID OTLEY Host Company Representative (Print)	William R. Flood Supplier Company Representative (Print)
David Otley Host Company Representative Signature	William R. Flood Supplier Representative Signature
PLANT CONTROLLER Title	President Title
9/23/14 Date	9/23/14 Date
(607) 974-8605 Telephone Number	585-315-1307 Telephone Number
1001-0000-288 NYSEG 11-digit Customer Account Number	
327999 Host Customer's NAICS Business Code [1]	

([1] The 6-digit NAICS Principle Business Code from the Host Customer's IRS Tax Form Schedule C, Item B.)

NOTES & COMMENTS

Exhibit A-1

Savings Template

Inserted on CD:
Corning Diesel Plant Calculations Workbook

[redacted] Inc.

1770 Sweets Corners Road
Fairport, NY 14450
felsonenregy@gmail.com

February 16, 2015

Program Administrator—Block Bid Program
New York State Electric and Gas Corporation
89 East Avenue
Rochester, NY 14649

Attention: Gary Freeland

Subject: Commissioning Plan and Functional Test Procedures

Reference: Corning Diesel Plant 890 Addison Road, Painted Post, NY

Dear Gary:

NYSEG has requested that [redacted] Inc. submit a "Commissioning Plan and Functional Test Procedures" for the proposed compressed air project at the Corning Diesel plant, 890 Addison Road, Painted Post, NY, under RFP #14228. Following is a plan for the project. We would appreciate your review and acceptance of the plan prior to our signing the contract.

The Scope of Work for this comprehensive compressed air energy efficiency upgrade project will consist of replacing 4 existing, single-stage compressors (Model# EPE300-W125), with 4 new 300HP compressors – two of which will be two-stage compressors (Model# EPE300-A125), and two will be two-stage, VSD compressors (Model# R225NE-W100). In addition, we will be replacing two existing heatless regenerative desiccant air dryers with two new heated-blower desiccant dryers (Model Numbers HB3000 and HB6000). Further, automated compressor controls will be installed in order to optimize pressure and control flow efficiently. Along with the controls an air amplifier will be installed to serve dedicated higher pressure loads, allowing pressure at the compressors and throughout the rest of the plant to be reduced.

The equipment required to implement the foregoing scope of work will all be supplied by the Ingersoll Rand Corp. Start-up and commissioning of the equipment will be performed by Ingersoll Rand technicians. Please find attached four equipment start-up sheets. The I-R technicians will field verify the proper operation of all installed hardware and will complete the start-up checklists. A copy of the completed checklists will be provided to and reviewed with the customer and a second copy furnished to NYSEG.

In addition to the aforementioned major hardware, the project scope of work calls for the installation of "automated compressor controls." Four I-R documents are attached providing NYSEG with a detailed description of the required hardware. After the controls hardware and software installation has been completed this commissioning plan shall perform an overall test of the entire compressed air system to verify proper operation and energy savings.

Prior to applying for an incentive in the NYSEG Block Bid program on "Air Audit" was completed. Data loggers were installed on the existing equipment and the collected data was analyzed in an excel workbook format. A copy of that study was incorporated in the Incentive application. Post installation the data-loggers will be re-installed and system operation will be monitored for 7 days. This 7-day run time will be similar and consistent with Corning's plant operations during the pre-installation data collection. The collected data will then be analyzed using the same spreadsheet tools to estimate annual energy consumption for the improved compressed air system. The before and after spreadsheets will then be compared to determine the amount of savings being generated. Copies of the spreadsheet analysis shall be furnished to NYSEG.

Should you have any questions about this commissioning plan please call or e-mail me. Upon your acceptance of this plan we shall sign the contract and forward it to you promptly.

Submitted by:

William P. Flood
President

Accepted by:

Gary B. Breeland
Gary B. Breeland
Block Bid Program Coordinator

February 19, 2015

February 20, 2015

Compressed Air System Investigation

For

Corning – Diesel Plant

Painted Post, NY

Ingersoll Rand
800B Beaty St.
Davidson, NC 28036

April 2014

Mark Ames (704) 957-6719

Executive Summary

The plant's compressed air system was investigated during the week of April 28th, 2014. The goals of the audit were to analyze the compressed air supply, distribution, and demand and to determine if opportunities exist to reduce energy consumption and improve efficiency. Production was considered normal during the week of the analysis.

Compressed Air System Reliability

There have been no production issues related to the compressed air supply operation. A 1,600Acfm diesel compressor is available to operate, but is used only when one of the electric motor driven units is out of service. Environmental regulations limit the diesel's operating time to less than 50 hours per year without fines.

Compressed Air System Efficiency

All compressors are fixed speed designs installed in an environment with just under 40k-gallons of storage and flow control valves set to 100psig. In this environment, all compressors are set to run in a load/unload mode of control and operate at an average discharge pressure of 120psig. The pressure operating set-points of the six compressors were identical for both compressor rooms, and allowed for simultaneous starting compressor 3 and 4 causing excess energy consumption. By properly controlling compressor start/stop operations, managing system pressures to the minimum required levels and re-piping compressors vis-a-vie the flow control valves, tremendous energy savings will be generated. Installing a compressor system master controller along with an air amplifier for local higher pressure requirements, will allow harvesting these savings.

Compressed air usage

The primary consumers of compressed air are dense phase transporters in the Dry Blend area; open blowing for dust removal in each DRS (dust removal system), and desiccant dryer purge. Utilizing alternative drying technology that still will provide the quality of compressed air required by production for all conditions will reduce consumption by over 1,200Scfm.

Compressed Air System Operating Cost

The current average electrical unit cost of [redacted]/kWhr costs the facility an estimated [redacted] annually for compressed air. The proposed changes will reduce the existing annual energy consumption by 2.9MWhr worth [redacted] and will greatly reduce the potential for a production interruption caused by the failure of a compressed air supply component.

Technical Summary of Issues and Observations

1. All compressors are operating upstream of flow control valves. Base load requirements call for three of the six compressors 100% of the time. Operating at a higher pressure consumes more energy than necessary.
2. With the existing compressor controls, operating set points are not cascading allowing for simultaneous starting of two off-line compressors.
3. Desiccant dryers are heatless regenerative designs providing a -40°F pressure dew-point. Combined purge volume exceeds the output of one of the 300hp compressors.
4. No float alarms are installed on the condensate drain valves. Failures can go unnoticed. Example, one of the two mist eliminator filters in compressor room 2 was full of liquid.
5. Heat exchange through compressor coolers is negatively impacted by build-up of sediment originating from ambient airborne dust entering the cooling water system at the cooling towers.
6. Compressed air header pressure averages 100psig although most critical pressure requirements are less than 90psig.
7. Identified critical pressure requirements exist in Wet Tower 3rd floor – Littleford mixer door cylinders and air over oil for atomization. These critical pressure requirements can be served by an air amplifier.
8. Dry Blend - Majority of consumption is for dense phase conveying. Other use for powder fluidization and dust collector filter regeneration.
9. Production – Majority of consumption is open blowing for dust removal through engineered nozzles.

Actions to reduce energy

1. Install a new compressor station to include two 300hp, 2 Stage fixed speed compressors, filters, and dryer to supply base load to current compressed air demands.
2. Replace two of the existing fixed speed 300hp with two 300hp, 2 Stage variable speed compressors to efficiently provide trim variances to the dry blend and to production.
3. Install heated blower desiccant dryers to eliminate dryer purge air.
4. Install master controller to automatically set compressor pressures to the minimum requirements.
5. Install an air amplifier to boost header pressure to critical loads.

		8,729,795	**$567,437**	5,815,396	**$378,001**	**2,914,399**	**$189,436**
	$ / hr		$64.776		$39.642		
	$ / hr / cfm		$0.014		$0.010		

vh Δ	2,914,399	Project Investment	**$2,198,950**
ings	333		

Environmental Impact	795.6	tons of CO^2 reduced
	6059	# of Trees available

These savings can only be achieved with the completion of all action items

Existing supply condition

Six identical Ingersoll Rand water-cooled single stage 300hp compressors rated for 1,363Acfm at 125psig exist in two separate compressor rooms. Normal air flow is from the compressor discharge through mist eliminator filters installed in parallel. Piping is installed to create a common header between the compressor rooms downstream of the mist eliminator filters so that compressed air can flow in parallel through four desiccant dryer stations. The dryers are heatless regenerative designs rated for 2,750Scfm and are equipped with a proprietary dew-point dependent switching control system. Each desiccant dryer is preceded and followed by coalescing filter. A common header is installed downstream of the desiccant dryers to allow compressed air to flow into ten 3,800-gallon receiver tanks. Two 8" forward acting flow control valves are installed to restrict air flow to both the dry blend and production header networks. **See attachment A1. Manufacturer's specification sheets for the dryers and CAGI reports for the compressors are attached separately.**

Normal system operation

The compressors are operating in a load/unload (automatic start) mode of control. The compressors are maintaining an average discharge pressure of 120psig and a dry capacity pressure (within the tanks) of 115psig. The flow control valves are each set to maintain 100psig in the dry blend and production header networks. Compressed air demand averaged 5,441Scfm but ranged from just under 5,000Scfm to just over 7,150Scfm. When the dry blend was isolated from production, peaks were measured to be 4,200Scfm for dry blend and 4,650 for production. It should be noted that the peak measurement in dry blend did not include rail car unloading which could increase its peak consumption by an additional 1,572Scfm.

Compressor power (amperage) and system pressures (psig) were recorded in 2 second intervals in an effort to trend supply performance relative to changes in demand. The results of the measurements can be seen in **Attachments B1, C1 & C2**. Compressor flow (SCFM) and power (kW) were calculated from the measured and manufacturer's data.

Distribution

Pressure was measured simultaneously in the supply rooms, downstream of the flow control valves and at key locations to determine if there were any measureable losses in the transmission of compressed air. The locations include the end of the piping on the 6th floor of the dry blend, in the room where the #6 dust collector is, beside the grind machine MP2, and in the 3rd floor of the wet tower. With the exception being localized pressure drops associated with the action of the MP2 dust recovery system; there were no significant losses in pressure from the outlet of the supply rooms.

Issues

All compressors operating at a higher pressure than required by production

In the current arrangement, all compressors are operating upstream of the two flow control valves at a higher pressure than is required by production. During the analysis, three compressors ran fully loaded while the other three cycled (loaded and unloaded) as demand varied. When operating at a higher pressure, a positive displacement compressor will consume more energy at the same percent load. With that said, the 300hp compressors will consume over

6% less energy when operating fully loaded at 100psig than they would when running fully loaded at 125psig. This means that three of the 300hp compressors are consuming nearly 50kW of energy for no reason.

Overlapping compressor operating set-points
The compressors are operating in a load/unload mode of control between user programmable pressure settings. The original operating pressure set-points are illustrated in **Attachment A2**. In this arrangement, two compressors can simultaneously load and unload as demand changes. The graph in **attachment B2** illustrates this activity. When pressure falls to 114psig, compressors C3 and C4 both start, one can support the change in demand while the second could have remained off.

Drying the compressed air
The installed desiccant dryers are designed to provide compressed air downstream that has a pressure dew-point of -40°F. To accomplish this, they must consume 15-18% (industry standard) of their rated flow to regenerate a saturated desiccant bed. The dryers are equipped with an energy management system that prolongs the drying cycle if the pressure dew-point is lower than -40°F; however, when purging, each dryer will consume over 400Scfm for purge, or roughly 30% of the output of a running 300hp. When all four dryers are purging simultaneously, two compressors must operate to support this demand.

Condensate drains valves are not equipped with float switches
The filters located upstream and downstream of the dryers are pulse on demand designs that are typically reliable, but can fail. The drain beneath on of the mist eliminator filters in compressor room 2 had failed to open as its whisper vent was closed. This resulted in the filter canister filling up with the separated condensate. This canister was drained and the drain valve was put back into service. Ideally, each drain should also have a condensate level float switch to both send a signal to alert maintenance and also energize a powered valve to fire on a timed basis to remove separated condensate while the primary drain is serviced. The drawing in **Attachment E** illustrates this switch installed.

Heat exchange through the compressor coolers
The ability of the compressor's coolers to exchange heat has been negatively impacted due to the buildup of sludge that has been present in the cooling water. Maintenance has installed a sand filter in an effort to improve the cooling water quality supplied to the compressors. To determine when it is time to clean the compressor's coolers, a comparison should be made between the cooling water temperature and the compressor's discharge air temperature when the compressor is operating fully loaded. When the compressor's discharge temperature is more than 20°F higher than the cooling water temperature, the coolers should be cleaned. This assumes that the cooling water flow and pressure is adequate.

Network pressure is maintained higher than required
Pressure in both networks (dry blend and production) is maintained at 100psig. During the analysis, the cylinders for the doors of the Littleford mixer and oil atomization, located on the 3rd floor of the wet tower, were identified as users requiring 90psig or higher. We did not have the ability to test either user to determine what the actual working pressure is; however, the mixer door control cylinders are Ø8", giving them each roughly 4,500lbs of force when supplied

90psig. The atomization pressure is regulated, but it could not be determined to what pressure. Both of these are low volume intermittent users of air that can be satisfied locally by installing an air amplifier. Considering that a significant portion of demand in the production area is unregulated, primarily the open blowing nozzles within each dust recovery station (DRS), supplying the 3rd floor wet tower users with high pressure air while supplying everything else with a lower pressure air will reduce consumption and hence the energy required to support production.

Demand

Compressed air demand has major constituents, dense phase conveying air in dry blend; open blowing for dust recovery (DRS) in production, and desiccant dryer purge in the supply room and to a smaller degree, the dust collection pulse jets in dry blend.

The regulated pressures for the dense phase conveying were recommended by the supplier of the equipment. Spreadsheets exist that document these pressures. It has been our experience in industry that operators will adjust valves without understanding the ramifications, so it is recommended that each regulator and boosting pressure metering valve be inspected and adjusted if necessary. Testing was not performed to determine if any of these pressures could be lowered in an effort to reduce compressed air consumption without negatively impacting productivity.

The dense phase conveying system in the rail car unloading building is significantly larger than the other systems. In an effort to better understand the demands within this network, the system was isolated from the supply and other areas so that by monitoring the rate of pressure decay within the two storage tanks, and comparing that rate to the tank and piping capacity, that the rate of compressed air flow at various stages of conveying could be calculated. During the test, a lightweight material (CSG) was being transferred. This material is likely to consume the most compressed air during transfer due to its fluid nature and ultimately its low resistance to air flow. When transferring, the rate of air flow was 1,383Scfm, and of this volume, 110Scfm was for the pneumatic air vibrators that are typically used. Upon conclusion of the material transfer, compressed air is used to purge the transfer lines, and the rate of air flow increases to 1,572Scfm. The duration of the transfer could last for 10 minutes while the purge could last for up to 3 minutes. Considering the volume of stored potential energy in the supply room is 350ft³/psig, it is likely that each time the rail car transfer is occurring, a compressor will either have to load or start to match the demand. The results of the testing can be seen in **Attachments C3 & C4**.

As stated, using compressed air for the purpose of removing dust is not an economically efficient method. The tables in Attachment F2 show how much air can flow through an orifice at a given pressure and how much that air flow costs to generate annually. Considering that engineered nozzles are being used in an effort to reduce compressed air consumption, the nozzle design and inlet pressure must be reviewed to determine their individual air flows. Flow meters installed to measure the consumption by each saw line's DRS indicated roughly 900Scfm. This represents nearly 250bhp of compressor energy. Controls are in place in each DRS to shut off the air flow to the nozzles when there is no part present to clean; however, the combination of engineered nozzles and controls still requires that compressed air be generated at 120psig only to be expanded back to atmospheric pressure in an effort to attain a velocity.

New production lines with dust recovery systems (DRS) will utilize high volume low pressure air supplied from small horsepower blowers and engineered nozzles instead of using compressed air through engineered nozzles. Contingent upon the performance, this combination should be reviewed for each DRS to eliminate the use of high pressure air for the purpose of removing dust. Supply room recommendations will be made so that compressor and dryer energy can be shed efficiently with the reduction in compressed air demand.

Actions

Utilize alternative drying technology

A more efficient choice of dryer would be a heated blower desiccant. It is recommended that a single 6,000Scfm heated blower dryer be installed in parallel with the existing desiccant dryers in compressor room 2. The new dryer would act as the primary dryer while the desiccant dryers would be off line but available as backup.

This change will result in a reduction in compressed air consumption by a range of 1,300-1,700Scfm during peak demand conditions. This represents 250-320kW of compressor energy.

Install a new compressor station downstream of the flow control valves

The current compressed air demand for production exceeds 3,000Scfm. To most efficiently meet this level of demand, it will require fixed speed compressors to operate fully loaded at the lowest pressure. To provide this base load requirement, it is recommended that two 300hp 2-stage rotary screw compressors be installed with mist eliminator filters and a single 3,000Scfm heated blower desiccant dryer, and plumbed into the production network downstream of the flow control valve. See the proposed flow diagram in **Attachment D**.

It is recommended that the compressor be rated for a fully loaded output at 125psig to allow for the ability to displace into the network either downstream (low pressure) or upstream (high pressure) side of the flow control valves. The compressor should have a specific power of less than 18kW/100Scfm.

Replace two of the six 300hp compressors with two 300hp compressors with VFD

To more efficiently supply the variations in demand to both production and to the dry blend through the flow control valves, it is recommended that two of the six 300hp compressors be replaced with 300hp 2-Stage compressors equipped with variable speed drives. As with the base loaded compressor design, these units should be capable of fully loaded operation at 125psig and have an efficiency of less than 18kW/100Scfm. The proposed compressors should be capable of stopping and starting without running unloaded to eliminate this waste of energy.

Recommendations to lower network pressure

It is recommended that all point of use regulators be inspected. If the machine downstream of the regulator can operate at a pressure lower than the header pressure, adjust the regulated pressure accordingly. If the machine pressure requirement is higher than the header pressure, remove the regulator. The cylinders controlling the doors of the Littleford mixer require a pressure higher than the proposed header pressure. It is recommended that a 2:1 pressure booster (air amplifier) with a 60-gallon tank be installed to support just this use. The 2:1 booster will use

2 parts of compressed air to elevate the 1 part to double the pressure. A regulator should be installed to reduce the higher pressure air to the level required by the cylinders.

If the facility continues to use compressed air for the DRS modules in finishing, then it is recommended that the air supply for the DRS be segregated from the air supply for critical machine pneumatic control. These changes will allow for the network header pressure to be lowered, which will reduce the consumption by the unregulated and poorly regulated consumers. It is recommended that the flow control valve for production be adjusted to a pressure of 90psig or lower while the flow control valve for dry blend is adjusted to 80 psig or lower.

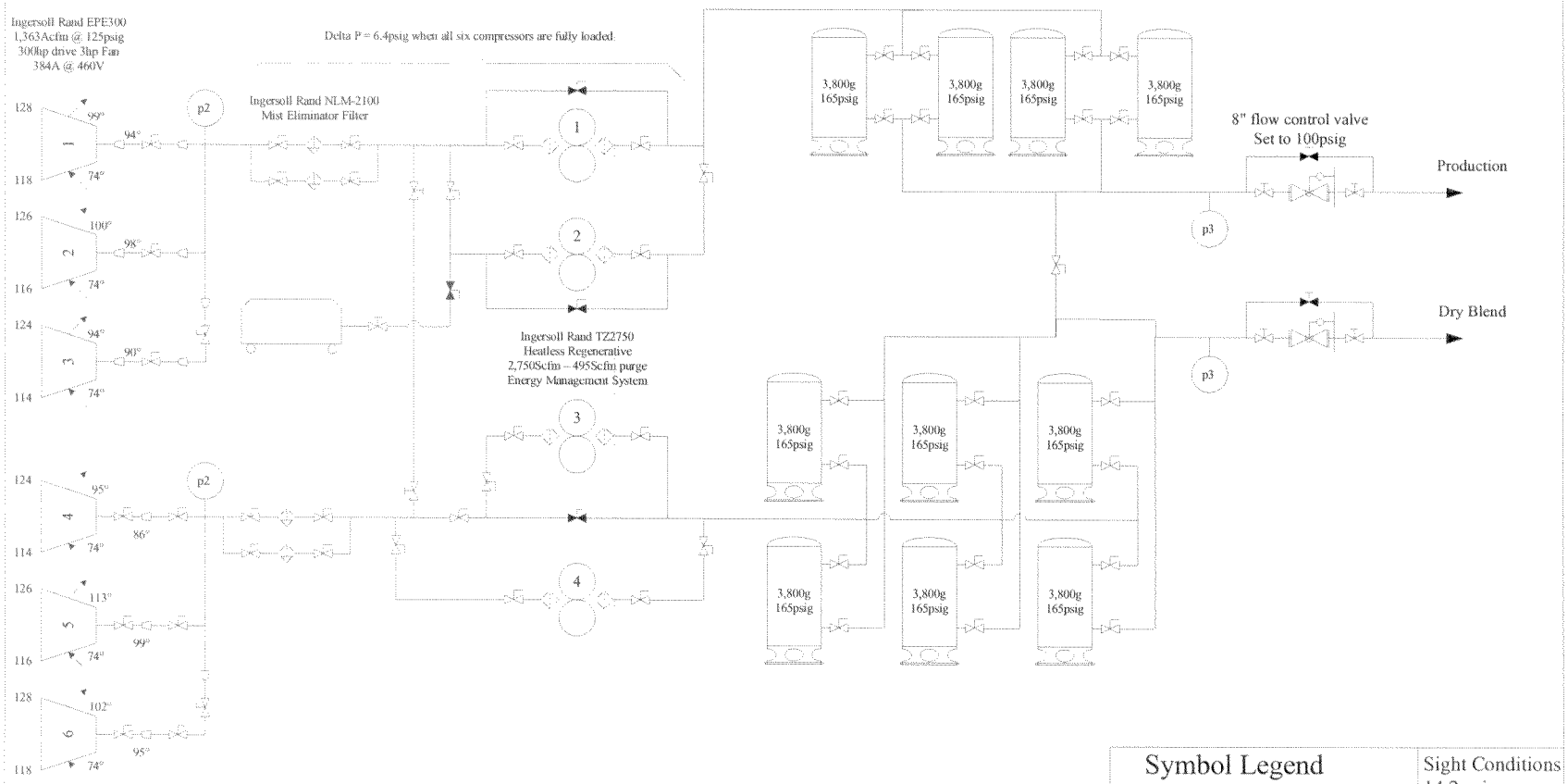
Summary

The recommendations are made to reduce energy, improve efficiency, and to reduce the potential of a production interruption due to the failure of a compressed air supply component.

Please feel free to contact me directly with any questions, comments, or concerns regarding this information.

Sincerely

Mark Ames
(704) 957-6719 (cell)



Available		Operating Profiles	Peak	Average	Low	Unproductive
Compressor Flow (Scfm)	8,011	Flow (Scfm)				
Compressor Power (kW)	1,568	kW				
Dryer Power (kW)	0	Network Pressure				
		Hours/year				

Symbol Legend

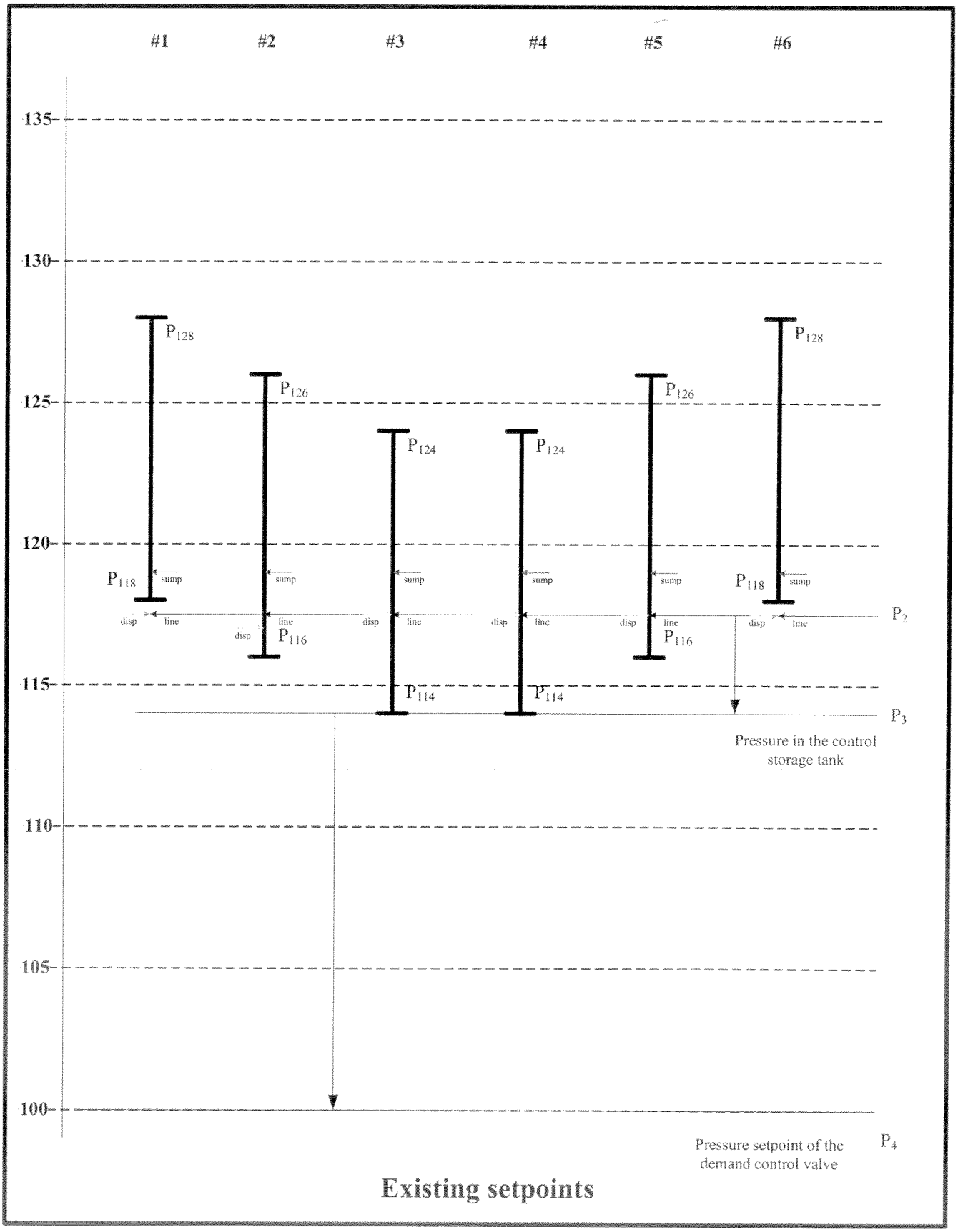
- Manual Valve - Open
- Manual Valve - Closed
- Filter
- Pipe Reduction
- Moisture separator

Sight Conditions
14.2 psia
60°F 30% R.H.

