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"IMPLEMENTACION DE MANTENIMIENTO PREDICTIVO PARA COMPRESORES CENTRIFUGOS EN UNA PLANTA DE VIDRIO"

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IMPLEMENTACION DE MANTENIMIENTO PREDICTIVO PARA COMPRESORES CENTRIFUGOS EN UNA PLANTA DE VIDRIO

Este trabajo es dedicado a Mariela, mis hijos Rodrigo y Cesar, mis hermanos y mi madre, a quienes agradezco por el sin fin de apoyos brindados en el desarrollo de mis estudios universitarios así como en la elaboración de este trabajo.

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En la actualidad, el crecimiento económico del país ha dinamizado al sector industrial, es así que, Owens Illinois Perú ha triplicado su capacidad de producción, esto es, actualmente cuanta con ocho líneas de producción en total.

La industria del vidrio es una actividad que por la tecnología alcanzada hasta hoy requiere un alto consumo de aire comprimido.

El mantenimiento predictivo es una herramienta muy poderosa para disminuir los tiempos de parada de los equipos en el sector productivo, por lo que su implementación es muy importante. Actualmente las plantas de fabricación de vidrio, dentro de una gama de equipos, cuentan con compresores centrífugos para la generación de aire comprimido, usan este tipo de equipos por la capacidad, eficiencia y calidad de aire que generan. La implementación de actividades predictivas en estos equipos es fundamental para la operación continua de estas plantas.

Owens Illinois Perú, como una empresa orientada a la mejora de la calidad y precio de su producto final, los envases de vidrio, está destinando recursos para la implementación de mantenimiento predictivo en sus equipos críticos. La implementación se ha iniciado en los compresores centrífugos, luego se extenderá a otros equipos como bombas de agua y ventiladores.

CAPITULO I

INTRODUCCION

La implementación del programa de mantenimiento predictivo para los compresores centrífugos, instalados en la planta Lurín de Owens Illinois Perú, es uno de los grandes retos que tiene la compañía para poder disminuir los tiempos perdidos a causa de la parada intempestiva de estos equipos; además, el programa servirá de base para que las otras plantas de la compañía puedan aplicar el mantenimiento predictivo con mucho éxito.

La planta Lurín actualmente cuenta con seis compresores centrífugos, la operatividad de estos equipos es fundamental para que la planta pueda producir envases de vidrio de manera continua y con la calidad esperada, por lo que el mantenimiento adecuado de estos equipos es primordial, con lo cual la compañía tendrá competitividad en el mercado.

Una de las justificaciones adicionales por lo que es muy importante el cuidado de estos equipos de generación de aire es el costo, un compresor C950 tiene un costo promedio de US$300 000, y la disponibilidad de un reemplazo, ya sea como equipo completo o repuestos, tiene tiempos de entrega que superan los tres meses.

1.1 ANTECEDENTES

Las plantas de vidrio actuales, requieren para su operación aire comprimido de alta y baja presión. El aire comprimido de baja presión se usa para el accionamiento de la mayoría de los mecanismos neumáticos, que permiten formar el envase y para el enfriamiento de la moldura. El aire comprimido de alta presión, es usado para pilotaje de válvulas y accionamiento de pistones que requieren altas prestaciones.

Los compresores centrífugos son usados en las plantas de vidrio porque el consumo de aire es relativamente plana; es decir, el consumo mínimo no es menor al 85% del consumo máximo.

La parada imprevista de los compresores causa pérdidas de producción debido a las parada de las maquinas de formación de envases y la demora en la estabilización de estas maquinas para lograr la eficiencia estándar. Por ejemplo, la parada de un compresor de baja por cinco minutos puede significar la parada de la máquina de formación por media hora y dos horas de eficiencia promedio de 70%, frente a una eficiencia estándar del 96%.

Actualmente la parada de compresores representa el 0.125% del tiempo de operación, esto significa una pérdida anual que bordea los US$70 000.00.

1.2 OBJETIVOS

El presente informe tiene por finalidad desarrollar un plan de mantenimiento predictivo para los compresores centrífugos de tres etapas, de una planta de vidrio, con el propósito de disminuir los tiempos de parada.

El plan de mantenimiento predictivo a desarrollar plantea la ejecución de las siguientes actividades:

- Análisis vibracional de los elementos rodantes
- Control de temperatura de aire en las tres etapas
- Tomografía de los empalmes eléctricos y bocinas de los impulsores y el motor eléctrico.
- Análisis de aceite
- Control de temperatura y presión de aceite
- Control de la señal de 4 a 20mA en la salida de los sensores de vibración, presión y temperatura.

Mediante el control de las variables indicadas líneas arriba se pretende disminuir drásticamente los tiempos perdidos.

1.3 ALCANCES

El informe está dirigido a la implementación de un plan de mantenimiento predictivo en compresores centrífugos de tres etapas, los cuales tienen incorporado sensores de vibración, temperatura y presión, cuyo registro será una vez por día, estará a cargo del mecánico de turno. El análisis vibracional para determinar los espectros de fallas se efectuara mensualmente, mediante un servicio externo.

Los análisis de aceite y termografías serán realizados por terceros, con una frecuencia trimestral.

1.4 JUSTIFICACION

La planta cuenta con seis compresores centrífugos y la parada de estos equipos afecta significativamente la producción y la seguridad de lo equipos de formación de envases. Actualmente los estos equipos tienen paradas imprevistas que estimamos que pueden ser disminuidos considerablemente con la implementación de un plan de mantenimiento predictivo.

1.5 LIMITACIONES

Actualmente tenemos registros de algunos parámetros, tales como presión y temperatura del aire, presión y temperatura de aceite, vacio de la admisión, vibración de los impulsores; más no de todo lo que se pretende controlar con la implementación del mantenimiento predictivo, esto conlleva a recurrir a las recomendaciones del fabricante para determinar los límites de cada parámetro.

CAPITULO II

DESCRIPCION DE LA PLANTA Y USOS DEL AIRE COMPRIMIDO

2.1 Descripción de la planta

Owens Illinois Perú, es una compañía americana que tiene por finalidad la fabricación y distribución de envases de vidrio. La compañía ingresa al país mediante la compra de la planta Callao en 1998 y en el año 2007 construye la planta de Lurín. Actualmente la compañía tiene dos plantas en el Perú, con un horno en la planta de Callao y 2 hornos en la planta de Lurín; Horno A en Callao y Hornos B y C en Lurín, la capacidad de cada una de ellas es de 250 MTN/día. La construcción del tercer horno C, se concluyó el mes de setiembre del 2010, con lo cual la compañía produce un promedio de 750 MTN/día. Ambas plantas utilizan gas natural para la fundición del vidrio, en una cantidad promedio de 30000 m3/día por horno, es decir un total de 90000 m3/día.

Los envases que se fabrican van desde las botellas para gaseosas, cervezas, rehidratantes hasta frascos para alimentos como espárragos, alcachofas, etc. La planta Lurín también produce vidrio de distintos colores entre ellos ámbar, verde y Flint.

2.2 Usos del aire comprimido

El aire comprimido es un recurso principal en una fábrica de vidrio, porque la mayoría de los equipos son neumáticos y el enfriamiento de la moldura también se realiza con aire comprimido. La planta usa dos niveles de