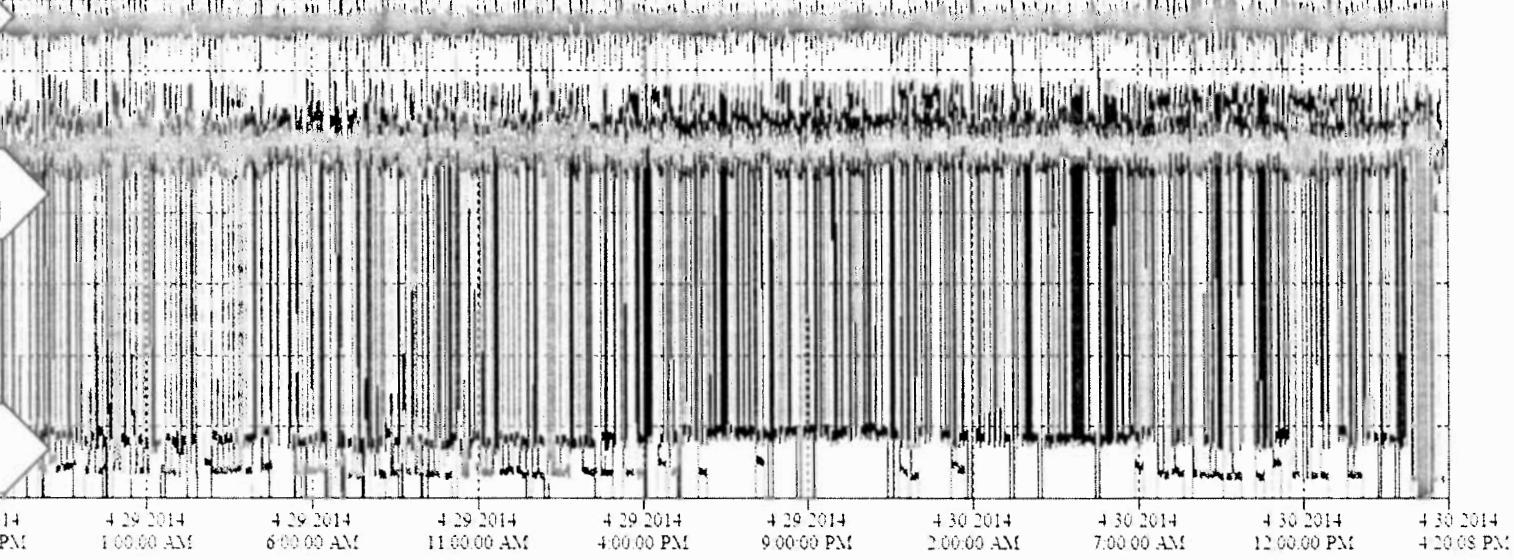
Std. Conditions
14.5 psia
68°F 0% R.H.

Customer:	**Corning Diesel Plant – Corning, NY**		
Title:	Existing Supply	Date:	April 28, 2014
Ingersoll-Rand		Drawn By:	Mark J. Ames
Drawing #	IR-CDP-0001	Rev.	01

Attachment A1 - Existing Process Flow Diagram

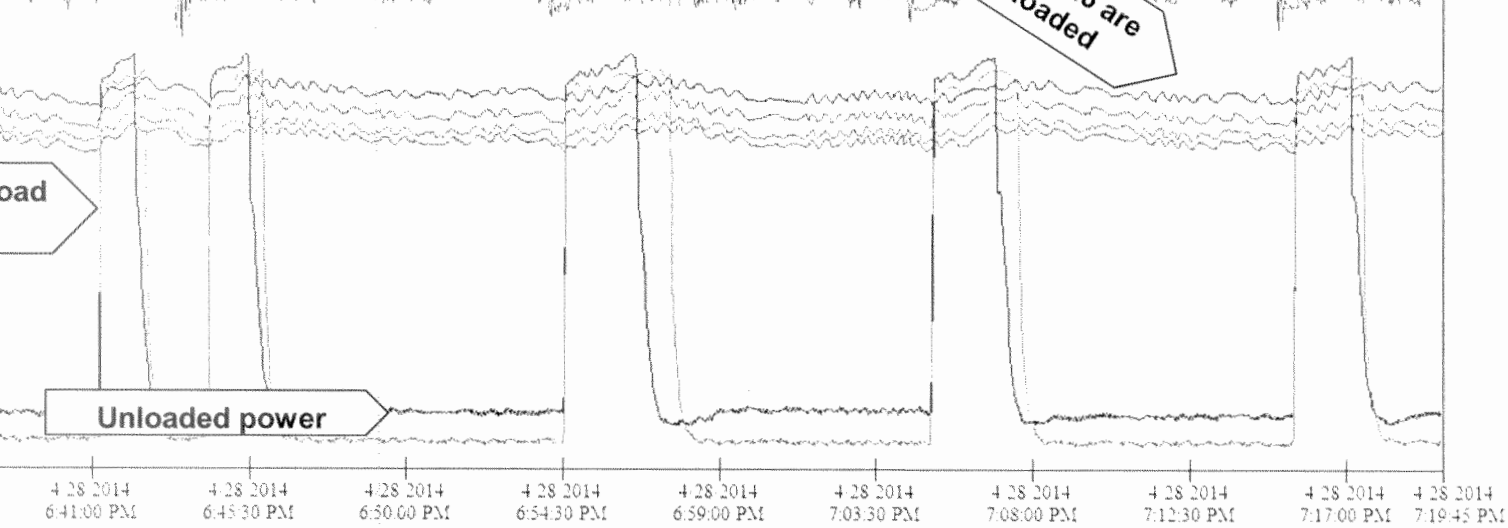


Attachment A2 - Existing Compressor operating set-points



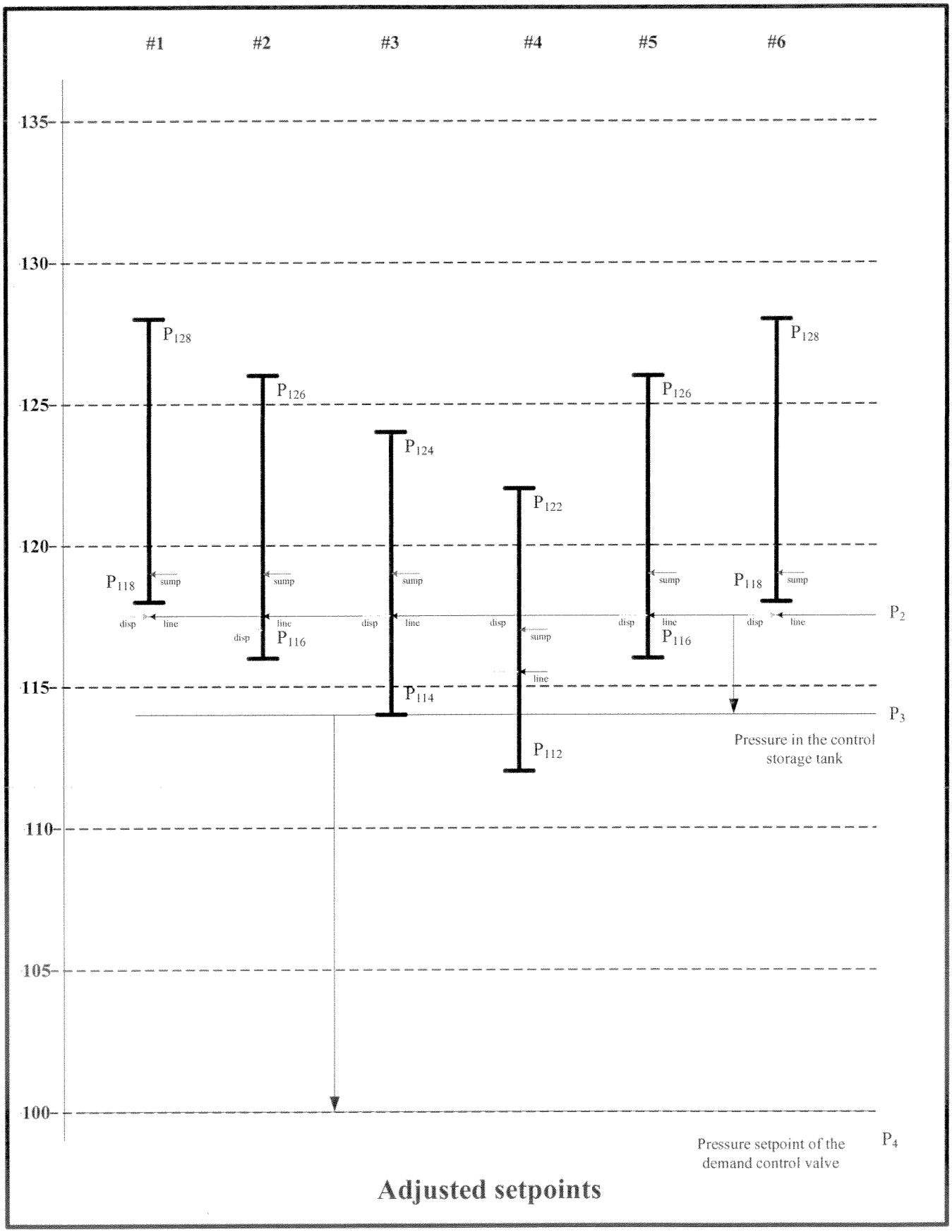
Attachment B1 – recorded data – Normal system operation

network pressures were monitored in 2 second intervals to determine how efficiently the supply of compressed air
nal productive conditions, all six 300hp compressors operate. Network pressures were measured at the compressor
he filters and dryers, at the inlet and outlet of the flow control valves, and at multiple points in production.

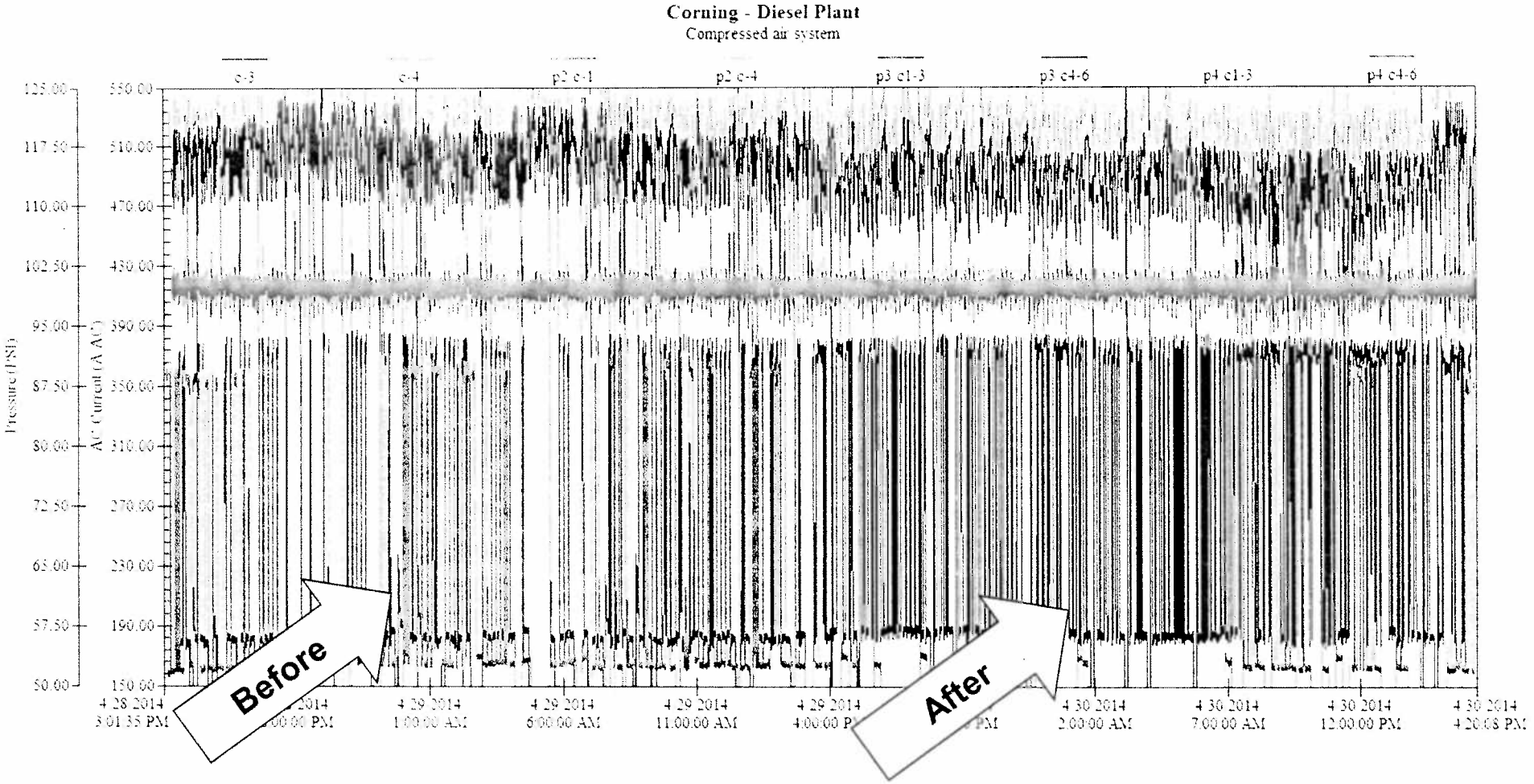


Attachment B2 – recorded data – Normal system operation

compressors 3 & 4 are too close resulting in a simultaneous response to changes in demand. This reaction increases
verage of 40kW.

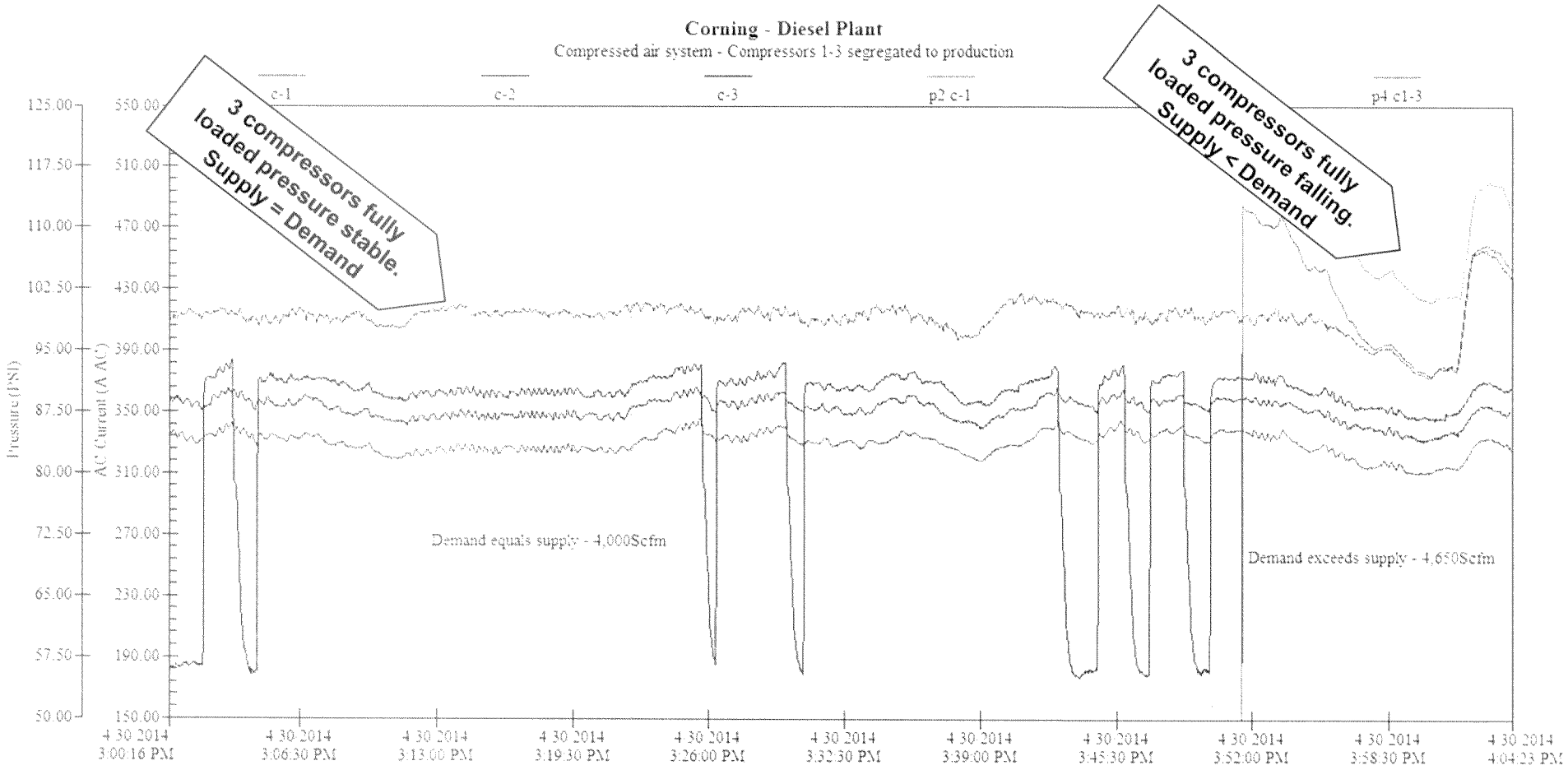


Attachment B3 - Adjusted Compressor operating set-points



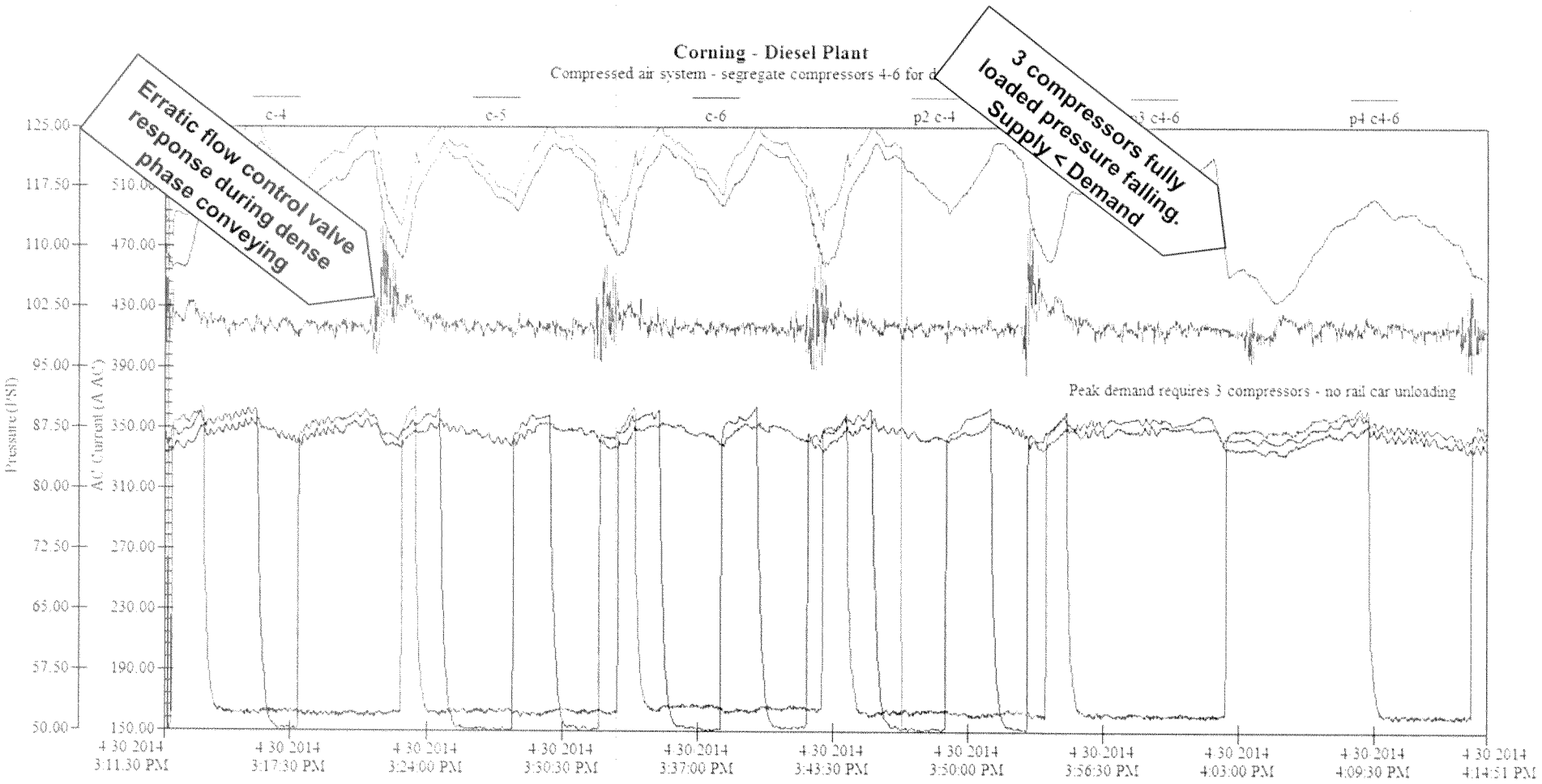
Attachment B4 – Normal system operation – before and after compressor set-point change

The purpose of this graph is to illustrate the effects of adjusting the load pressure of compressor #4 from 114psig to 112psig. After the adjustment, compressor #3 supports the trim variations without starting compressor #4. Because of this change, the average power is reduced by 40kW from 7pm-7am M-F [redacted]15k annually).



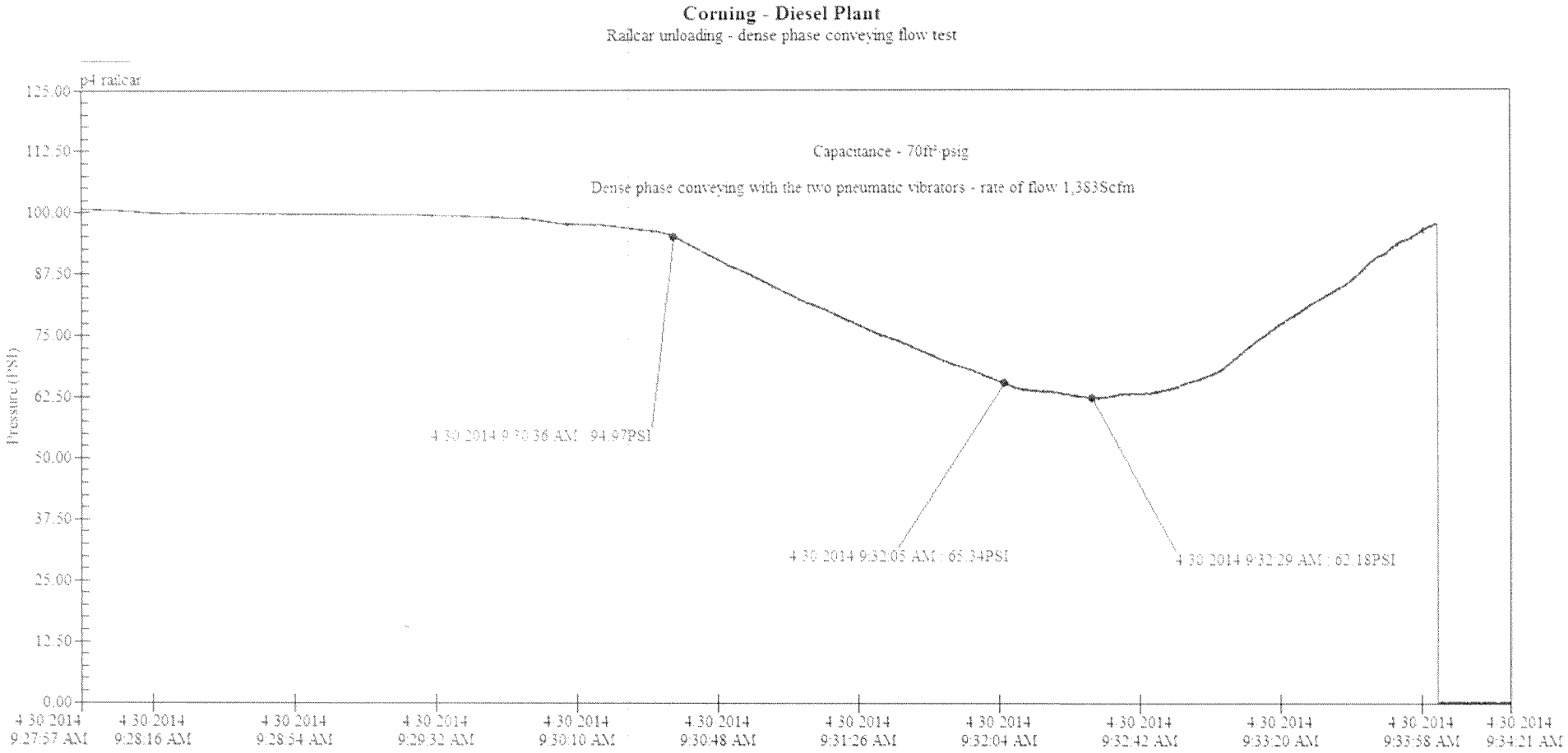
Attachment C1– Testing to determine production demand

The purpose of this graph is to illustrate the effects of isolating compressors #1, #2, and #3 from compressors #4, #5, and #6 so that production's peak demand could be measured separately from the Dry Blend demand. At roughly 3:50pm, operators of the Saw line started the second line to test the action of the saws. When doing this, the air nozzles within the DRS began blowing. This simulated peak productive consumption, and as can be seen on the right side of the graph, network pressure fell while three compressors ran fully loaded. The calculated flow during this peak period was 4,650Scfm.



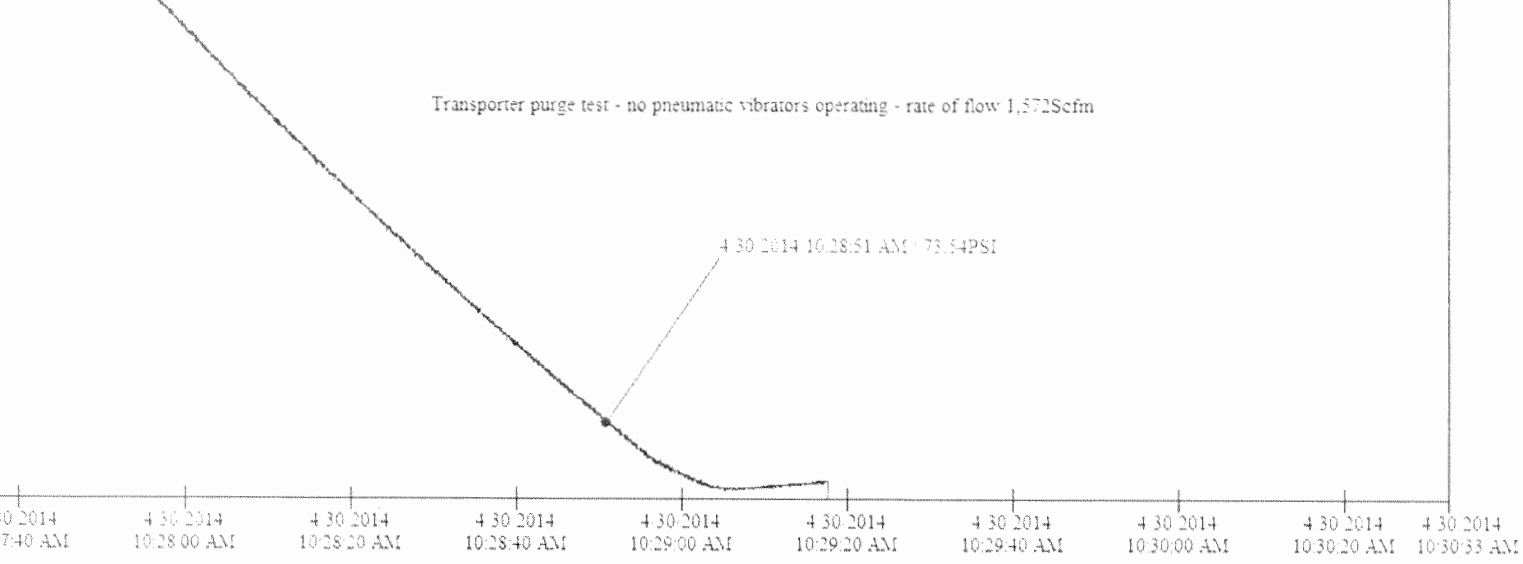
Attachment C2– Testing to determine Dry Blend demand

When isolating compressors #4, #5, and #6, peak demand exceeded 4,200Scfm while rail car unloading was not occurring. Should rail car unloading occur during peak conditions, compressed air demand will increase by an additional 1,572Scfm.



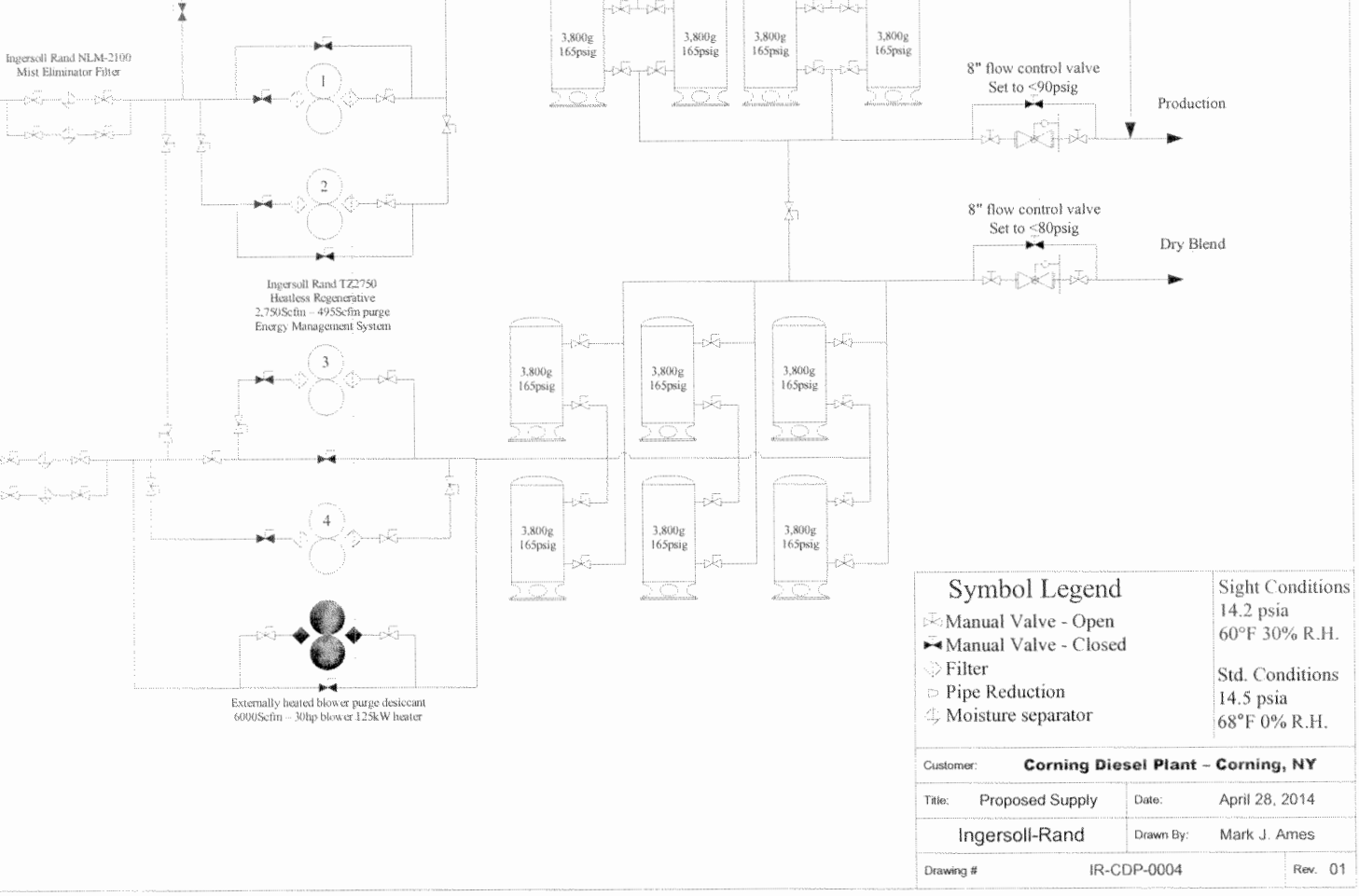
Attachment C3– Testing to determine Dry Blend dense phase conveying demand

The tanks and piping within the rail car unloading area equate to a capacity of 70ft³/psig. When testing to determine consumption, this section of the network was isolated from the supply and other demand so that the rate of pressure decay within a fixed volume could be used to compare with the capacity. The first test was to determine consumption during transfer.

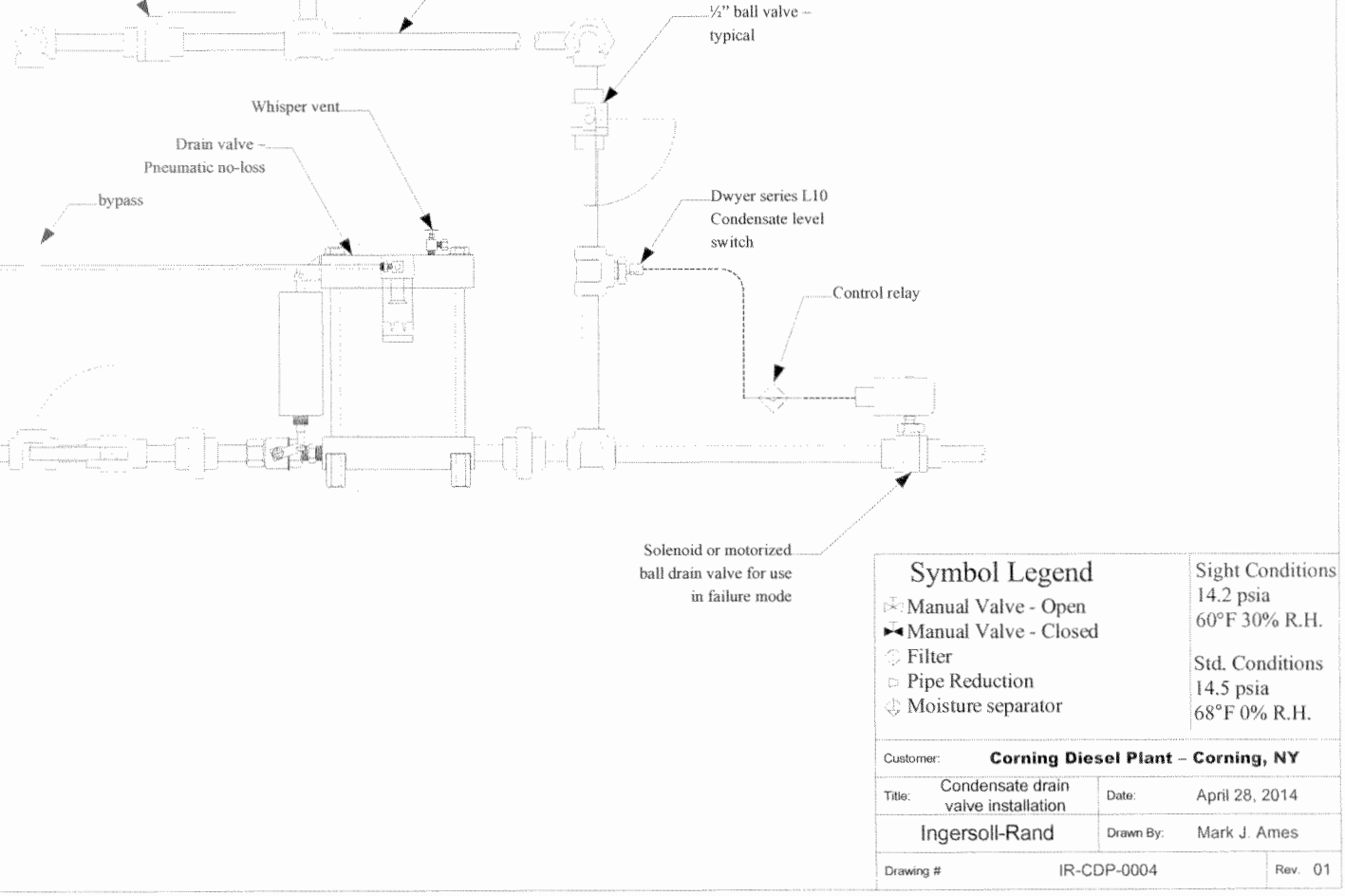


nt C4– Testing to determine Dry Blend dense phase conveyor line purge demand

determine consumption during the line purge cycle.



Attachment D– Proposed Process Flow Diagram



chment E– Recommended installation of condensate drain valve float switch

0		462		82			
0		1368		1368		1368	
0		1368		1368		1368	1212
Scfm Total		**7302**		**5554**		**5070**	**2325**
npressor/Dryer kW Total		**1374**		**1183**		**1079**	**581**
mand reduction opportunities							
Desiccant dryer purge		1238		825		413	413
yer purge from 3000Scfm base		-90		-90		-90	
yer purge from 6000Scfm trim		-77		-41		-40	-53
icipated increase in production							
Leak reduction							
Artificial Demand		350		266		243	111
New Scfm Total		**5882**		**4594**		**4543**	**1854**
mpressor/Dryer kW Total		**989**		**766**		**757**	**327**

ment F1– Existing vs. Proposed demand profile using the existing compressors

Orifice chart - cfm flow

Table is based upon a 100% coefficient of flow. For sharp edged orifices, a multiplier of .61 may be used for approximate results

	Size of Orifice										
PSIG	1/32	1/16	3/32	1/8	5/32	3/16	1/4	5/16	3/8	7/16	1/2
50	0.916	3.661	8.22	14.7	22.8	32.9	58.6	91	132	180	235
60	1.06	4.23	9.5	16.9	26.35	37.9	67.6	105	152	207	271
70	1.2	4.79	10.53	19.2	29.9	43	76.7	120	173	235	307
80	1.34	5.36	12.04	21.4	33.33	48.1	85.7	131	193	262	343
90	1.48	5.92	13.33	23.7	36.9	53	94.8	147	213	289	379
100	1.62	6.49	14.58	26	40.5	58	104	162	234	316	415
110	1.76	7.05	15.82	28.2	43.9	63	113	178	254	345	452

	Orifice chart - cfm flow when multiplied by .61										
	Size of orifice										
PSIG	1/32	1/16	3/32	1/8	5/32	3/16	1/4	5/16	3/8	7/16	1/2
50	0.56	2.23	5.01	8.97	13.91	20.07	35.75	55.51	80.52	109.80	143.35
60	0.65	2.58	5.80	10.31	16.07	23.12	41.24	64.05	92.72	126.27	165.31
70	0.73	2.92	6.42	11.71	18.24	26.23	46.79	73.20	105.53	143.35	187.27
80	0.82	3.27	7.34	13.05	20.33	29.34	52.28	79.91	117.73	159.82	209.23
90	0.90	3.61	8.13	14.46	22.51	32.33	57.83	89.67	129.93	176.29	231.19
100	0.99	3.96	8.89	15.86	24.71	35.38	63.44	98.82	142.74	192.76	253.15
110	1.07	4.30	9.65	17.20	26.78	38.43	68.93	108.58	154.94	210.45	275.72
120	1.17	4.65	10.46	18.61	28.98	41.48	74.42	115.90	167.14	227.53	297.68

Attachment F2–Cost to generate compressed air

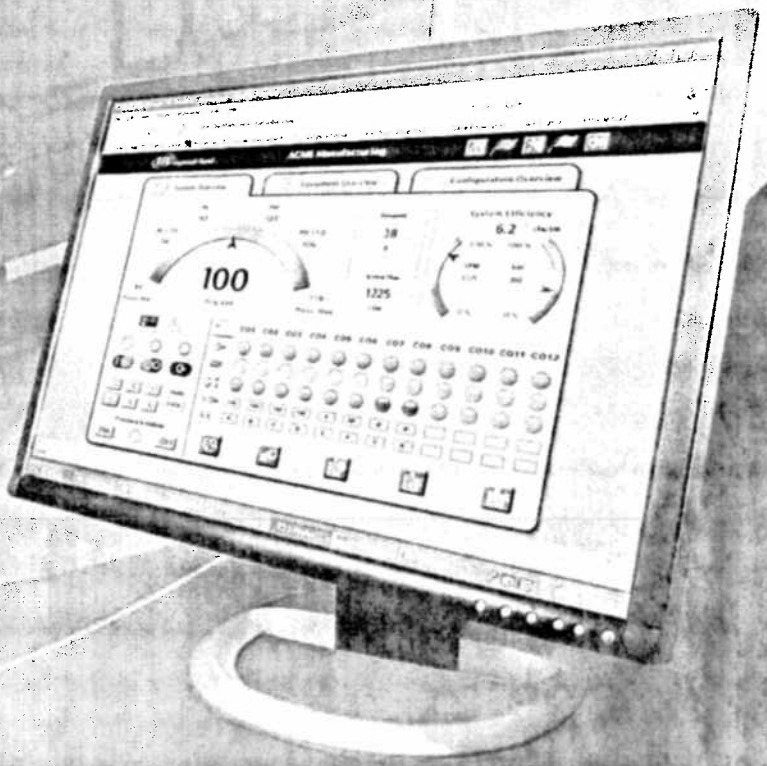
Ingersoll Rand

X-Series System Visualization

A Better Way to View Your System

Simply add a VX module to any X8i or X12i network, complete some basic configuration, connect to your Local Area Network (LAN) or directly to a PC and view your compressed air system on your computer monitor. No special software is required.

With X-Series System Visualization you can monitor critical system and equipment parameters, drill down to individual compressors to view operational status and be alerted to any alarm messages. Complete system viewing from a local or remote PC has never been easier.



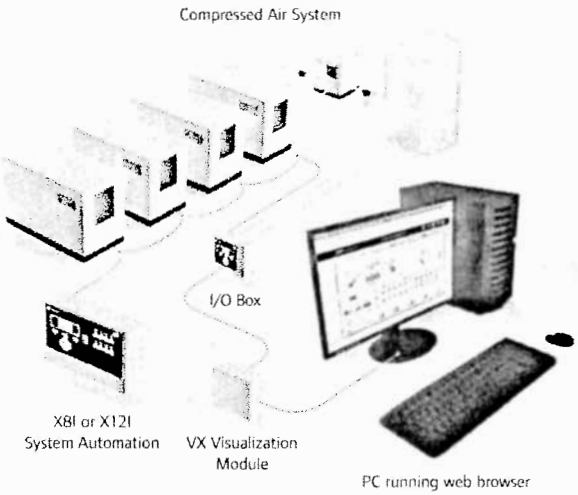
Benefits

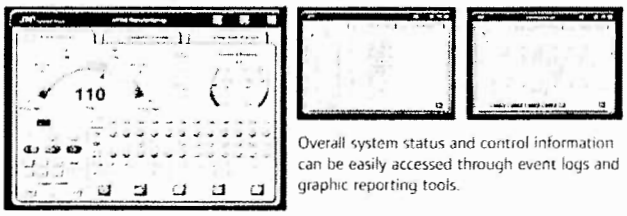
- Convenient remote view of system and equipment status
- Critical parameter monitoring and fault notification
- Parameter graphing and trending
- System performance reporting and operating summaries
- Historical event recording
- Equipment maintenance scheduler
- Easy connection to the X-Series control network
- No special software to buy or maintain

Ingersoll Rand
Industrial Technologies

Visualization

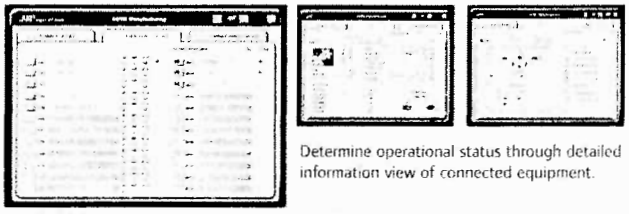
Advanced Air System Monitoring





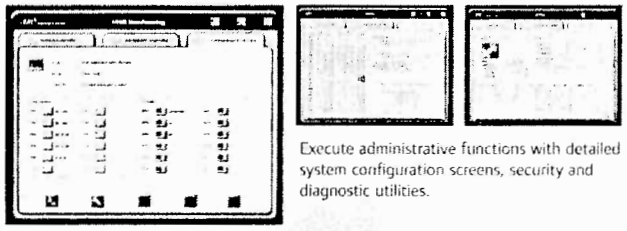
Overall system status and control information can be easily accessed through event logs and graphic reporting tools.

System Overview (SOV)



Determine operational status through detailed information view of connected equipment.

Equipment Overview (EOV)



Execute administrative functions with detailed system configuration screens, security and diagnostic utilities.

Configuration Overview (COV)

How Visualization Works

X-Series System Visualization is accessed and navigated just like a web site. With the VX module added to the X-Series control network and communicating directly to a PC or a LAN over Ethernet connectivity, X-Series System Visualization can be accessed using a standard web browser such as Internet Explorer. Navigating to the Visualization sign-on screen is simple — once signed in with the appropriate security login and password, users will immediately view full system operating parameters and equipment operating status at a glance. The system overview screen is a launching point for more detailed equipment information, as well as access to parameter graphing tools and a reporting utility. Depending on the security level, users can also custom configure the pressure control set points, the compressor sequence and schedule, select compressor utilization priorities and even access some special remote control functionality...all from a connected PC. Managing and viewing your compressed air system has never been easier!

Integrated Features

- System status and control
- System performance monitoring/reporting
- Equipment status monitoring
- Equipment maintenance scheduler
- Graphing and trending tools
- Reporting tools
- Configurable event logs
- Warning and alarm monitoring
- Email messaging
- Fully field configurable

Ingersoll Rand
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P.O. Box 1840
800-D Beaty Street
Davidson, NC 28036
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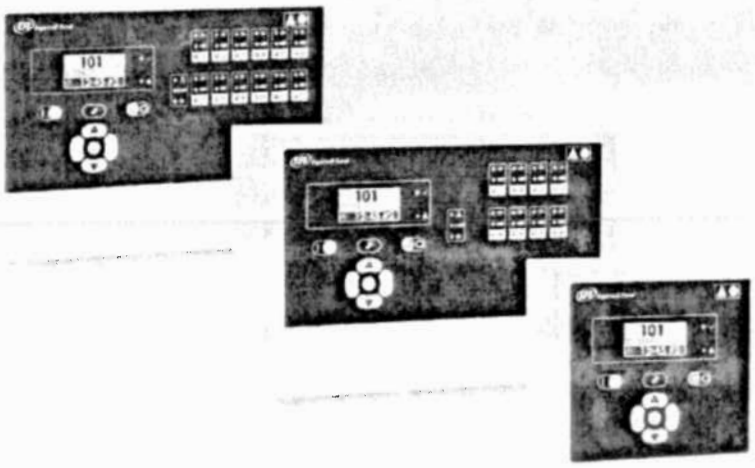
(704) 655-4039 Fax

Ingersoll Rand

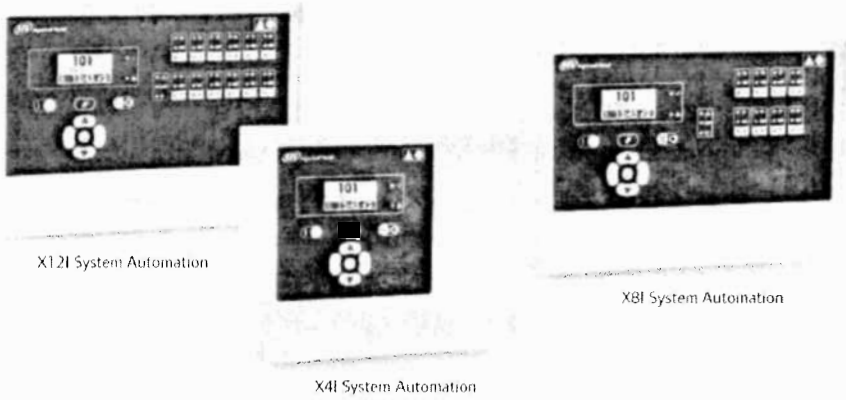
X-Series System Automation



Ingersoll Rand
Industrial Technologies

Energy Savings – on Demand!

As much as 20% to 60% of the energy used to operate compressed air systems is wasted. This is primarily due to operating more compressors than necessary, operating the wrong combination of compressors or maintaining elevated system pressure.



X12I System Automation

X8I System Automation

X4I System Automation

Now You Can Cut Operating Costs... with Your Existing Equipment!

Ingersoll Rand X-Series System Automation eliminates waste by managing up to twelve positive displacement compressors simultaneously. This includes compressors of different capacities, different types (fixed speed, variable speed and variable capacity), and in any combination or configuration.

Through advanced control functionality and universal connectivity, the X-Series System Automation products will work with your existing compressors, from Ingersoll Rand or any manufacturer, to improve operating efficiency, reduce energy costs and eliminate waste!

Here's how the X-Series products deliver a unique combination of efficiency, reliability and tremendous cost-savings:

- Operate compressors only as needed, bringing standby compressors on-line incrementally during periods of peak demand.
- Manage the compressed air system at your minimum required pressure without compromising air supply reliability.
- Dynamically match the most energy-efficient compressor or combination of compressors with compressed air demand.
- Operate one or more variable-speed compressors to minimize wasted energy due to unloaded compressor run-on time or short cycle operation.

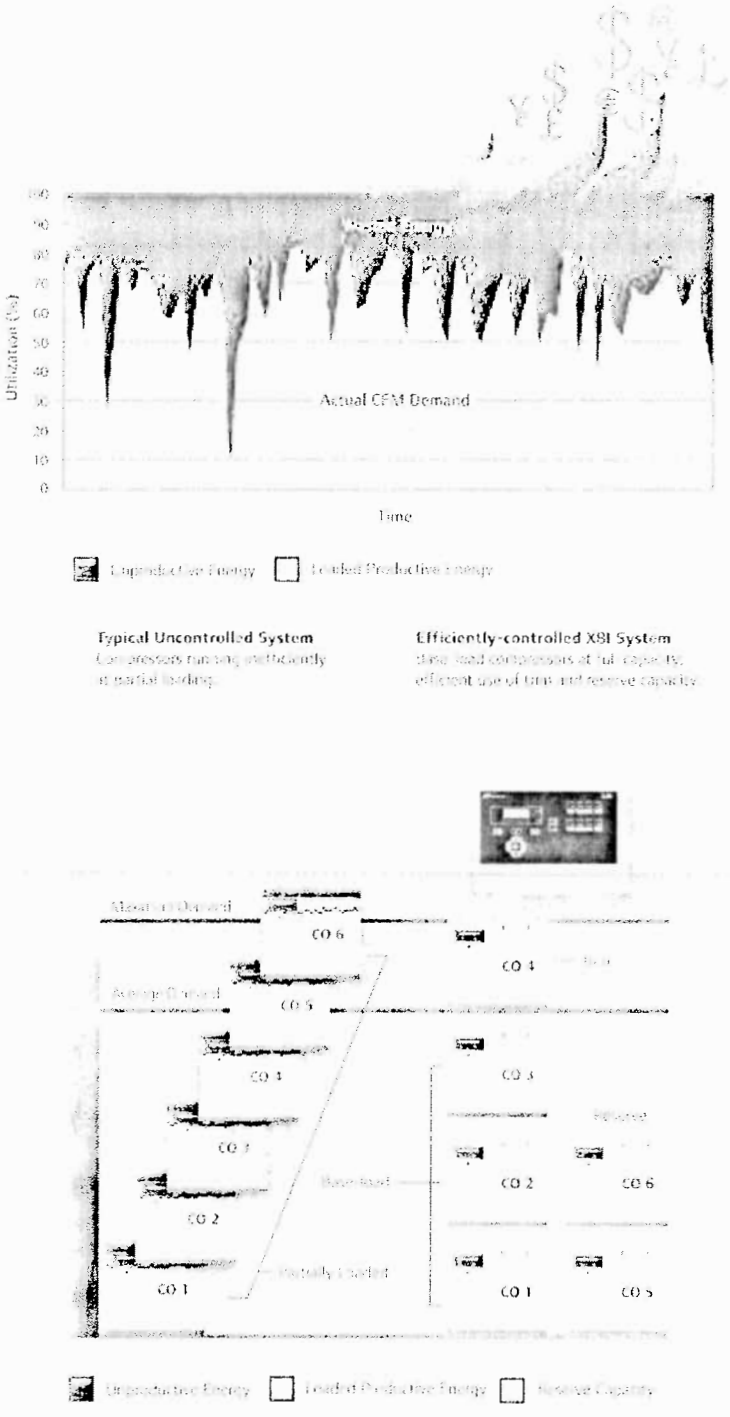
The Big Savings Picture at a Glance

Be Energy Efficient while Increasing Your Reliability

The practice of operating a compressor in standby mode (unloaded), to ensure maximum capacity when needed, uses approximately 30% or more of the energy required to run that same compressor fully loaded. Systems with multiple compressors of varying sizes, types and configurations complicate the task of manually coordinating and maintaining the correct compressor settings.

X-Series System Automation products eliminate the complexity of compressor control coordination and increase energy efficiency. With the X-Series System Automation in control, only the appropriate compressors operate at the proper time. Unnecessary compressors previously used for normal operations will be kept off-line and available for emergency requirements or primary equipment upset increasing system reliability.

In addition to optimizing energy use, efficient compressor utilization reduces costs by reducing downtime...not only is the time between scheduled preventive maintenance extended, but with fewer compressors operating, fewer repairs will be necessary!



Using the Ingersoll Rand X-Series System Automation to manage a multi-compressor system creates opportunities for significant savings and increased reliability. Keeping compressors off-line until needed eliminates unloaded running costs and creates reserve capacity.

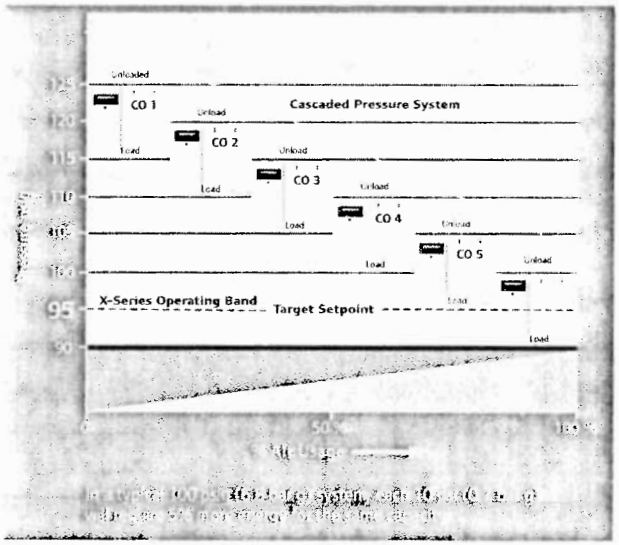
Eliminate the Artificially High Cost for "Comfort"

Through advanced control features, X-Series System Automation **efficiently manages air compressor operation in virtually any configuration.**

Manual coordination of compressor pressure settings to facilitate effective compressor operation can be complicated. Demand fluctuations, air treatment, compressor location, varying compressor capabilities, piping size and design are just some of the variables that impact control settings.

Traditionally, "cascaded" pressure settings over a wide pressure range are utilized to operate compressors more effectively. The result is operating the system at elevated pressures for a majority of the time. Only when the system is at full capacity does the system approach optimum efficiency.

Maintaining system pressure above the optimum pressure in order to provide a comfort factor for periods of sudden demand, or a cascaded pressure control, requires more energy. It also exaggerates artificial demand resulting from the increased air consumption of leaks and poorly regulated air outlets.



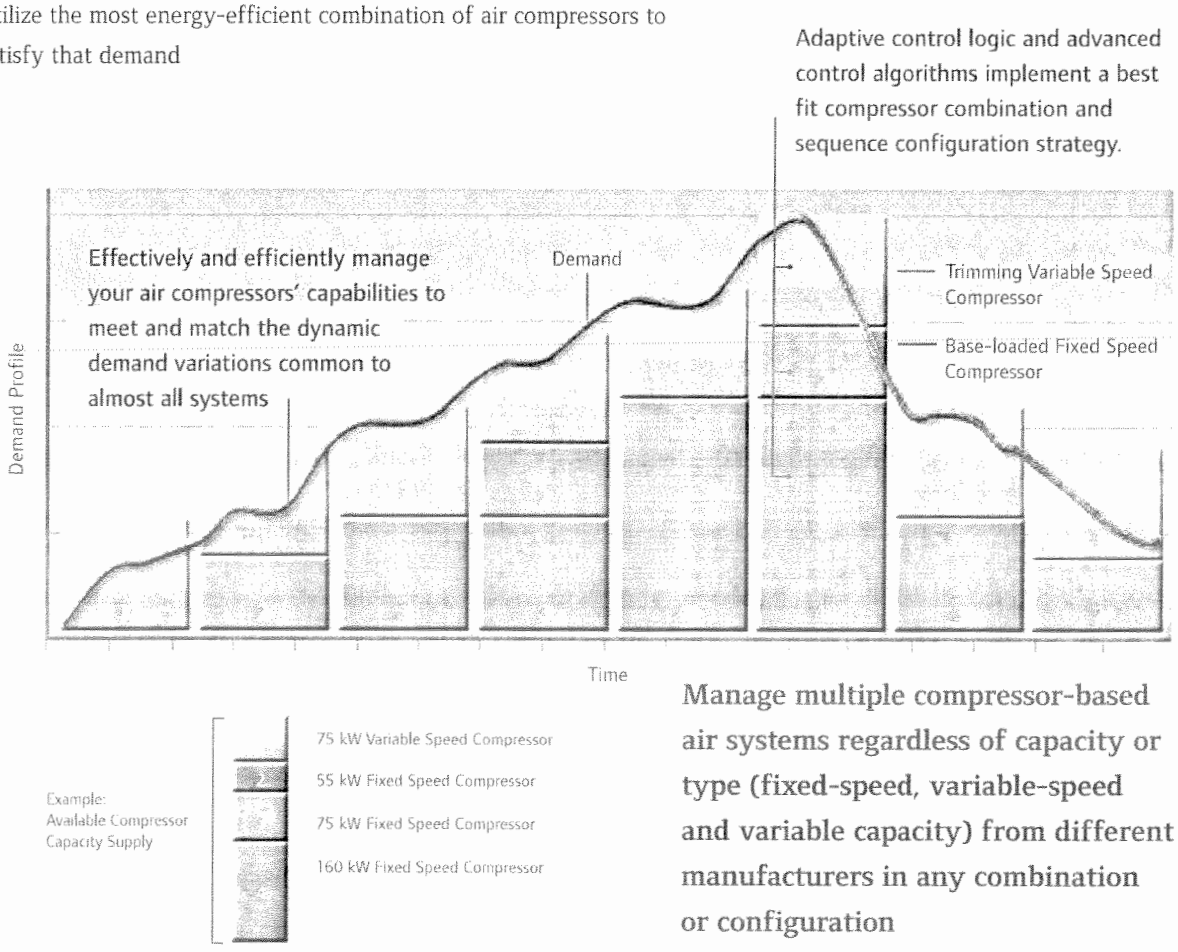
X-Series Automation eliminates inefficiency by controlling all compressors in a tight pressure band around a single, optimum system pressure, as illustrated by the blue band in the example above.

Tailoring Supply to Demand

The X8I and X12I feature **Energy Control Mode** that monitors and "learns" system demand requirements by comparing pressure dynamics with compressor operating capabilities and efficiencies.

The primary functions of Energy Control Mode are to:

- Match compressed air supply to compressed air demand, dynamically
- Utilize the most energy-efficient combination of air compressors to satisfy that demand



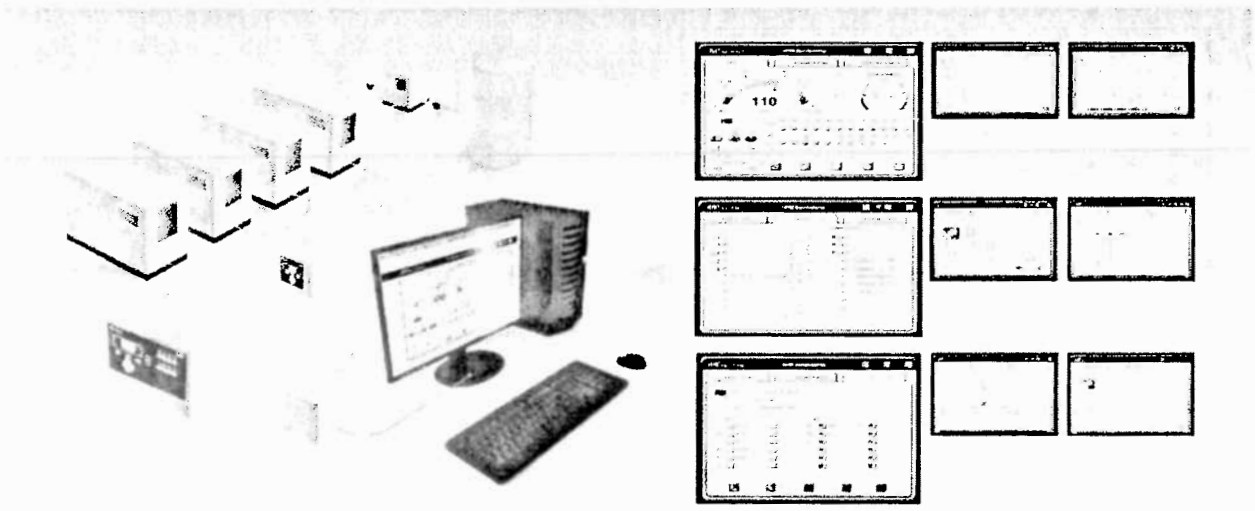
Manage multiple compressor-based air systems regardless of capacity or type (fixed-speed, variable-speed and variable capacity) from different manufacturers in any combination or configuration

A Better Way to View Your System

Ingersoll Rand X-Series System Automation now offers a **window into your compressed air system** with the introduction of System Visualization.

An Easy Upgrade Makes It Possible

Simply add a VX module to any X8I or X12I network, complete some basic configuration, connect to your Local Area Network (LAN) and view your compressed air system on your PC. No special software is required – just use a standard web browser such as Internet Explorer. With System Visualization you can monitor critical system and equipment parameters, drill down to individual compressors to view operational status and be alerted to any alarm messages. Complete system viewing from a local or remote PC has never been easier.



Integrated Features

- System status and control
- System performance monitoring/reporting
- Equipment status monitoring
- Equipment maintenance scheduler
- Graphing and trending tools
- Reporting tools
- Configurable event logs
- Warning and alarm monitoring
- Email messaging
- Fully field configurable

X-Series Functionality

X-Series System Automation	X4	X8	X12
Number of Compressors	4	8	12
Compressor Integration			
Fixed Speed - On-line/Off-line	X	X	X
IR-VSD 7.5-40 hp Nirvana	X	X	X
IR-VSD 50-300 hp Nirvana		X	X
Other VFD or Variable Capacity Control		X	X
System Pressure			
Standard 0-232 psig (Optional up to 1,000 psig)	X	X	X
Programmable Pressure Profiles	3	4	6
System Control Modes			
Programmable on Elapsed Time	X	X	X
Programmable on Real Time	X	X	X
EHR (Equal Hours - Run Time)	X	X	X
FIFO (First in - First out)	X		
FILO (First in - Last out)	X	X	X
ENER (Energy Control - Auto Sequence Selection)		X	X
Special Control Functionality			
System Standby	X	X	X
System Pre-fill	X	X	X
Program Bypass (Immediate Forward)	X	X	X
Power Outage Restart	X	X	X
Controller Failure, Revert to local	X	X	X
Prioritized Compressor Selection	X	X	X
Anti-cycling Control - Rate of Pressure Change	X	X	X
Pressure Balancing Function			X
Zone Control Function			X
Auxiliary Equipment Pre-start Function			X
System Instrumentation Inputs (4-20 mA)			X
Auxiliary **Input** Contact - Remote Control			
Configurable Remote Control Function	1	1	1
Dedicated Control Functions			9
Auxiliary **Output** Contact - Remote Control			
Configurable Remote Control Function	1	1	5
X-Series Network Integration Options			
Bolt-on or Competitive VFD Integration		X	X
Remote I/O - System Instrumentation/Control		up to 2	up to 12
Remote Communication - System Modbus Gateway		X	X
System Visualization - Hardware and Software		X	X

PackageCare is a service contract designed to help customers get the most out of their air system investme[redacted]nether it's Ingersoll Rand equipment or a competitor's, a new compressor or used, with PackageCare customers get hassle-free system reliability, backed by the most comprehensive service program in the industry. We're the only OEM in the industry offering this type of service coverage.

Ingersoll Rand
Industrial Technologies

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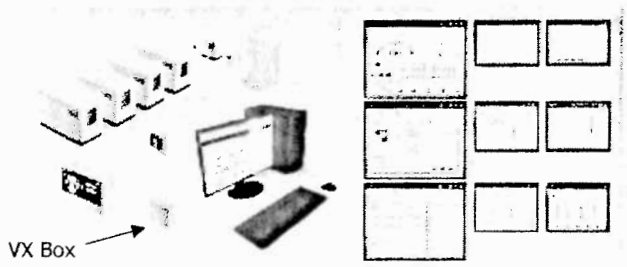
Ingersoll Rand X-Series System Automation: Visualization
Detailed Description

INTRODUCTION

Ingersoll Rand System Visualization offers a window into a compressed air system by adding a VX Module to an X8I or X12I control network and using only a web browser on your PC. The VX Box incorporates hardware and software to allow monitoring of the X8I and X12I Automation system as well as all connected equipment. The software allows you to monitor your air system at a glance or take a more detailed look into system operation, equipment status and setup through an intuitive web-page based user interface. To access the application running on the VX Box, simply connect via a Web Browser from any PC using an Ethernet connection.



The VX Box connects to the X8I or X12I controller via the two-wire RS485 network. The VX Box is suitable for wall mounting and can be located up to 4,000 ft. (1,219 m) from the X8I or X12I unit. The VX Box connects to the customer's PC or LAN via Ethernet, using a RJ45 connector, Cat5e 10/100BaseT cable.

The PC can be local "stand alone" or part of a LAN. The VX Box is fully field configurable using standard screen templates. Please note that Ingersoll Rand System Automation Visualization requires **Internet Explorer 7 (or newer) or Mozilla Firefox 2 (or newer)**. Certain functions may not behave correctly when using older browser software.

Once logged into the VX Box, the following items are available to the user:

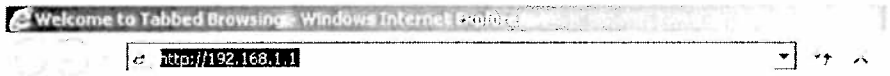
System status & control
System performance reporting
Equipment status monitoring
Equipment maintenance scheduler
Graphing & Trending tools
Reporting tools
Warning & Alarm monitoring
Email messaging
SMS messaging (to follow)

Ingersoll Rand X-Series System Automation: Visualization Detailed Description

System Login

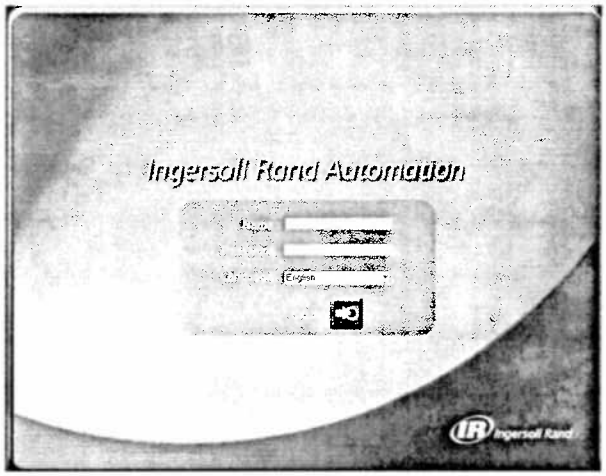
To log in to the Visualization software, you must first type the address into your browser. The Visualization software is preconfigured with a default Static IP address. This can also be changed to DHCP by the system administrator.

For example, with a static IP address enabled VX Box, you might type this:



For example, with a DHCP enabled VX Box, you might type this:

If the VX box is configured correctly, you will then see the Ingersoll Rand Automation splash screen in your browser.



User Access

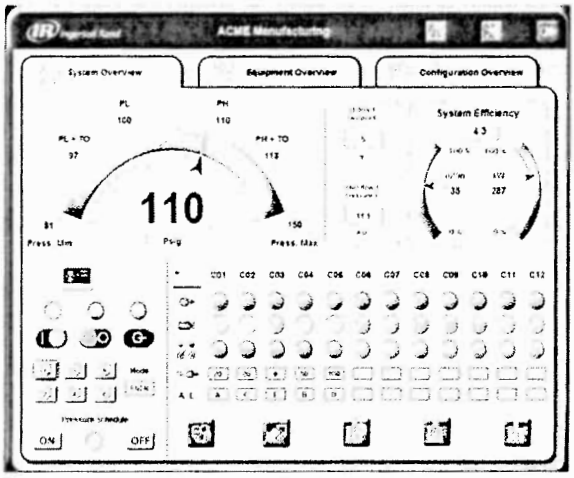
The Visualization software comes preconfigured with three default user accounts. The system administrator can assign users one of three levels of access (view only, user, and administrator) which will determine which functions will be available. For example, only users with administrator access will be able to view or modify the configuration overview parameters. It is highly advised that the administrator change these accounts as soon as feasible to prevent unauthorized access to the Visualization software. The three level of access rights are as follows:

1. VIEW – The user is able to view all information on the SOV and EOV screens and their detail view screens. The user is unable to change any set points or access the Configuration Overview (COV) screens.
2. USER – The user has all rights available to the VIEW access level as well as being able to change set points on the table configuration screens, pressure schedule screens, and is able to manually start and stop compressors, as well as start and stop the X8I/X12I.
3. ADMIN – The user has all rights of the VIEW, and USER access levels as well as full access to the Configuration Overview (COV) screens, the account management utility, and the diagnostics screen.

Please note that there can be as many as **five (5) maximum** users logged into the system at one time, and only one administrator logged in at one time.

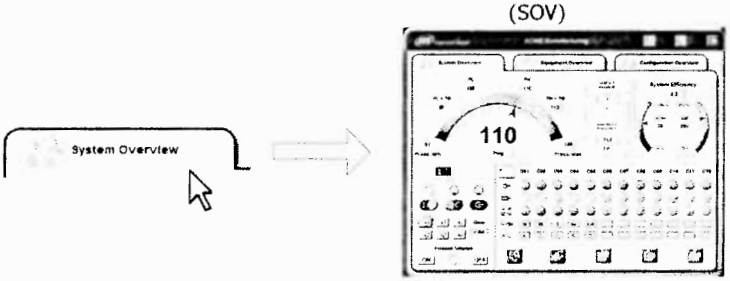
Ingersoll Rand X-Series System Automation: Visualization
Detailed Description

Upon successfully logging in you will see the system overview screen (SOV)



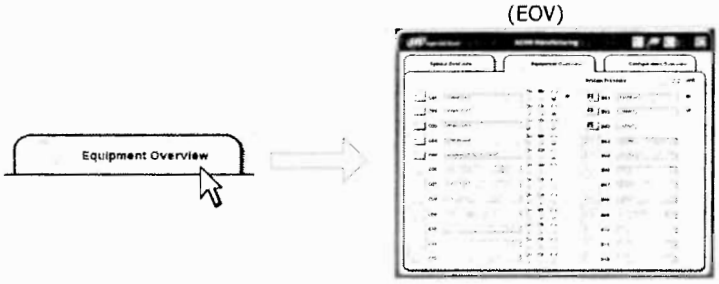
The Visualization interface is has three major segments:

(SOV)



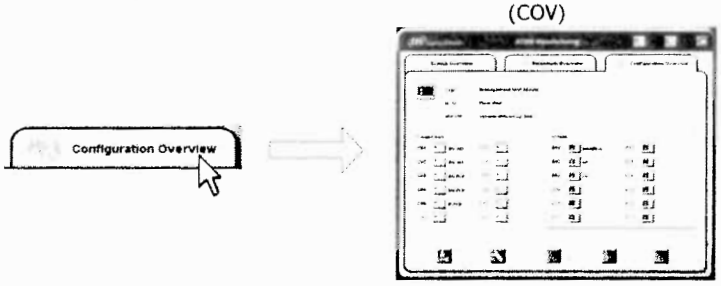
From here the user can monitor and adjust (with the correct security) important air system data such as air system pressure and efficiency, status of each compressor, and X8I and X12I status in an easy to read dashboard style interface. The system overview screen is also the launching point for set point and scheduling screens plus performance reports and historical graphing and trending tools.

(EOV)



From here the user can monitor more detailed compressor information such as the model and manufacturer of the compressor, capacity and power data, and configurable data points.

(COV)

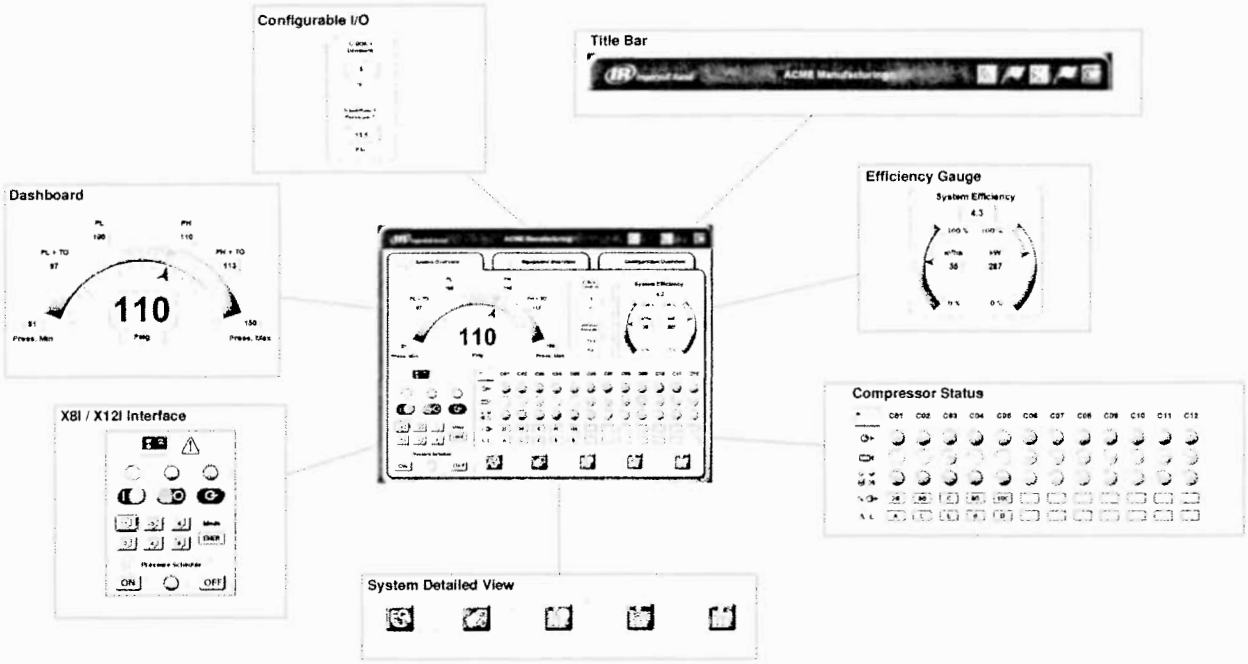


From here the system administrator(s) can view and change air system configurations such as adding or removing a compressor, I/O box, or Intelliflow valve. Manage user accounts and network configuration and view diagnostic information.

Ingersoll Rand X-Series System Automation: Visualization
Detailed Description

SYSTEM OVERVIEW

The system overview screen presents an overall high level view of your compressed air system and is divided into functional sections.



Dashboard

The dashboard area of the System Overview (SOV) is where system pressure information is displayed in an easy to read gage interface. The dashboard prominently displays system pressure as well as set points from the X8I or X12I system controller. The arrow on the pressure gauge represents where the system pressure is in relation to the system controller's set points. If the arrow is in the green zone system pressure is currently optimal and the system controller will take no action. If the arrow reaches the yellow zone the system controller will consider actions to load or unload a compressor to return system pressure to the green zone. In the red zone the system controller is taking increasingly urgent action to return the system pressure to the green zone. Clicking on the units display will allow toggle between PSIG and BAR G.

X8I and X12I Interface

The X8I and X12I interface allows remote control of the system controller from the Visualization software. The user can monitor and change the current operating state of the X8I and X12I as well as change system controller set points. The X8I and X12I controls can only be used by users with USER or ADMIN rights. All other users will only be able to view the status (VIEW).

X8I and X12I Remote On/Off

The Remote On/Off control allows a user with USER or ADMIN rights to activate or deactivate the X8I and X12I. The Remote On/Off is activated by clicking the ON or OFF buttons. The On indicator light will turn blue to confirm that the Remote On/Off has been turned On and will turn gray if has been turned Off. The Off indicator will turn blue to confirm that the Remote On/Off has been turned Off and will turn gray if has been turned On. The indicators will also change state if the Remote On/Off has been activated or deactivated from the X8I and X12I.

Table Configuration and Control

The X8I and X12I control interface allows the user to see which pressure table is currently active and which sequencing algorithm the system controller is currently utilizing. The user can also edit any pressure table set points. The X8I has four tables and the X12I has six tables. The current active table will be highlighted in blue, such as table 1 in the picture above. If the active table changes; either by the pressure schedule or by a user changing the default table on the X8I and X12I the highlight will move within two seconds of the change being made. If the system controller is in a standby state no table will be highlighted. The table configuration screen allows anyone with USER or ADMIN rights to change the X8I and X12I table set points. Users with VIEW rights will only be able to view the settings.

Pressure Schedule Control

The pressure schedule control allows a user with USER or ADMIN rights to activate or deactivate the pressure schedule on the X8I and X12I. The pressure schedule is activated by clicking the ON button. The indicator light will turn blue to confirm that the pressure schedule has been activated. The pressure schedule can be deactivated by clicking the OFF button. The indicator will then turn grey to confirm that the pressure schedule has been deactivated. The indicator will also change state if the pressure schedule has been activated or deactivated from the X8I and X12I.

Ingersoll Rand X-Series System Automation: Visualization
Detailed Description

Compressor Status

The compressor status section gives the current operating condition of all compressors that are connected to the X8I and X12I. The overview duplicates the data that is given on the X8I and X12I control panel, using the same style of lights. The compressor status overview is view only and may not be adjusted by any users.

Compressor Address– This indicator will be the system compressor number

Compressor Load Status – This indicator will be green when the compressor is in a loaded condition and grey when the compressor is unloaded.

Compressor Running Status – This indicator will be yellow when the compressor's motor is running and grey when the compressor's motor is not running.

System Control Indicator – This indicator will be blue when the compressor is under X8I and X12I control and red when the compressor is under local control or placed into service maintenance mode, or otherwise unavailable to the X8I and X12I.

Compressor Load Percentage – This value displays the load percentage the compressor is currently reporting. This will vary for variable speed drive compressors and be either 0% or 100% for fixed speed compressors.

Compressor Sequence Position – This letter will display which place in the sequence the compressor is assigned. This letter can range from A to K for a 12 compressor system, with A being the 1st compressor in the sequence and K being the 12th. An @ symbol in this field will indicate that the compressor has been restricted from use in the priority settings.

System Efficiency Gauge

The system efficiency gage calculates and displays an overview of air system energy efficiency. This is intended to be a guide only and is based on user input, monitored status, and in some cases, measured data. The system efficiency units are configurable by a user with administrator rights. System efficiency can be displayed in units of cfm/kW, kW/cfm, or kW/m^3/min. The system capacity readout uses the name plate capacity of the compressors in the air system and monitors compressor load states to calculate how much compressed air is being placed into the system (A flow meter can also be used for this value). The capacity gage shows how much capacity is being utilized in relation to the capacity of all compressors in the system. The system power consumption readout uses the name plate power consumption of the compressors in the air system and monitors compressor load states to calculate the current power draw of the compressors. The power consumption gage shows how much power is being consumed in comparison to the power consumed when all compressors are at maximum load. The system efficiency reading is only a guideline and should be used for monitoring day to day changes in compressed air system efficiency. True system efficiency can only be determined with accurate flow and power meters and detailed calculations.

Configurable I/O

The configurable I/O section of the SOV screen allows the user to select two data points to display on the SOV. The user configurable I/O may be from the X8I or X12I, an Intelliflow valve, or an I/O box. Typical use of these points would be to measure dew point, pressure, temperature, system flow etc.

Ingersoll Rand X-Series System Automation: Visualization
Detailed Description

Title Bar

Visualization navigation uses a simple point and click interface. A title bar will be present at the top of every screen and will display information about system name, alarms, and will provide access to event and service logs. The components of the title bar are as follows:

Installation Name – This is a name that is used to identify the compressed air system.

Event Log Button – This will bring the user to the Visualization event log. 

The Event Log records certain events that occur in your air system or in the Visualization software itself. The events that are recorded are placed into one of three categories:

Alarms – Alarms are events that indicate that an abnormal situation has occurred on a compressor, X8I and X12I, I/O Box, or Intelliflow valve but the piece of equipment is still functioning normally.

Trips/Shutdowns – Trips/Shutdowns are events that indicate that an abnormal situation has occurred on a compressor, X8I and X12I, I/O Box, or Intelliflow valve and the piece of equipment has been stopped.

System Information – System information events record user logins and logouts.

Event log can be configured to record all 3 types of events or any combination.

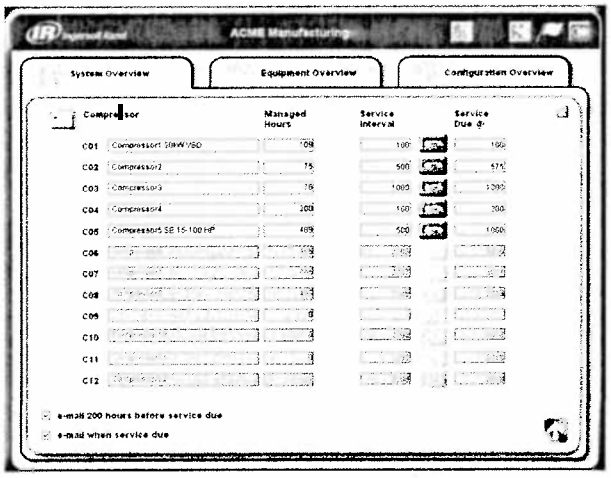
Event log has a Print function for record keeping requirements

The event log will record the last 500 events. Once this 500 event limit has been reached the oldest events will be cleared and the newest events will appear at the top of the event log.

General Alarm Flag – This red flag will appear if there is an alarm condition present on the X8I/X12I or any of the compressors in the system. If there is no alarm present or the alarm has been resolved this red flag will disappear.

Ingersoll Rand X-Series System Automation: Visualization
Detailed Description

Service Maintenance Button – This will bring the user to the maintenance reminder utility 



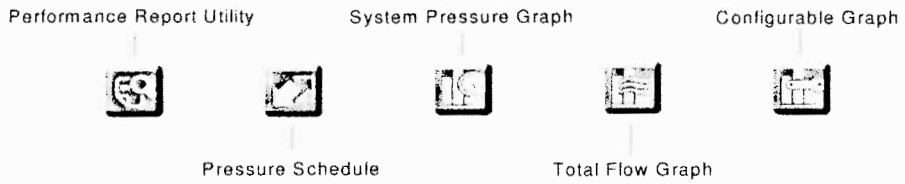
The Service Utility is used to set up maintenance reminders for compressors in the system. The user enters a specified maintenance interval based on the compressor's factory service recommendations and the Visualization software will provide a visual cue on the title bar as well as optional email reminders that are sent to selected users.

Service Reminder Flag – This flag will appear if a service reminder has been set up for a compressor and service is now due. Once the service reminder has been updated this flag will disappear.

Log Out Button – This will log out the current user and return the user to the Visualization login screen.

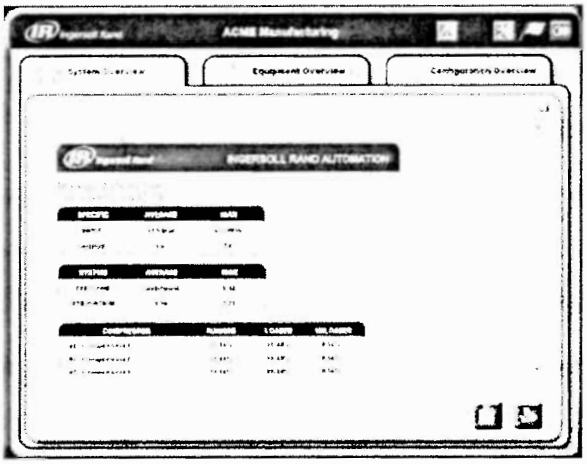
Ingersoll Rand X-Series System Automation: Visualization
Detailed Description

System Detail View



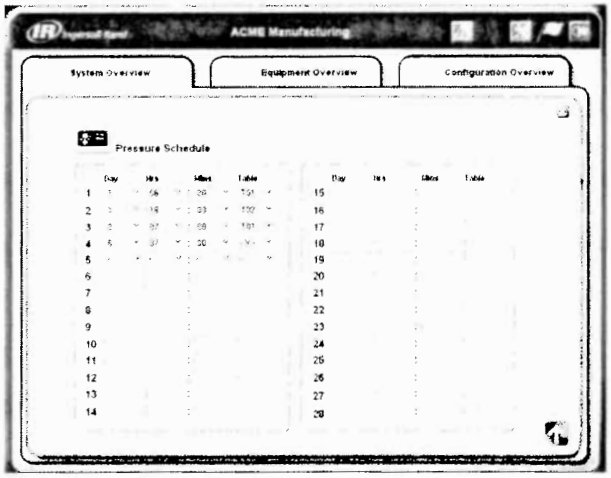
The system detail view buttons provide access to the Visualization software's reporting and graphing utilities. The system detail view buttons also provide access to the X8I and X12I pressure schedule.

Performance Report Utility



The performance report provides a summary of the compressed air system's performance for the past hour, day, week, or 4 week period. The performance report provides information on the average and maximum output capacity, power consumption, and utilization of the entire air system. Information on the utilization of each individual compressor is also displayed. The time period of the performance report is selected based on the current graph being viewed. For example, if you are currently viewing the 4 week graph, clicking the performance report utility will produce a performance report for that 4 week period of time.

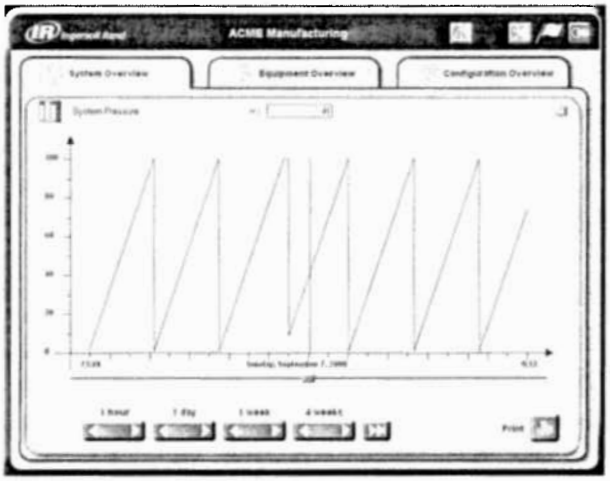
Pressure Schedule



The X8I and X12I pressure schedule can be modified from the visualization software by users with USER or ADMIN rights. The pressure schedule lets you schedule when the 4 (X8I) or 6 (X12I) pressure tables are utilized. Users with VIEW rights can only view the current pressure schedule.

Ingersoll Rand X-Series System Automation: Visualization
Detailed Description

Graphing Utility



The graphing utility allows the user to plot certain data points, such as system pressure, output flow, or compressor load percentages for hour, day, week, or 4 week periods. There are three graphing utility buttons on the system overview screen.

System Pressure – Quick Graph

System Flow – Quick Graph

Graphing Tool – Configurable Graphs

The graph can be navigated by using the grey slider below the time axis. Sliding the cursor all the way to the left will navigate to previous data using the same time scale currently selected. Sliding the cursor all the way to the right will navigate to the next data using the same time scale. The slider can also be used to view the value of the graph at the selected point in time.

Ingersoll Rand X-Series System Automation: Visualization
Detailed Description

EQUIPMENT OVERVIEW

The Equipment Overview (EOV) gives a summary of the operating conditions of all compressors, I/O boxes, and Intelliflow Valves in the compressed air system. Compressors are shown along the left side of the screen with their user assigned name and a summary of status: load state, running state, system control state, and alarm flag if the compressor is currently in an alarm or trip condition. I/O boxes and Intelliflow valves are shown on the right side of the screen with their user assigned name and an alarm flag if the unit is in an alarm or trip condition. The EOV screen contains only view only data.
Click on the Compressor or I/O Box icons to open the detail view.

Compressor Detail View

The Compressor Detail View (CDV) screen shows relevant data about the selected compressor. The CDV contains view only data with the exception of the manual controls. Manual controls are only usable by users with USER or ADMIN rights.

Compressor Status

The compressor status box duplicates the status indicator lights shown on the SOV and EOV screens as well as providing more detailed information about the compressor. The graphic represents the compressor technology, a picture of a pair of rotors for example, for a rotary screw compressor and a piston for a reciprocating compressor. The model, manufacturer, and X8I and X12I interface type are also displayed.

Ingersoll Rand X-Series System Automation: Visualization
Detailed Description

Compressor Nameplate Data

The nameplate data section shows the power consumption and output characteristics of the compressor. This data is usually taken from the compressor specifications and motor nameplate data. This data must be input by an administrator and is used in calculating the system efficiency as displayed on the System Overview screen. Care must be taken to enter the correct information for accurate performance data.

Capacity is the volume flow of air from the compressor at its rated pressure. Capacity will be in the units selected by the administrator.

Package Power is the power consumption of the compressor at full load at its rated pressure. Pressure will be in units selected by the administrator. Power units are always in kW.

Unloaded Power is the power consumption of the compressor running in an unloaded state. Units are always kW.

VSD Minimum Capacity is the volume flow of air from a variable speed compressor when it is running at its minimum load percentage. This value will always be 0 for a fixed speed machine. Units will be selected by the administrator.

VSD Minimum Power is the power consumption of a variable speed compressor when it is running at its minimum speed. The units are always kW.

Warning State will show a text description of the current alarm or trip affecting the compressor. This value will be blank and the red alarm flag will disappear if there is no alarm. Please note that text descriptions are only available for IntelliSys controlled compressors with ir-485 or irV-485 interface.

Managed Hours show how many hours the compressor has been running while under control of the X8I and X12I.

User Configurable Compressor Data

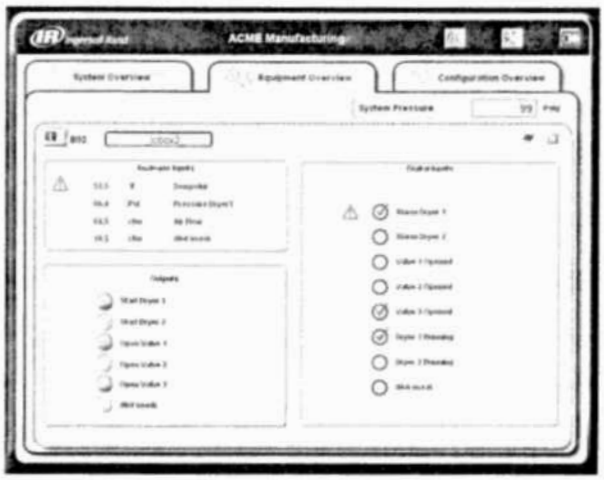
Administrators can set up to six additional data points to be read from each compressor. These data points will be displayed on the CDV screen with administrator defined titles and units. Data points will typically be chosen from the available data from the compressor IntelliSys controller (Modbus info for the specific controller will be required). These additional data points are only available for IntelliSys controlled compressors with IR-485 or IRV-485 interface.

Manual Start/Stop Control

The Manual Start/Stop control allows a user with User or Administrator rights to take the compressor out of X8I and X12I control to start and stop the compressor remotely using the interface on the CDV screen. The Manual Control interface will only appear for IntelliSys controlled compressors with IR-485 or IRV-485 interface. The compressor's local controller must also be set to accept remote start/stop commands before Manual Control will function.

Ingersoll Rand X-Series System Automation: Visualization
Detailed Description

I/O Box Detail View



The I/O Box Equipment Detail View (EDV) screen shows all data from the I/O box's analog and digital inputs and outputs. The system pressure is displayed in the upper right corner using the units selected on the SOV screen. The I/O box's name is displayed next to its network address across the top of the EDV screen. An alarm state will cause the red alarm flag to be displayed on the upper left part of the EDV screen.

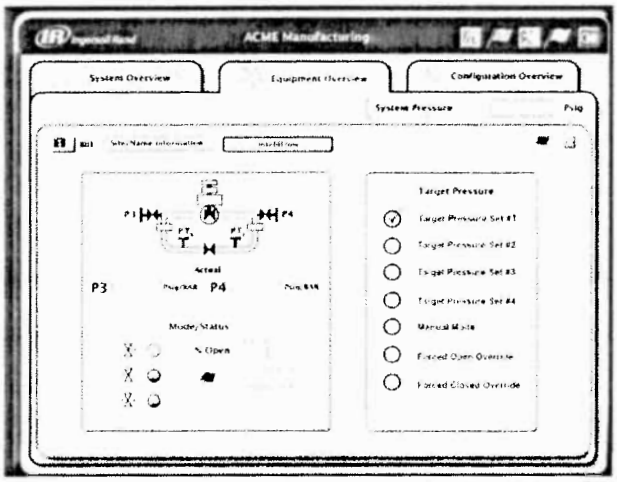
The Analog input information is displayed as configured by the Administrator when setting up the I/O Box configuration. (Labels and values shown here are only examples)

The Output states of the I/O box's six relay outputs are shown. A blue indicator means the relay is in its true state while a gray indicator means that the relay is in its false state.

The Digital Input states of the I/O box's eight digital inputs are shown. A check mark indicates that the input is true while an empty circle indicates that the input is false.

Ingersoll Rand X-Series System Automation: Visualization
Detailed Description

Intelliflow Detail View



The Intelliflow Equipment Detail View (EDV) screen shows the current operating condition of any connected Intelliflow valves. **Visualization is only compatible with Intelliflow valves equipped with the IX controller (Mid-2009).** The system pressure is displayed in the upper right corner using the units selected on the SOV screen. The Intelliflow box's name is displayed next to its network address across the top of the EDV screen. An alarm state will cause the red alarm flag to be displayed on the upper left part of the EDV screen.

P4 Outlet Pressure is the pressure read on the demand (process) side of the Intelliflow Valve.

P3 Inlet Pressure is the pressure read on the supply (compressor) side of the Intelliflow Valve.

% Open is the Intelliflow Valve current position.

The selected control method is also shown, forward control, backward control, or both, indicated by the indicator light turning blue beside the current method.

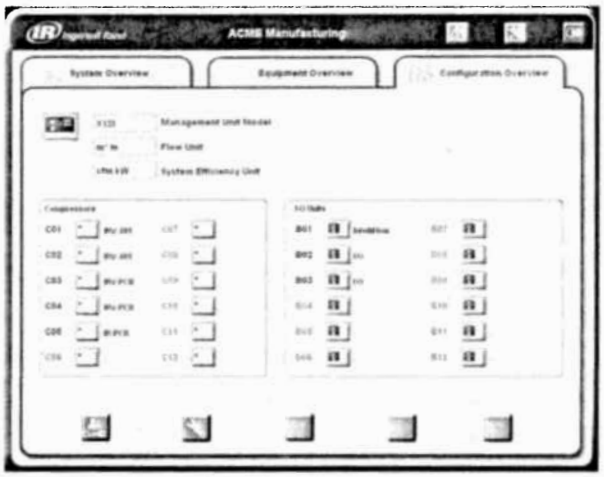
Any current alarms will be displayed and a red flag will appear

The target pressure selection for the Intelliflow valve is shown. A check mark indicates that the selection is true while an empty circle indicates that the input is false.

Ingersoll Rand X-Series System Automation: Visualization
Detailed Description

CONFIGURATION OVERVIEW

See Visualization Software Manual for details of this section



The Configuration Overview (COV) screen is only accessible by users with Administrator rights. The COV gives administrators access to change the configuration of system parameters as well as access to account management and diagnostic utilities. Users with User or View only access will see the tab on their screen but be unable to click on it to access the configuration screens.

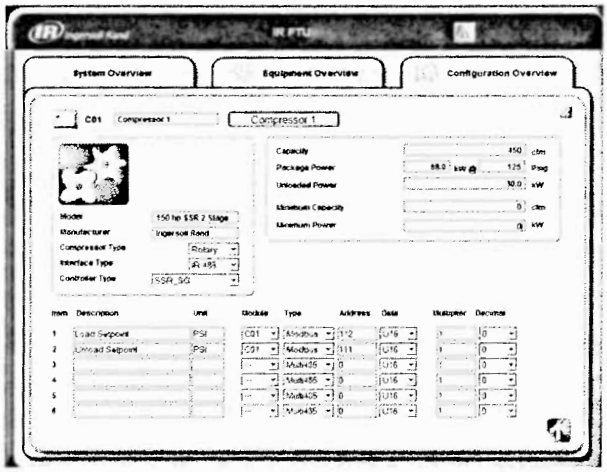
X8I and X12I System Setup

The X8I and X12I System Setup allows the administrator to change the type of system controller, flow and efficiency units, and set up the user configurable data points that are displayed on the SOV screen.

Ingersoll Rand X-Series System Automation: Visualization Detailed Description

See Visualization Software Manual for details of this section

Compressor Configuration



The Compressor Setup allows the administrator to enter compressor specific information and configurable data points that are displayed on the EOV screen.

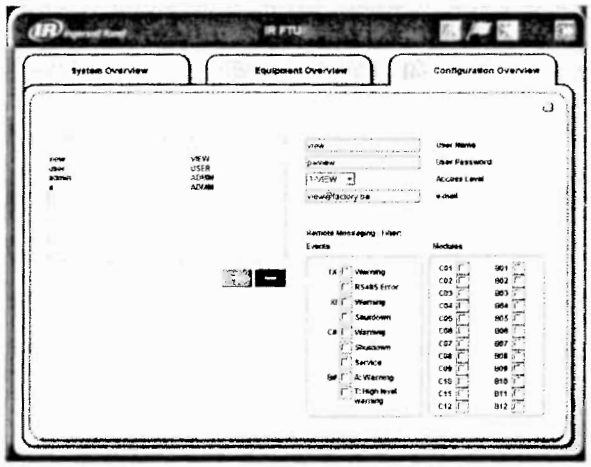
I/O Box Configuration

The I/O Box Setup allows the administrator to enter I/O Box specific information that is displayed on the EOV screen.

Ingersoll Rand X-Series System Automation: Visualization
Detailed Description

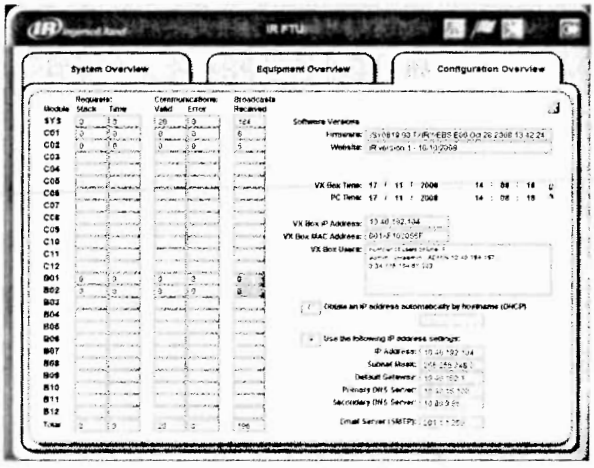
See Visualization Software Manual for details of this section

Account Management



The administrator can create any number of users desired and assign each user one of three levels of access, as well as assigning email notifications to various events that may occur. The list of accounts that currently exist are listed by user name and access rights. Clicking on an account will highlight that account in red and display its attributes.

Diagnostics



The Diagnostics page allows the administrator to view the Ethernet configuration of the VX box, the time and date information, which users are currently logged in, serial communications information, and VX box software information.

Ingersoll Rand System Automation X8I and X12I
Detailed Description

INTRODUCTION

The X8I and X12I is an advanced system controller designed to provide safe, reliable and energy-efficient management of your compressed air system. The X8I is capable of controlling up to eight positive displacement air compressors and X12I is capable of controlling up to twelve positive displacement air compressors. The compressors may be fixed-speed, variable-speed or multi-step and have electro-pneumatic- or microprocessor-based controls. The X8I or X12I will load or unload fixed-speed compressors plus control the loading of variable capacity/speed compressors as necessary to maintain a user-adjustable pressure band. The system pressure is controlled via a single pressure point in the system. This is not a cascading pressure control scheme. Additionally, the X12I has advanced pressure functions, described later in this document (ref. pressure balancing).

The X8I and X12I features an Energy Control Mode that takes the guesswork out of manually programming the schedules and sequence of multiple compressor systems. Adaptive control logic, developed for the X8I and X12I, dynamically selects and utilizes the most efficient set of compressors to meet air system demand. Energy Control Mode is designed to manage systems that include compressors of different capacities and different air compressor types (fixed-speed, variable-speed and variable-capacity) in any combination or configuration.

The X8I or X12I can also automatically manage the system around multiple pressure profiles. Up to four separate pressure profiles in the X8I and up to six separate pressure profiles in the X12I can be designated by the user to provide customized control of the compressor system. Each pressure profile can be changed automatically, based on a specified time of day and day of the week or manually from the controller faceplate. User-programmed schedules, sequences and compressor priority designations are available for custom applications should they be required. Finally, in the unlikely event of an X8I or X12I failure or a communication failure, the affected compressor(s) will default to local control and settings. This will provide the maximum reliability to your air system.

X8I and X12I FUNCTIONALITY

PRESSURE CONTROL

Pressure control is achieved by maintaining the system pressure within an acceptable range, or pressure band, which is defined and programmed by the user. Pressure will rise in the band when system demand is less than the loaded compressor's output. Pressure will fall in the band when system demand is greater than the loaded compressor's output. Simply stated, pressure control is achieved by unloading/loading and load-controlling variable-speed compressors to closely match compressor output with system demand, within the defined pressure band.

ANTI-CYCLING CONTROL

The most efficient way to utilize most air compressors is either fully loaded or off, with the exception of variable-speed compressors, which can operate efficiently at reduced loading. Compressor cycling (start-load-unload-stop, etc.) is essential to maintain pressure control. Excessive cycling, however, can result in poor compressor efficiency as well as increased maintenance. Anti-cycling control helps ensure that only the compressors that are actually required are started and operated while all others are kept off. Anti-cycling is an active control algorithm that continually analyzes pressure dynamics to determine the last possible second to add or cycle another compressor into the system. Anti-cycling control consists of two components:

Tolerance

Tolerance is a user-adjustable setting that determines how far above the unload set point and below the load set point system pressure will be allowed to stray. Tolerance keeps the X8I or X12I from overcompensating in the event of a temporary significant increase or decrease in system demand.

Damping

The damping setting is a user-adjustable set point that determines how quickly the controller samples and recalculates, effectively speeding up or slowing down the reaction time.

Damping also works in conjunction with tolerance to determine how long the pressure can remain in the tolerance band. The further into the tolerance band, the shorter the wait time to add or subtract a compressor—all relative to the damping setting.

Ingersoll Rand System Automation X8I and X12I
Detailed Description

X8I and X12I FUNCTIONALITY (continued)

COMPRESSOR SEQUENCE/CONTROL STRATEGY

There are three main system control strategies available with the X8I or X12I that range from fully automatic to fully programmable.

ENER: Energy Control Mode

The primary function of ENER mode is to dynamically match compressed air supply with compressed air demand while utilizing the most energy-efficient combination of air compressors. Energy control is made possible by the advanced control logic of the X8I or X12I that processes individual compressor capacity, variable capacity capabilities and changes in system pressure to automatically implement and continuously adapt 'best fit' configurations as demand variations occur. Compressor control and utilization are dynamically automated and, therefore, do not require the programming of special sequences, schedules, rotation configurations or time intervals.

FILO: First In/Last Out

The primary function of FILO (First In/Last Out) mode is to provide a traditional approach to efficiently operate a compressed air system consisting of fixed- and variable-speed compressors. The various sequences, sequence change schedules, priorities and rotation assignments are all selectable and programmed by the user. The rotation strategy defines how the compressors are arranged in a new sequence whenever a rotation event occurs. Rotation events are triggered by a periodic rotation based on a set interval, a set time of day each day or a set time of day once a week. Complete knowledge of system characteristics is normally required in order to effectively implement this strategy.

EHR: Equal Hours Run Mode

The primary function of EHR mode is to keep the running hours of all compressors in the system as close as possible. This provides the opportunity to service all of the compressors at the same time, given that the expected service interval for the compressors is similar. Note: EHR is not an energy-efficient mode of operation and is typically used when all the compressors are similar in size.

TABLES AND THE PRESSURE SCHEDULE

The X8I operates based on settings configured into *one of four tables* and the X12I operates based on settings configured into *one of six tables*. Each table contains specific operation mode instructions including: *high pressure (PH)*—the pressure at which the X8I or X12I will consider reducing supply, *low pressure (PL)*—the pressure at which the X8I or X12I will consider increasing supply, the *sequence control strategy (SQ)* as well as individual utilization priority settings for each compressor. Using the real-time clock feature and pressure schedule functionality, the X8I or X12I can be instructed to select the appropriate table based on time of day and day of the week. This functionality allows the X8I or X12I to switch between multiple different system configurations without disruption to control. This is particularly useful in shift changes, where pressure profiles need to be changed, or during weekends when the system is to be deactivated. The pressure schedule functionality provides enhanced system efficiency and automation.

PRIORITY SETTINGS

Priority settings modify compressor utilization and/or sequence assignments. Compressors can be assigned a priority from 1 to 8 in the X8I and 1 to 12 in the X12I, where 1 is the highest priority. Any compressor can be assigned any priority and any number of compressors can share the same priority. When using ENER mode, priorities allow you to segregate a compressor or compressor groups for utilization (for example, primary compressors vs. pure standby/emergency). When using FILO control, priorities allow you to set up primary compressors, custom rotation groups and standby compressors. All compressors that have the same priority number will rotate inside their own group. The group with the highest priority will always be in the front of the sequence.

Ingersoll Rand System Automation X8I and X12I
Detailed Description

X8I and X12I FUNCTIONALITY (continued)

SYSTEM STANDBY
Compressors can be maintained off-line to minimize losses due to system leaks in pressurized systems idle during non-productive periods.

PREFILL
Prefill provides an energy-efficient method of increasing pressure to normal operating levels upon system start. This feature avoids the potential for all compressors to inefficiently start and load in an attempt to quickly get the system pressure up to normal levels.

SYSTEM WARNINGS
The X8I and X12I are equipped to alert the user when critical system parameters are exceeded. Low pressure, high pressure and insufficient capacity warnings will be activated at each occurrence and will be visible on the X8I or X12I front panel.

CONFIGURABLE AUXILIARY INPUT/OUPUT (I/O) CONTACTS
The X8I and X12I are equipped with auxiliary I/O contacts that can be configured to control the X8I or X12I, system components, or to activate remote alarms.

FAIL-SAFE CONTROL
Should the X8I or X12I experience a disruption in normal operation or if an X8I or X12I shutdown fault occurs, control is automatically transferred back to each compressor. The fail-safe control maintains the air system integrity and reliability, even under emergency conditions.

POWER OUTAGE/RESTART OPTION
The X8I or X12I is fully compatible with compressors equipped with the power outage restart option (PORO). The X8I or X12I will store its operating state in non-volatile memory. This information is retained in case of power loss. If the power failure auto-restart function is enabled, and the X8I or X12I was in a "started" state when the power disruption or failure occurred, the X8I or X12I will automatically restart when power is restored. If the power failure auto-restart function is enabled and the X8I or X12I was in a "stopped" state when the power disruption or failure occurred, the X8I or X12I will not automatically restart when power is restored.

ADDITIONAL FUNCTIONALITY - X12I ONLY

PRESSURE BALANCE FUNCTION
This function can be used to control to a 'balanced' system pressure across an air system that has multiple remote compressor rooms and/or where pressure differentials vary across the air system. The Pressure Balance Function allows the X12I to monitor up to two remote pressures values in addition to its own primary system pressure value (three pressure values total). These two remote pressure values can be obtained from Ingersoll Rand Intellisys compressor controllers via ir485 or irV485 Gateways, Remote Compressor Management Boxes, or I/O Boxes. The X12I can then be programmed to use one of three available functions to produce a calculated 'balanced' system pressure for system control. The three selectable control functions are:

Control basis lowest pressure
Control basis highest pressure
Control basis an average of the X12I and remote pressures

ZONE CONTROL FUNCTION
The main purpose for 'zone control' functionality is to facilitate a balanced pressure across a site air network by ensuring air generation is distributed. In some applications, large pressure differentials can develop in remote areas of an air network if air generation is concentrated in one area. Zone Control allows compressors to be assigned to one of three 'zones' and the X12I will always attempt to balance utilization across the zones to maintain, as near as possible, an equal number of utilized compressors in each zone. .

START FUNCTION:
The 'Start' function enables auxiliary equipment to be pre-started prior to utilization of any compressors. The function also monitors the auxiliary equipment during normal running operation. This function is

intended for automated control and monitoring of auxiliary equipment critical to air compressor system operation; air dryer(s) or cooling water pump(s) for example.

ADDITIONAL FUNCTIONALITY - X12I ONLY

DIGITAL INPUTS (OPTIONS)

The X12I is equipped with ten auxiliary digital inputs. Digital Input 1 is Menu Configurable. Digital Input 2 will force a Sequence/rotation change. Digital Input 3 will enable Remote Start and Stop of the X12I. Digital Input 4 will force the X12I into Standby Override. Digital Input 5 to 10 will force a Table 1 to 6 Override.
This functionality enables remote control of the X12I without the requirement for serial communication.

DIGITAL OUTPUTS (OPTIONS)

The X12I is equipped with five digital, relay contact, outputs. Each of the Relay Outputs (1 to 5) is Menu Configurable. Each can be used for remote control or Warnings/Alarms functionality.

ANALOG INPUTS (OPTIONS)

The X12I is equipped with 3 predefined 4-20Ma Loop Powered analog inputs. (Loop Powered= the X12I provides the supply power to the transducer.) The three inputs are:

A Second Pressure Sensor that is configurable to provide either redundant pressure control or a pressure differential.
An Airflow Sensor for monitoring the system airflow.
A Dewpoint Sensor for monitoring the system dewpoint

VIRTUAL RELAY AUTOMATION

The X12I is equipped with Virtual Relay Automation. The 'Virtual Relay' concept is a configurable system-wide automation system. The concept allows output relay functions to be configured to respond to any 'virtual relay' condition, status, or signal function available in the unit or from another compatible unit on the system network.

Ingersoll Rand System Automation X8I and X12I
Detailed Description

INSTALLATION

The X8I and X12I is a self-contained and independently powered unit, mounted in a NEMA 12, IP54 control enclosure. A separate 115/230V, 60/50 Hz power supply must be provided to the X8I or X12I. For more information, *Please reference the X8I and X12I Quick Set-Up Guide* and *the X8I or X12I Operators Manual.*

PRESSURE TRANSDUCER

A single pressure transducer is provided; the standard is 232psi (16bar) with optional pressure transducers being available with ranges up to 870 psi (60 bar). The pressure transducer must be installed at a stable point in the air system. The pressure sensing point should be chosen carefully. It should be free of flow restrictions, excessive pressure drops and excessive demand surges. A common receiver tank is an excellent choice. The pressure transducer can be located up to 330 ft (100 m) from the X8I or X12I.

COMPRESSOR CONNECTIVITY

Compressors will be connected to the X8I or X12I using various "standard" interface configurations depending on the specific on-board compressor control. The X8I will manage up to eight positive displacement compressors or the X12I will manage up to twelve positive displacement compressors in any combination of connection/interface configurations. Four (4) standard connection configurations are available via: ir-PCB, ir-485 Gateway, irV-485 Gateway and Direct RS485 cable connection.

X8I and X12I INTERFACE CONFIGURATION GUIDE

Competitive		Ingersoll Rand				
Pressure Switch	Microprocessor	Pressure Switch	IntelliSys Controllers			S3
			Fixed-speed	Nirvana	Nirvana 7.5-15	Fixed-speed
ir-PCB	**ir-PCB**	**ir-PCB**	**ir-485 Gateway**	**irV-485 Gateway**	**ir-PCB**	**Direct**

The ir-PCB connects using a six- or seven-conductor shielded cable or individual wires running through grounded conduit no greater than 330 ft (100 m) in length. Each ir-PCB connected compressor is wired to the X8I or X12I in parallel. Up to four ir-PCB compressors can be connected directly to the X8I or X12I. Four more ir-PCB compressors can be connected via the EXP Box for a total of eight compressors for the X8I and an additional four more ir-PCB compressors can be connected via a second EXP Box for a total of twelve compressors for the X12I (see the Installation Summary section on the following page).

The ir-485 and irV-485 Gateways connect using a shielded RS485 communication cable. Up to eight compressors (X8I) or up to twelve compressors (X12I) connected via ir-485, irV-485 Gateway or RS485 can be networked together, daisy-chain style, using an RS485 communication cable with a total length no greater than 4,000 ft (1,219 m). It is recommended the ir-485 and irV-485 Gateways be mounted in the compressor control cabinet. If this recommendation cannot be adhered to, the ir-485 and irV-485 Gateways can be remote mounted but must be located within 33 ft (10 m) max. of the Intellisys Controller. The total number of compressors that can be connected in any combination is eight (X8I) and twelve (X12I). For detailed interface information, *please reference the X8I and X12I Application & Compressor Interconnect Guide.*

REMOTE LOAD & UNLOAD

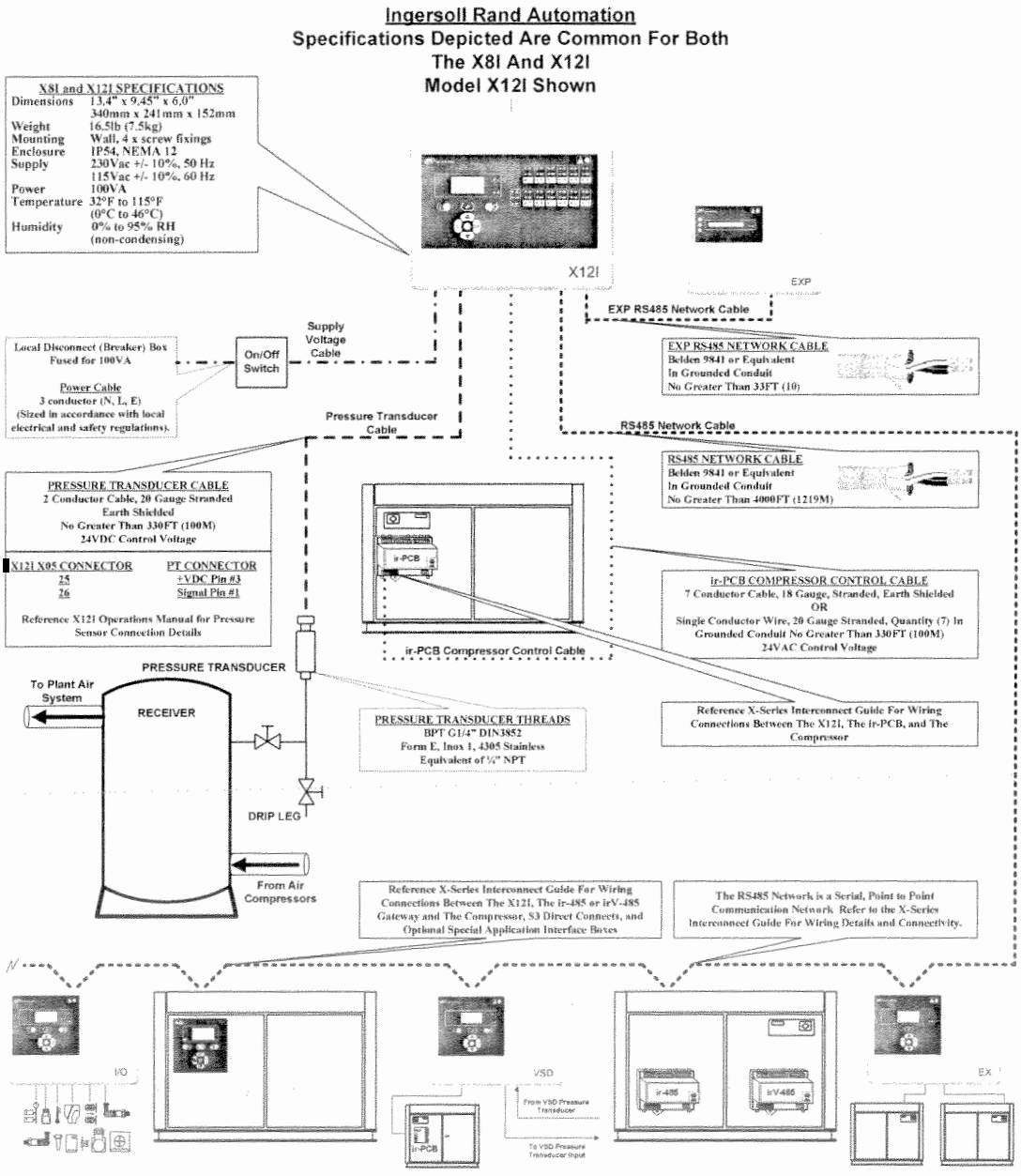
All compressors managed by the X8I or X12I must have the ability and the connection points to accept a remote load and unload command. Most compressors have this ability or can be configured to have this ability. On rare occasions however, compressor control is designed without any remote control capability.

AUTO START & STOP

The X8I or X12I manages compressors by issuing load and unload commands to individual fixed-speed compressors and by targeting pressure commands to individual variable-speed compressors. Starting and stopping of the compressors is accomplished through the automatic start and stop functionality that resides in the on-board control of each compressor. Auto start and stop is required on each compressor to receive the full energy saving benefits of the X8I or X12I. Units without the auto start/stop function will run unloaded until the load command is received.

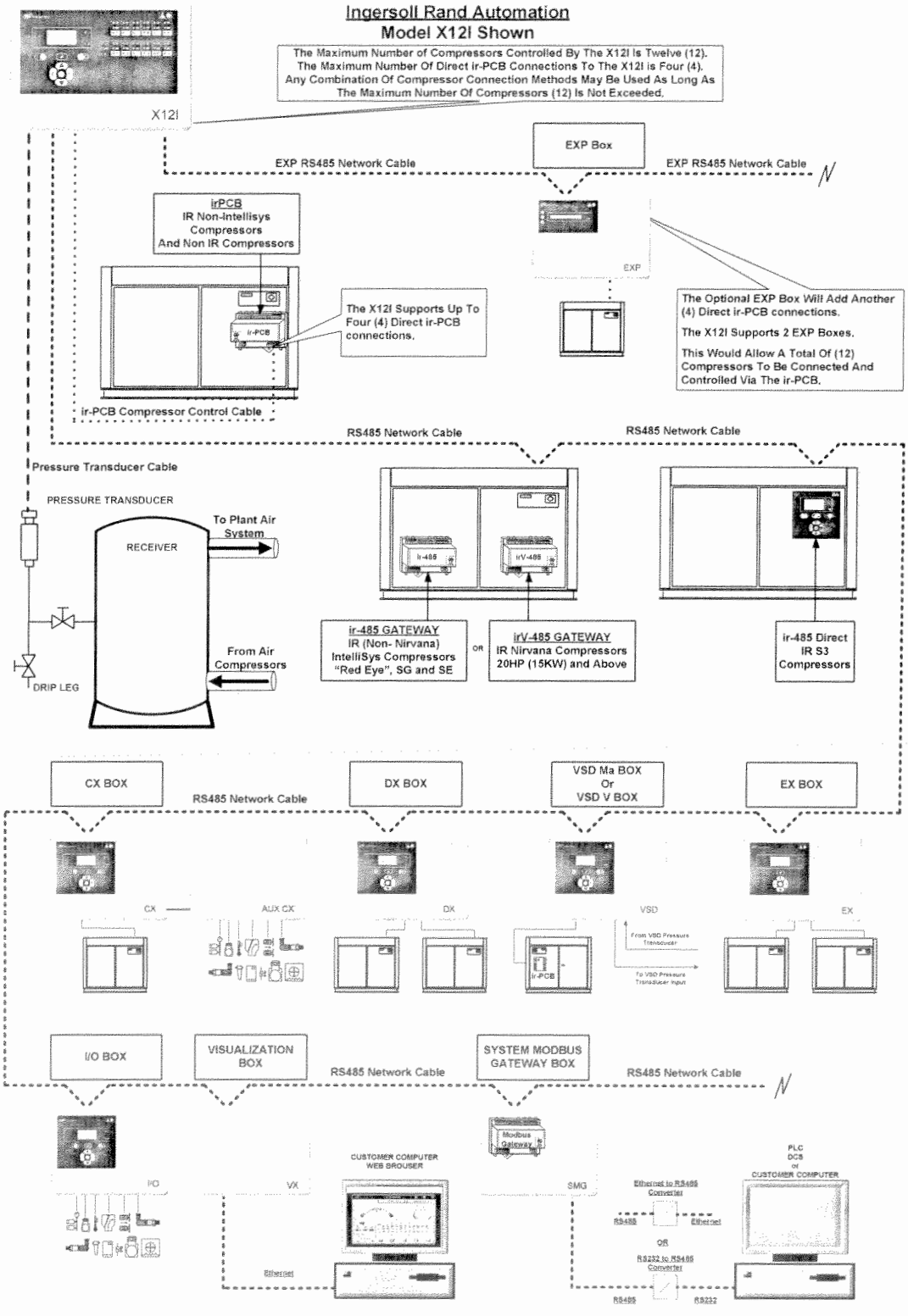
Ingersoll Rand System Automation X8I and X12I
Detailed Description

INSTALLATION – Summary



Ingersoll Rand System Automation X8I and X12I
Detailed Description

SYSTEM OVERVIEW



Ingersoll Rand System Automation X8I and X12I
Detailed Description

OPERATION

SETUP

Once the X8I or X12I is properly set up it will operate automatically. Every X8I or X12I comes preset from the factory in ENER mode and with typical default settings. For more information, *please reference the X8I and X12I Quick Set-Up Guide.*

In order to realize the full benefits of the X8I or X12I, some field configuration is required. For more information, *please reference the X8I or X12I Operators Manual.*

The following are common user-definable parameters:

- X8I or X12I System Pressure Band: Compressors will be loaded/unloaded and load-controlled based on system pressure in relation to the user-selected pressure band (high pressure set point and low pressure set point)
- Units of measure: Pressure can be displayed in psi, bar or kPA
- Anti-cycling control: Tolerance and damping are used to tune the system, to adjust the response time and to assure that compressors are utilized only as required
- Three sequence strategies: ENER (energy control mode: automatic selection and sequence), FILO (first in/last out) or EHR (equal run hours)
- Four (X8I) or Six (X12I) control tables: Each table consists of high pressure (PH), low pressure (PL), minimum pressure alarm (PM), sequence strategy (SQ) and compressors' priority
- Eight (X8I) or Twelve (X12I) priority levels: Individual units or groups of compressors can be prioritized for custom utilization
- Pressure schedule: The control table is selected based on a user-defined pressure schedule
- Automatic or manually programmed prefill mode: Efficiently charges an empty system
- Start sequencing: Starts the X8I or X12I and engages the current sequence
- Stop sequencing: Stops the X8I or X12I and returns each compressor to local control and pressure settings
- Standby mode: Holds the compressors off-line based on a user-defined schedule

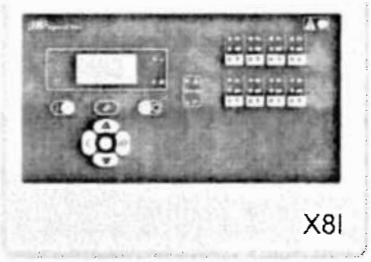
Ingersoll Rand System Automation X8I and X12I
Detailed Description

PRODUCTS

X8I System Controller Kit (42659250)
The following components are included:

- X8I Controller mounted in a NEMA 12, IP54 enclosure
- Pressure transducer 232 psi (16 bar)
- Compressor interface installation kit for eight compressors: Brackets, mounting hardware and 330 ft (100 m) of wire
- Operator's Manual (CD)
- Quick Set-up Guide
- Application and Compressor Interconnect Guide (CD)

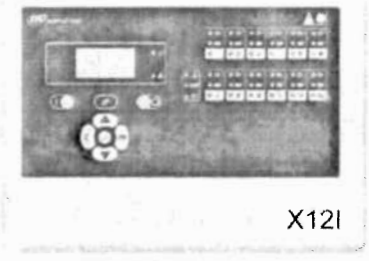
(Control cable/wire is not included – X8I to compressor interface and X8I to pressure transducer)
(Optional Pressure Transducers are available from Aftermarket with ranges up to 870 psi (60 bar)


X8I

X12I System Controller Kit (42659292)
The following components are included:

- X12I Controller mounted in a NEMA 12, IP54 enclosure
- Pressure transducer 232 psi (16 bar)
- Compressor interface installation kit for eight compressors: Brackets, mounting hardware and 330 ft (100 m) of wire
- Operator's Manual (CD)
- Quick Set-up Guide
- Application and Compressor Interconnect Guide (CD)

(Control cable/wire is not included – X12I to compressor interface and X12I to pressure transducer)
(Optional Pressure Transducers are available from Aftermarket with ranges up to 870 psi (60 bar)


X12I

Ingersoll Rand System Automation X8I and X12I
Detailed Description

X8I OR X12I COMPRESSOR INTERFACE AND NETWORK PRODUCTS

These products are supplied and ordered separately depending on the compressors to be connected.

Compressor Interface

Each air compressor in your system must be interfaced to the X8I or X12I. Interface methods may vary depending on the compressor type and/or local control configuration. Currently, all compressors with the exception of the recently introduced R-Series fixed-speed contact-cooled rotary compressor, will connect via either an ir-PCB (hardwire connection) or an ir-485/irV-485 Gateway (RS485 connection). For detailed interface information, *please reference the X8I and X12I Application & Compressor Interconnect Guide.*

ir-PCB kit: 39266119

- Four ir-PCB interface modules
- Instructions

ir-485 Gateway Kit: 39266085

- One ir-485 interface module
- One 24 Vdc power supply
- Interface to compressor connection wire
- Instructions

irV-485 Gateway Kit: 42665141

- One irV-485 interface module
- One 24 Vdc power supply
- Interface to compressor connection wire
- Instructions

Ingersoll Rand System Automation X8I and X12I
Detailed Description

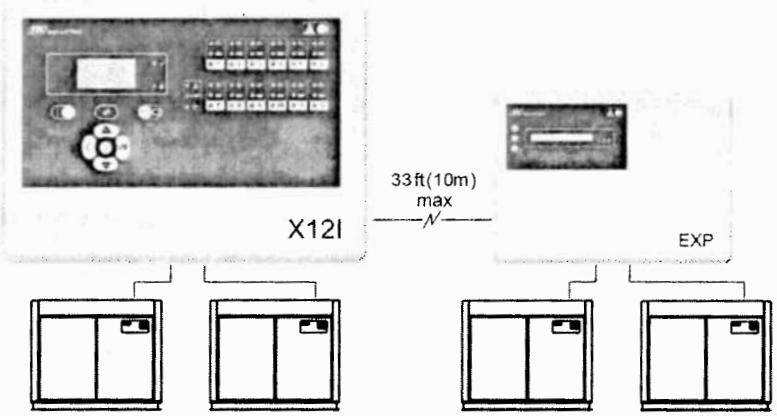
NETWORK PRODUCTS: ACCESSORIES FOR SPECIAL APPLICATIONS

Expansion Module: EXP (Optional)
42659516

Mixed-manufacturer or pressure switch compressors are directly connected via hardwire and an ir-PCB interface.

The X8I or X12I standard configuration has four direct-connect ir-PCB terminal connections. This capability can be extended with the use of an optional EXP expansion module. Four more ir-PCB compressors can be connected via the EXP Box for a total of eight mixed-manufacturer or pressure switch compressors for the X8I and an additional four more ir-PCB compressors can be connected via a second EXP Box for a total of twelve mixed-manufacturer or pressure switch compressors for the X12I

The ir-PCB expansion module is suitable for wall mounting and must be located adjacent to the X8I or X12I unit (max 33 ft or 10 m). Compressors connected to the ir-PCB expansion module using a six-wire cable and a compressor interface ir-PCB must be within a 330 ft (100 m) distance. For detailed interface information, *please reference the X8I and X12I Application & Compressor Interconnect Guide.*



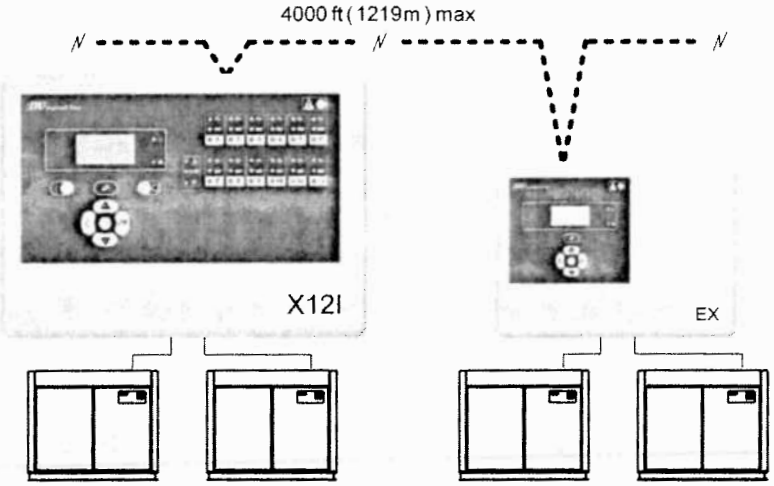
Ingersoll Rand System Automation X8I and X12I
Detailed Description

NETWORK PRODUCTS: ACCESSORIES FOR SPECIAL APPLICATIONS

Remote Compressor Management: EX Box (optional)
42659375

The EX Box, an "EXtension" to the X8I or X12I, provides remote ir-PCB connectivity. The EX Box is connected on the RS485 network and is typically used to provide ir-PCB (mixed-manufacturer compressor) connectivity at a remote location beyond the maximum distance specification for ir-PCB-type connection, 330 ft (100 m). This effectively expands the hardwire connection scheme of the ir-PCB to the full RS485 distance specification.

Multiple EX Boxes can be connected to the X8I or X12I as long as the number of compressors does not exceed the maximum number of compressors (8 for the X8I and 12 for the X12I). The EX Box connects to the X8I or X12I controller via the two-wire RS485 network. The EX Box is suitable for wall mounting and can be located up to 4,000 ft. (1,219 m) from the X8I or X12I unit. One or two air compressors can be connected to the EX Box using a six-wire cable and a compressor interface ir-PCB within a 330 ft (100 m) distance. For detailed interface information, *please reference the X8I and X12I Application & Compressor Interconnect Guide.*



Ingersoll Rand System Automation X8I and X12I
Detailed Description

NETWORK PRODUCTS: ACCESSORIES FOR SPECIAL APPLICATIONS

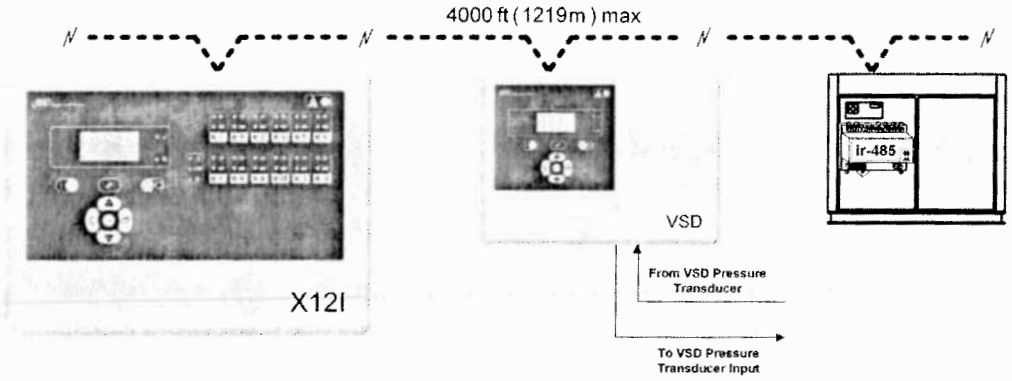
Remote Compressor Management: VSD Control Integration: VSD B Box (optional)
23410780

Ingersoll Rand "IntelliSys Controlled" air compressor with a Bolt-On VSD

The VSD B Box provides a method of system integration for an Ingersoll Rand Intellisys controlled Air Compressor with a Bolt-On VSD (variable speed drive) (non - Nirvana). The VSD B Box will provide the required functionality to enable system integration and efficient control using the X8I or X12I automation system.

Each air compressor in a system that requires VSD B Box integration must be equipped with an individual VSD Box. The VSD B Box connects to the compressor via the ir-485 Gateway interface. The compressor/VSD pressure sensor is routed through the VSD B Box; in some cases, a CT is installed on the drive to determine compressor speed.

Multiple VSD B Boxes can be connected to the X8I or X12I as long as the number of compressors does not exceed the maximum number of compressors (8 for the X8I and 12 for the X12I). The VSD B Box and the ir-485 Gateway connects to the X8I or X12I controller via the two-wire RS485 network. The VSD B Box is suitable for wall mounting and can be located up to 4,000 ft. (1,219 m) from the X8I or X12I unit. The ir-485 Gateway should be mounted in the compressor control cabinet. If this recommendation cannot be adhered to, the ir-485 Gateway can be remote mounted but must be located within 33 ft (10 m) max. of the Intellisys Controller. For detailed interface information, please reference the X8I and X12I Application & Compressor Interconnect Guide.



Ingersoll Rand System Automation X8I and X12I
Detailed Description

NETWORK PRODUCTS: ACCESSORIES FOR SPECIAL APPLICATIONS

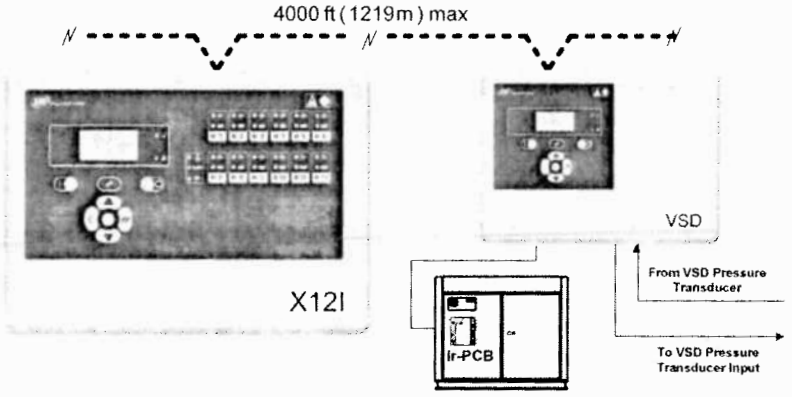
Remote Compressor Management: VSD Control Integration: VSD mA and Vo Box (optional)
VSD mA 42659417
VSD Vo 42659425

Ingersoll Rand air compressor with "Pressure Switch control" with a Bolt-On VSD
Non-Ingersoll Rand air compressors with Bolt-On or integrated VSD.

The VSD mA and Vo Box provides a method of system integration for a VSD (variable speed drive) air compressor not equipped with any accessible means of remote connectivity (such as IR- Nirvana). The VSD mA and Vo Box will provide the required functionality to enable system integration and efficient control using the X8I or X12I automation system.

Each air compressor in a system that requires VSD mA and Vo Box integration must be equipped with an individual VSD Box. The VSD mA and Vo Box connects to the compressor via the ir-PCB interface. The compressor/VSD pressure sensor is routed through the VSD mA and Vo Box; in some cases, a CT is installed on the drive to determine compressor speed.

Multiple VSD mA and Vo Box can be connected to the X8I or X12I as long as the number of compressors does not exceed the maximum number of compressors (8 for the X8I and 12 for the X12I). The VSD mA and Vo Box connects to the X8I or X12I controller via the two-wire RS485 network. The VSD mA and Vo Box is suitable for wall mounting and can be located up to 4,000 ft. (1,219 m) from the X8I or X12I unit. For detailed interface information, *please reference the X8I and X12I Application & Compressor Interconnect Guide.*



Ingersoll Rand System Automation X8I and X12I
Detailed Description

NETWORK PRODUCTS: ACCESSORIES FOR SPECIAL APPLICATIONS

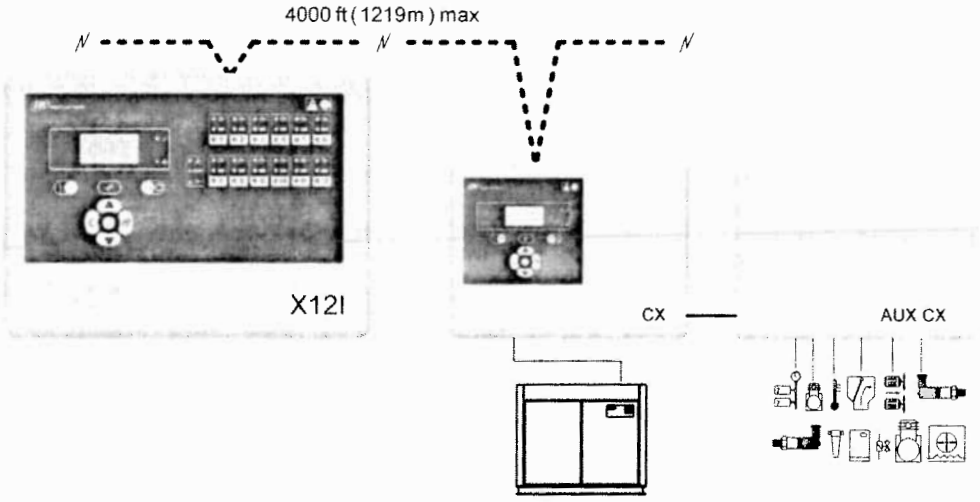
Remote Compressor Management: CX Box (optional)
CX 42659383
IO 42659391

The CX Box is intended to provide a method of system integration for non-Ingersoll Rand air compressors that are not equipped with any accessible means of remote connectivity.

The CX Box provides advanced monitoring and control functionality for the following compressor types:

- Load/Unload
- 3-Step
- 5-Step
- Poppet Valve
- Modulation Valve
- Spiral Valve
- Variable Speed Inverter Drive

Multiple CX Boxes can be connected to the X8I or X12I as long as the number of compressors does not exceed the maximum number of compressors (8 for the X8I and 12 for the X12I). The CX Box connects to the X8I or X12I controller via the two-wire RS485 network. The CX Box is suitable for wall mounting and can be located up to 4,000 ft. (1,219 m) from the X8I or X12I unit. The air compressors can be connected to the CX Box using a six-wire cable and a compressor interface ir-PCB within a 330 ft (100 m) distance. For detailed interface information, *please reference the X8I and X12I Application & Compressor Interconnect Guide.*



Ingersoll Rand System Automation X8I and X12I
Detailed Description

NETWORK PRODUCTS: ACCESSORIES FOR SPECIAL APPLICATIONS

Remote Compressor Management; DX Box (optional)
42659367

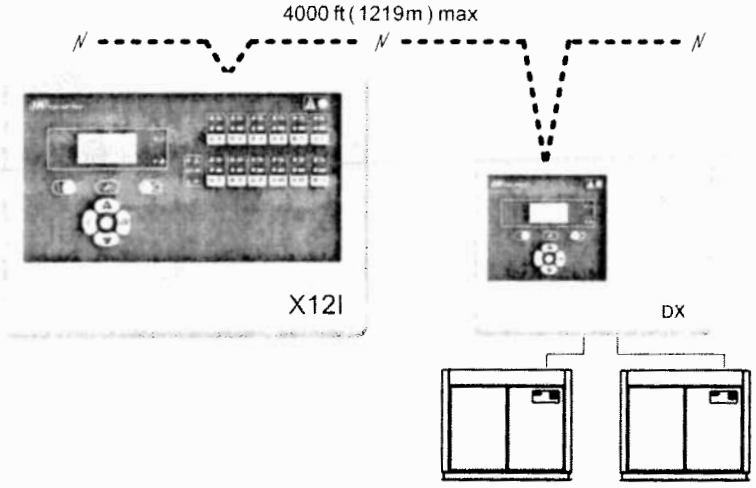
The DX Box is designed to allow two fixed speed online/offline air compressors to be seen as one compressor by the X8I or X12I.

This functionality provides the ability to:

a) Group two adjacent air compressors together as a single coherent unit.
b) Combine two similar capacity compressors together to form a three-step variable output group acting as a single coherent variable output unit.
c) Take advantage of a small or minimal capacity compressor, grouped together with a medium or higher capacity compressor, to form a high capacity, variable output, group acting as a single variable output 'top-up' compressor.

The DX Box also provides optional local pressure sensor connections. The compressor discharge pressures, local system pressure and air treatment differential pressures can be displayed. The monitored local pressure is available on the system network and can be utilized by the X12I for advanced pressure related functions.

Multiple DX Boxes can be connected to the X8I or X12I as long as the number of compressors does not exceed the maximum number of compressors (8 for the X8I and 12 for the X12I). The DX Box connects to the X8I or X12I controller via the two-wire RS485 network. The DX Box is suitable for wall mounting and can be located up to 4,000 ft. (1,219 m) from the X8I or X12I unit. The two air compressors can be connected to the DX Box using a six-wire cable and a compressor interface ir-PCB within a 330 ft (100 m) distance. For detailed interface information, *please reference the X8I and X12I Application & Compressor Interconnect Guide.*



Ingersoll Rand System Automation X8I and X12I
Detailed Description

NETWORK PRODUCTS: ACCESSORIES FOR SPECIAL APPLICATIONS

Remote Input & Output: I/O Box (Optional)
42659409

The I/O Box provides additional general purpose I/O to add system monitoring capabilities and distributed system automation. Each I/O Box features:

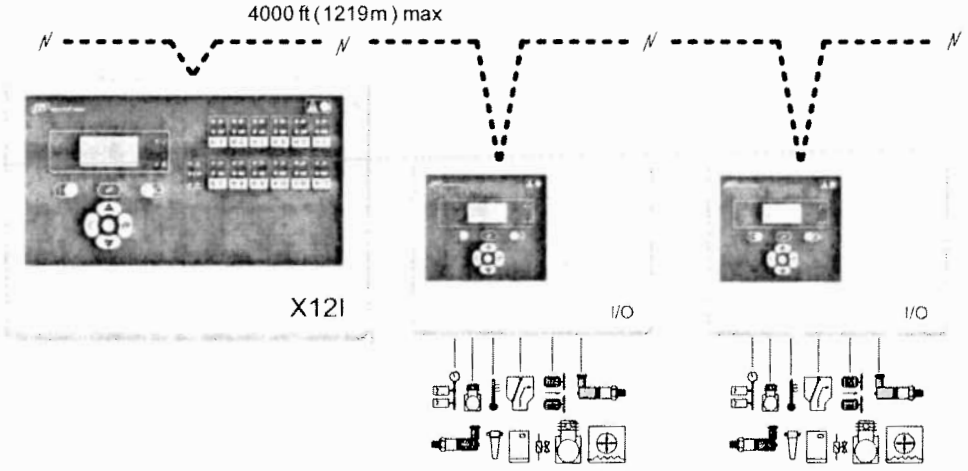
- Eight digital inputs
- Five analog inputs
- Six relay outputs

Digital inputs monitor switching contact devices. Each input can be set to act as an alarm or high-level alarm input. Digital inputs can also be used for metering (for example, m^3, ft^3, kWh) providing accumulated pulse count from a metering device.

Analog inputs monitor sensor devices (for example, pressure, pressure differential, temperature, dewpoint, flow, current, power, bearing condition). Each input is equipped with adjustable high- or low-level detection that can be used to activate an alarm or high-level alarm. The Analog devices/instrumentation must be 4-20Ma Loop Powered analog inputs. (Loop Powered= the IO Box provides the supply power to the transducer).

Relay outputs use 'virtual relay automation' technology and are totally configurable with dual input logic functions. Relay functions can be assigned utilizing any status or condition information available on a system network from any compatible unit connected to the network.

Multiple I/O Boxes can be connected to the X8I or X12I as long as the number of I/O Boxes does not exceed the maximum number of allowable (2 for the X8I and 12 for the X12I). The I/O Box connects to the X8I or X12I controller via the two-wire RS485 network. The I/O Box is suitable for wall mounting and can be located up to 4,000 ft. (1,219 m) from the X8I or X12I unit.



Ingersoll Rand System Automation X8I and X12I
Detailed Description

NETWORK PRODUCTS: ACCESSORIES FOR SPECIAL APPLICATIONS

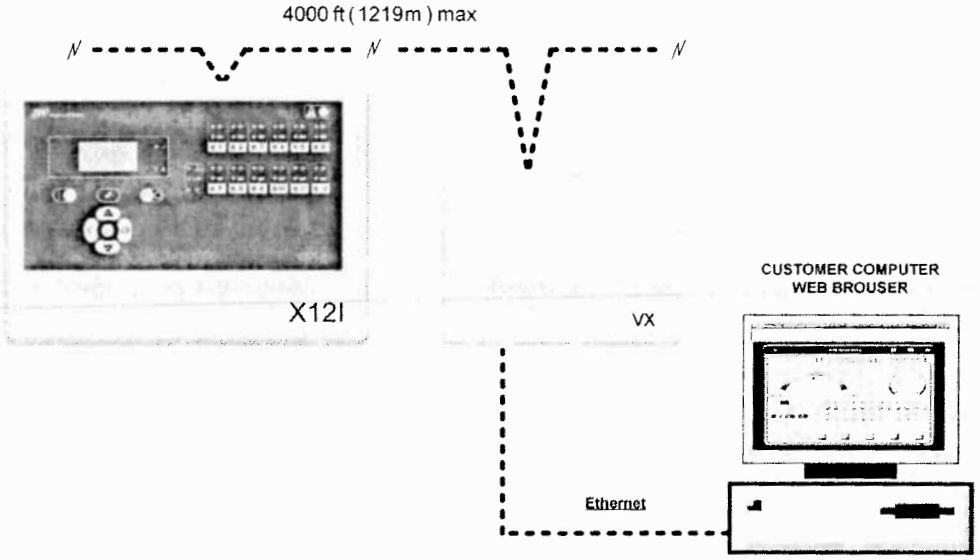
Visualization: VX Box (Optional)
23358039

The VX Box provides "visualization" of the X8I or X12I Automation System. The VX Box incorporates hardware and software to allow monitoring of the X8I and X12I Automation system and equipment in a simple format. To access the application running in the VX Box, simply connect via a Web Browser from any PC using an Ethernet connection. The PC can be local "stand alone" or part of a LAN. The VX Box is fully field configurable using standard screen templates.

Once logged into the VX Box, the following items are available to the user:

- System status & control
- System performance reporting
- Equipment status monitoring
- Equipment maintenance scheduler
- Graphing & Trending tools
- Reporting tools
- Warning & Alarm monitoring
- Email messaging
- SMS messaging (to follow)

The VX Box connects to the X8I or X12I controller via the two-wire RS485 network. The VX Box is suitable for wall mounting and can be located up to 4,000 ft. (1,219 m) from the X8I or X12I unit.

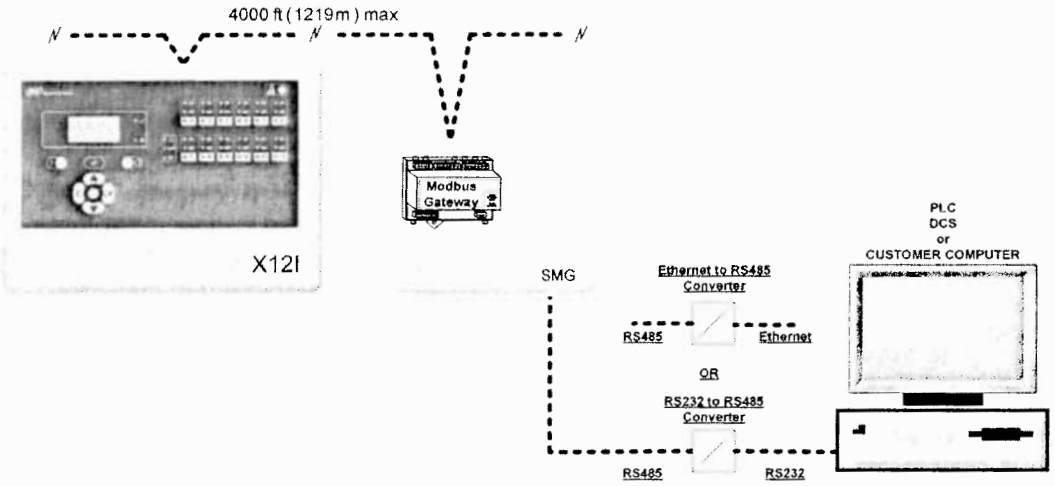


Ingersoll Rand System Automation X8I and X12I
Detailed Description

NETWORK PRODUCTS: ACCESSORIES FOR SPECIAL APPLICATIONS

System Modbus Gateway: SMG Box (Optional)
39266093

The SMG Box is designed to provide a RS485 Modbus connection to the X12I Automation System. This allows a customer's computer, PLC, or DCS to connect to, monitor, and control the X12I Automation System from a remote location. The SMG Box connects to the X8I or X12I controller via the two-wire RS485 network. The SMG Box is suitable for wall mounting and can be located up to 4,000 ft. (1,219 m) from the X8I or X12I unit.



INGERSOLL-RAND AIR CENTER
28 CORPORATE CIRCLE # 2
EAST SYRACUSE, NY 13057
(315) 434-9040

Air Amplifiers Start-up Checklist

Date of Inspection: _____/_____/_____

Customer Name: _____

Customer Address: _____

Service Provider: _____ **Signature:** _____

Model No.: _____

Serial No.: _____

1. **Check all fitting and connections for air leaks:** _____
2. **Check filters for proper installation:** _____
3. **Verify Paint/Finish is acceptable:** _____
4. **Verify inlet air pressure: :** _____
5. **Verify/adjust outlet air pressure: :** _____
6. **Verify proper installation/operation of drain valves:** _____
7. **Additional observations or comments:** _____

Ingersoll Rand

INGERSOLL-RAND AIR CENTER
28 CORPORATE CIRCLE # 2
EAST SYRACUSE, NY 13057
(315) 434-9040

Heated Blower Desiccant Dryers Start-up Checklist

Date of Inspection: _____/_____/_____

Customer Name: _____

Customer Address: _____

Service Provider: _____ **Signature:** _____

Model No.: _____

Serial No.: _____

1 **Verify Tanks are properly charged with desiccant:** _____

2 **Check all fitting and connections for air leaks:** _____

3 **Check filters for proper installation:** _____

4 **Verify input heater voltage:** _____

5 **Verify input motor voltage:** _____

6 **Motor Nameplate information:** _____

7 **Inspect Contactors:** _____

8 **Verify proper motor rotation:** _____

9 **Check all electrical connections:** _____

10 **Verify Paint/Finish is acceptable:** _____

11 **Verify inlet air pressure: :** _____

12 **Verify outlet air pressure: :** _____

13 **Verify proper installation/operation of drain valves:** _____

14 **Additional observations or comments:** _____

Ingersoll Rand
Industrial Technologies

PackageCare

Maintenance and Start-up Checklist

☐ Start-up ☐ AirCare ☐ PM ☐ Inspection

Date of Inspection: _____ / _____ / _____
Customer Name _____
Customer Address _____
Ingersoll Rand Service Provider: _____

Compressor Type: ROTARY CONTACT COOLED - NIRVANA
Model No.: _____ Size (HP): _____
Serial No.: _____
Work Order No.: _____

General Inspections (Check and Record, If Applicable)

OK
Fixed/Changed/Cleaned During Visit
Still Requires Repair/Changing/Cleaning

1. Total Running Hours _____
2. Full Load Package Discharge Temp (°F / °C) _____ / _____
3. Full Load Airend Discharge Temp (°F / °C) _____
4. Full Load Injection Coolant Temp (°F / °C) _____
5. Target Pressure (PSIG / BarG) _____
6. Auto Stop Pressure (PSIG / BarG) _____
7. Immediate Stop Pressure (PSIG / BarG) _____
8. Sump Pressure (PSIG / BarG) _____
9. Inlet Filter Condition _____
10. Last Inlet Filter Change (Date) ____ / ____ / ____ (Hours) _____
11. PDM Filter Condition _____
12. Check Coolant Level _____
13. Inspect for Coolant Leaks _____
14. Coolant Filter change at: (2000 hr or 1 year) ____ / ____ / ____
15. Full Load Separator Press Drop (PSIG / BarG) _____
16. Date of Last Separator Element Change _____
17. Inspect and Clean Scavenge Orifice and Screen _____
18. Room Ambient Temperature (°F / °C) _____
19. Thermostatic Control Valve Temp (°F / °C) Port A_____ B_____ C_____ D_____
20. Average Capacity (CFM / M3m) _____
21. Inspect for Air Leaks _____
22. Inspect All Air Cooled Cooler Cores _____
23. Inspect and Clean Condensate Drain _____
24. Inspect Main and Blower Motors _____
25. Inspect and Clean Main Motor Cowl _____
26. Last Blower Motor Grease (Date) ____ / ____ / ____ (Hours) _____
27. Cooling Water Inlet - Water Cooled (Temp) _____ (Press) _____
28. Cooling Water Discharge - Water Cooled (Temp) _____ (Press) _____
29. Safety Valve Installed and Operational _____

Electrical Inspections (Check and Record the Following)

OK
Fixed/Changed/Cleaned During Visit
Still Requires Repair/Changing/Cleaning

30. Input Voltage (Full Load) _____
31. DC Bus Voltage (Full Load) _____
32. Package kW _____
33. Motor Nameplate Data (HP/kW) _____ RPM _____ V _____ A _____
34. Motor Speed (Max Speed) RPM _____
35. Motor Voltage (Max Speed & Target Press) VOLTS _____
36. Motor Current (Max Speed & Target Press) AMPS _____
37. Inspect Contactors _____
38. Check Electrical Connections _____
39. HAT Operating Temp (°F / °C) _____

Diagnostics Inspections (Check and Record the Following)

FLUID

40. Coolant Type _____
41. Last Coolant Change (Date) ____ / ____ / ____ (Hours) _____
42. Coolant Analysis Sample Taken — Every 2000 hr or 1 year (Whichever is 1st)
43. Condensate Analysis (Optional) _____

VIBRATION

IR30 Shock Pulse Readings	(One Stage)		(Two Stage)			
MR speed	MR1	MR2	LPM1	LPM2	HPM1	HPM2
44. Loaded _____ (dBm)						
45. Loaded _____ (dBc)						
Loaded _____ (dBi)						

AIR QUALITY (Optional, Use Only if Suspected Air Quality Issues)

46. Test Via Coupon (Metallic Strips) _____
47. Test OnGuard 2000 Electronic Analysis _____

Start-up Checklist (ONLY for Initial Start-Up)

Date of Start-Up: _____ / _____ / _____

YES NO

1. Fast Acting Class J,T or Semi-Conductor Fuses Installed
2. **Line Reactor Installed (Req. for 5 Yr Ext Warranty Coverage of Var Speed Drive)** _____
3. Paint Finish Acceptable _____
4. Missing Electrical or Parts _____
5. Damaged Metal / Cover _____
6. Chemical / High Dust area? _____
7. Unit Outdoors _____
8. If Outdoors, MOD included? _____
9. Other _____
10. Does Customer Have Adequate Spare Parts? If NO, enter spare parts recommendations below.

YES NO

Is there any additional maintenance needed?
If yes, is it urgent?

RECOMMENDATIONS

_____
_____
_____

Inspected By : _____ Cert. # _____
(Serviceman's Signature)

Reviewed By : _____
(Customer's Signature)

_____
(Customer's Name/Title (Printed))

PackageCare

Keep original with machine history, copy to customer. Start-up/Inspection sheets required for warranty processing.

July 2008
80440605 Rev E

Ingersoll Rand
Industrial Technologies

PackageCare

Maintenance and Start-up Checklist

☐ Start-up ☐ AirCare ☐ PM ☐ Inspection

Date of Inspection: _____ / _____ / _____
Customer Name _____
Customer Address _____
Ingersoll Rand Service Provider: _____

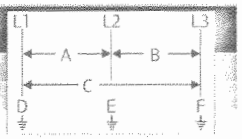
Compressor Type: ROTARY CONTACT COOLED - ROTARY
Model No.: _____ Size (HP): _____
Serial No.: _____
Work Order No.: _____

General Inspections (Check and Record, If Applicable)

OK
Fixed/Changed/Cleaned During Visit
Still Requires Repair/Changing/Cleaning

1.	Total Running Hours/Loaded Hours		_____ / _____
2.	Package Discharge Press (Off Line / On Line)		_____ / _____
3.	Full Load Package Discharge Temp (°F / °C)		_____
4.	Full Load Airend Discharge Temp (°F / °C)		_____
5.	Full Load Injection Coolant Temp (°F / °C)		_____
6.	Unloaded Sump Press (PSIG / BarG)		_____
7.	Unloaded Inlet Vacuum (PSIG / BarG)		_____
8.	Inlet Filter Condition		_____
9.	Last Inlet Filter Change	(Date)	____/____/____
		(Hours)	_____
10.	Check Coolant Level		_____
11.	Inspect for Coolant Leaks		_____
12.	Coolant Filter change at: (2000 hr or 1 year)		_____
13.	Full Load Separator Press Drop (PSIG / BarG)		_____
14.	Date of Last Separator Element Change		____/____/____
15.	Inspect and Clean Scavenge Orifice and Screen		_____
16.	Inspect and Clean Gearcase Breather		_____
17.	Room Ambient Temperature (°F / °C)		_____
18.	Thermostatic Control Valve Temp (°F / °C)	Port A___ B___ C___	
19.	Belt Alignment Checked and in Good Condition		_____
20.	Belt Tension System Checked		_____
21.	Inspect for Air Leaks		_____
22.	Inspect All Air Cooled Cooler Cores		_____
23.	Inspect and Clean Condensate Drain		_____
24.	Inspect Main and Fan Motors		_____
25.	Last Main Motor Grease	(Date)	____/____/____
		(Hours)	_____
26.	Last Fan Motor Grease	(Date)	____/____/____
		(Hours)	_____
27.	Cooling Water Inlet - Water Cooled	(Temp)	_____
		(Press)	_____
28.	Cooling Water Discharge - Water Cooled	(Temp)	_____
		(Press)	_____
29.	Safety Valve Installed and Operational		_____

Electrical Inspections (Check and Record the Following)



OK
Fixed/Changed/Cleaned During Visit
Still Requires Repair/Changing/Cleaning

30.	Voltage (Full Load)	A_____ B_____ C_____
		D_____ E_____ F_____
31.	Voltage (No Load)	A_____ B_____ C_____
		D_____ E_____ F_____
32.	Motor Amperage (Full Load)	T1/U_____ T2/V_____ T3/W_____
33.	Motor Amperage (No Load)	T1/U_____ T2/V_____ T3/W_____
34.	Voltage Drop Across Starter	L1_____ L2_____ L3_____
35.	Total Pkg Amps (Full Load)	L1_____ L2_____ L3_____
36.	Motor Nameplate Data	(HP/kW)_____
		RPM_____ V_____ A_____
37.	Inspect Contactors	_____
38.	Check Electrical Connections	_____
39.	HAT Operating Temp (°F / °C)	_____

Diagnostics Inspections (Check and Record the Following)

FLUID

40.	Coolant Type		_____
41.	Last Coolant Change	(Date)	____/____/____
		(Hours)	_____
42.	Coolant Analysis Sample Taken		**Every 2000 hr or 1 year** (Whichever is 1st)
43.	Condensate Analysis (Optional)		_____

VIBRATION

IR30 Shock Pulse Readings — (One Stage): MBR, MR1, MR2; (Two Stage): LPM1, LPM2, HPM1, HPM2

		MBR	MR1	MR2	LPM1	LPM2	HPM1	HPM2
44.	Loaded (dBm)							
45.	Loaded (dBc)							
	Loaded (dBi)							

AIR QUALITY (Optional, Use Only if Suspected Air Quality Issues)

46. Test Via Coupon (Metallic Strips) _____
47. Test OnGuard 2000 Electronic Analysis _____

Start-up Checklist (ONLY for Initial Start-Up)

Date of Start-Up: _____ / _____ / _____

		YES	NO
1.	Paint Finish Acceptable		
2.	Missing Electrical or Parts		
3.	Damaged Metal / Cover		
4.	Chemical / High Dust Area?		
5.	Unit Outdoors		
6.	If Outdoors, MOD Included?		
7.	Other _____		
8.	Other _____		
9.	Other _____		
10.	Does Customer Have Adequate Spare Parts? If NO, enter spare parts recommendation below.		
	Is there any additional maintenance needed?		
	If yes, is it urgent?		

RECOMMENDATIONS

_____
_____
_____

Inspected By : _____ Cert. # _____
(Serviceman's Signature)

Reviewed By : _____
(Customer's Signature)

_____
(Customer's Name/Title (Printed))

PackageCare

Keep original with machine history, copy to customer. Start-up/Inspection sheets required for warranty processing.

July 2008
80440571 Rev D

Ingersoll Rand
Industrial Technologies

COMPRESSOR DATA SHEET

Rotary Screw Compressor

	MODEL DATA - FOR COMPRESSED AIR		
1	Manufacturer: **Ingersoll Rand**		
2	Model Number: EPE300-2S	Date:	**July 2014**
	☑ Air - Cooled ☐ Water-Cooled ☑ Oil-Injected ☐ Oil-Free	Type:	**Screw**
		# of Stages	**2**
3*	Rated Capacity at Full Load Operationg Pressure [a,e]	**1476**	acfm [a,e]
4	Full Load Operating Pressure [b]	**125**	psig[b]
5	Maximum Full Flow Operating Pressure [c]	**125**	psig[c]
6	Drive Motor Nameplate Rating	**300**	hp
7	Drive Motor Nameplate Nominal Efficiency	**96.2**	percent
8	Fan Motor Nameplate Rating (if applicable)	**15**	hp
9	Fan Motor Nameplate Nominal Efficiency	**93.5**	percent
10*	Total Package Input Power at Zero Flow[e]	**54.1**	kW[e]
11	Total Package Input Power at Rated Capacity and Full Load Operating Pressure[d]	**236.6**	kW[e]
12*	Specific Package Input Power at Rated Capacity and Full Load Operating Pressure[e]	**16.0**	kW/100 cfm[e]

* For models that are tested in the CAGI Performance Verification Program, these are the items verified by the third party program administrator

Consult CAGI website for a list of participants in the third party vrification Program www.cagi.org

NOTES:

a. Measured at the discharge terminal point of the package in accordance with ISO 1217, Annex C; ACFM is actual cubic feet pe rminute at inlet
b. The operating pressure at which the Capacity (item 3) and Electrical Consumption item 11) were measured for this data sheet.
c. Maximum pressure attainable at full flow, usually the unload pressure setting for load/no load control or the maximum pressure attainable before capaxity control begins. May require additional power
d. Total package input power at other than reported operating points will vary with control strategy.
e. Tolerance is specified in ISO 1217, Annex C, as shown in table below.

Member CAGI Compressed Air & Gas Institute

Volume Flow Rate at specified conditions		Volume Flow Rate	Specific Energy Consumption	No Load / Zero Flow Power
m^3/min	ft^3/min	%	%	
Below 0.5	Below 15	+/-7	+/-8	
0.5 to 1.5	15 to 50	+/-6	+/-7	+/-10%
1.5 to 15	50 to 500	+/-5	+/-6	
Above 15	Above 500	+/-4	+/-5	

ROT 030
10/11 R8

This form was developed by the Compressed Air and Gas Institute fot the use of its members. CAGI has not independently verified the reported data

Ingersoll Rand
Industrial Technologies

HB HEATED BLOWER DESICCANT DRYER

HB150 - HB8000

Industrial Technologies
Davidson, NC 28036

DATE: 1-May-10
CANCELS: All Previous

ENGINEERING DATA - 60 HZ

	HB150	HB200	HB250	HB300	HB400	HB500
Inlet Capacity (scfm)	150	200	250	300	400	500
Desiccant per Tower (lbs)	118	172	199	235	302	374
Tower Diameter (inches)	10	12	14	14	16	16
Electrical	460/3/60	460/3/60	460/3/60	460/3/60	460/3/60	460/3/60
Blower HP	1	1	1.5	1.5	2	2
Heater Rating (kw)	3	4.5	6	6	9	12
Air In/Out Connections (inches)	1" FPT	1 ½" FPT	1 ½" FPT	1 ½" FPT	2" FPT	2" FPT
Width (inches)[1]	45	49	53	53	57	57
Depth (inches)[1]	33	37	38	38	48	48
Height (inches)[1]	66	67	68	68	83	83
Shipping Weight (lbs)[1]	874	1136	1379	1477	1897	2111

	HB600	HB800	HB1000	HB1200	HB1500	HB1800
Inlet Capacity (scfm)	600	800	1000	1200	1500	1800
Desiccant per Tower (lbs)	504	635	700	800	1100	1300
Tower Diameter (inches)	20	20	24	24	30	30
Electrical	460/3/60	460/3/60	460/3/60	460/3/60	460/3/60	460/3/60
Blower HP	5	5	7.5	7.5	15	15
Heater Rating (kw)	12	18	24	24	30	36
Air In/Out Connections (inches)	3" FPT	3" FPT	3" FPT	3" FPT	3" FPT	4" FLG
Width (inches)[1]	64	64	78	78	98	98
Depth (inches)[1]	59	59	59	59	65	68
Height (inches)[1]	88	88	80	80	92	92
Shipping Weight (lbs)[1]	2804	3198	3767	4091	5515	6113

	HB2100	HB3000	HB4000	HB5000	HB6000	HB8000
Inlet Capacity (scfm)	2100	3000	4000	5000	6000	8000
Desiccant per Tower (lbs)	1464	2113	2569	3600	4320	5760
Tower Diameter (inches)	30	36	42	48	54	60
Electrical	460/3/60	460/3/60	460/3/60	460/3/60	460/3/60	460/3/60
Blower HP	15	20	25	30	30	40
Heater Rating (kw)	45	60	80	100	125	175
Air In/Out Connections (inches)	4" FLG	6" FLG	6" FLG	6" FLG	6" FLG	8" FLG
Width (inches)[1]	98	120	126	138	150	168
Depth (inches)[1]	67	78	83	87	94	98
Height (inches)[1]	92	100	92	97	103	105
Shipping Weight (lbs)[1]	6911	5504	7029	7520	8800	8380

[1]Dimensions and Shipping Weight on HB1800 and larger are for the dryer only (filters ship loose). HB3000 and larger shipping weight does not include desiccant (shipped loose).

Capacity on all models is based on 100°F, 100 psig.
Maximum allowable inlet temperature is 120°F.
Maximum inlet pressure is 150 psig.
Safety valve setting is 165 psig.
NEMA cycle time is 8 hours.

Ingersoll Rand

MAY 1, 2014
INTER-OFFICE CORRESPONDENCE
MARKET RESEARCH STUDY RESULTS

To: New York Sales and Service Team Members

From: Charles Funk---Northeast Division Manager

Subject: Growth Opportunities

As you are all aware, over the last year we have worked with our partners in Corporate Marketing to sharpen our forecasting and identify future sales opportunities. I want to thank all of our field personnel for collecting information and data on not only existing IR equipment in the field, but that of our competitors as well. I would like to share some of the information that jumped out of the analysis.

In short, the equipment used by many manufacturers is getting very old and creaky. Even as various economic indicators seem to point towards an upward trend, industry research experts like McGraw-Hill ably note that domestic capital spending has remained anemic by historical standards, especially in the manufacturing sector. In contrast, as can be seen almost daily in the Wall Street Journal, companies have spent heavily on acquisitions/mergers and stock buybacks as a method for obtaining results for shareholders---rather than investing in upgrading capital equipment to more effectively compete with competitors. Frankly, I have seen a bit of this at some of our manufacturing facilities as well, so I certainly can attest to this fact.

Our data in NYS shows a vast majority of our compressors in service in the manufacturing sector are between 30 and 50 years old. For example, the Xerox toner plant in Webster still has a functioning 2000 HP unit in service. And they are far from the exception, but rather appear to be the norm. On the one hand I would like to congratulate our Service Team for providing excellent maintenance to enable this equipment to work daily. Additionally, I understand the profit margins for parts and service contracts. However, with our strong line-up of industry leading equipment, I believe we need to renew our focus on making sales presentations to customers to replace our (and our competitors!) very old equipment. We are in the process of developing sales programs to entice customers to abandon this old equipment in lieu of our new two-stage and VSD designed machines.

In concluding, I believe we need to move diligently and aggressively to convince customers to have this equipment upgraded as a method of improving their bottom line. I would encourage ALL of you to take advantage of our industry-best Corporate Air Audit/Analysis team as a first step in demonstrating to our customers the advantages of an equipment upgrade in improving their profitability and competitiveness. Lastly, you will be hearing more shortly from the Corporate Sales and Marketing team with new initiatives to help this market automate to our highly reliable, energy efficient equipment.

Ingersoll Rand

COMPRESSOR DATA SHEET

Rotary Screw Compressor

MODEL DATA - FOR COMPRESSED AIR			
1	Manufacturer: **Ingersoll-Rand**	Date: **December 2009**	
2	Model Number: **EPE300** ☐ Air-cooled ☒ Water-cooled ☒ Oil-injected ☐ Oil-free	# of Stages: **1** VALUE	UNIT
3	Rated Capacity at Full Load Operating Pressure [a, f]	**1363**	acfm [a,f]
4	Full Load Operating Pressure [b]	**125**	psig [b]
5	Maximum Full Flow Operating Pressure [c]	**135**	psig [c]
6	Drive Motor Nameplate Rating	**300**	hp
7	Drive Motor Nameplate Nominal Efficiency	**94.5**	percent
8	Fan Motor Nameplate Rating (if applicable)	**1**	hp
9	Fan Motor Nameplate Nominal Efficiency	**80**	percent
10	Total Package Input Power at Zero Flow [e]	**85.0**	kW [e]
11	Total Package Input Power at Rated Capacity and Full Load Operating Pressure [d]	**260.7**	kW [d]
12	Specific Package Input Power at Rated Capacity and Full Load Operating Pressure [g]	**19.1**	kW/100 cfm [g]

NOTES:

a. Measured at the discharge terminal point of the compressor package in accordance with the CAGI/PNEUROP PN2CPTC2 Test Code (Annex C to ISO 1217). ACFM is actual cubic feet per minute at inlet conditions.

b. The operating pressure at which the Capacity (Item 3) and Electrical Consumption (Item 10) were measured for this data sheet.

c. Maximum pressure attainable at full flow, usually the unload pressure setting for load/no load control or the maximum pressure attainable before capacity control begins. May require additional power.

d. Total package input power at other than reported operating points will vary with control strategy.

e. Tolerance is specified in the CAGI/PNEUROP PN2CPTC2 Test Code (Annex C to ISO 1217).

f, g. Tolerance is specified in the CAGI/PNEUROP PN2CPTC2 Test Code (Annex C to ISO 1217) as follows:

Volume Flow Rate at specified conditions		Volume Flow Rate [f]	Specific Energy Consumption [g]
m^3 / min	ft^3 / min	%	%
Below 0.5	Below 15	+/- 7	+/- 8
0.5 to 1.5	15 to 50	+/- 6	+/- 7
1.5 to 15	50 to 500	+/- 5	+/- 6
Above 15	Above 500	+/- 4	+/- 5

Member

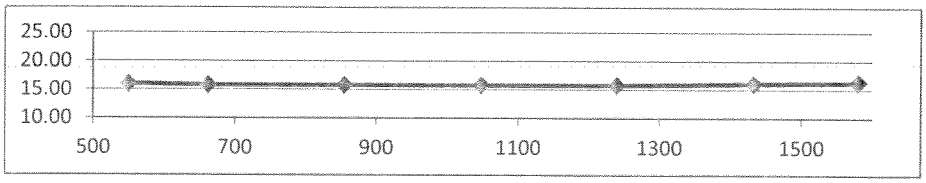
COMPRESSED AIR AND GAS INSTITUTE CAGI ®

This form was developed by the Compressed Air and Gas Institute for the use of its members. CAGI has not independently verified the reported data.

Ingersoll Rand

COMPRESSOR DATA SHEET

Rotary Screw Frequency Drive Compressor

MODEL DATA - FOR COMPRESSED AIR			
1	Manufacturer: **Ingersoll Rand**	**Rev C** Date: July 2014	
2	Model Number: R225NE ☐ Air - Cooled ☑ Water-Cooled ☑ Oil-Injected ☐ Oil-Free	# of Stages: 2 VALUE	UNIT
3	Full Load Operating Pressure [b]	**110**	psig[b]
4	Maximum Full Flow Operating Pressure	**110**	psig[c]
5	Drive Motor Nameplate Rating	**300**	hp
6	Drive Motor Nameplate Nominal Efficiencey	**95.4**	percent
7	Fan Motor Nameplate Rating (if applicable)	**1**	hp
8	Fan Motor Nameplate Nominal Efficiency	**90**	percent
9	Input Power (kW)	Capacity (acfm) [ae]	Specific Power (kW/100 acfm)[e]
	257	**1580**	16.27
	229.5	**1432.4**	16.02
	195.5	**1239.8**	15.77
	165.1	**1047.2**	15.77
	134.8	**854.6**	15.77
	104.5	**662**	15.79
	88	**550**	16.00
10	Total Package Input Power at Zero Flow [d]	**0**	kW[d]
11			

NOTES:

a. Measured at the discharge terminal point of the compressor in accorance with the Annex E to ISO 1217. acfm is actual cubic feet per minute at tinlet condition.

b. The Operating pressure at which the Capacity and Electrical Consumption were measured for this data sheet.

c. Maximum pressure attainable at full flow, usually the unload pressure setting for load/no load control or the maximum pressure attainable before capacity control begins. May require additional power.

d. No Load Power. Total package input power at other than reported operating points will vary with control strategy.

e. Tolerance is specified in the Annex E to ISO 1217 as follows:

Volume Flow Rate at specified conditions		Volume Flow Rate[f]	Specific Energy Consumption[g]
m³/min	ft³/min	%	%
Below 0.5	Below 15	±7	±8
0.5 to 1.5	15 to 50	±6	±7
1.5 to 15	50 to 500	±5	±6
Above 15	Above 500	±4	±5

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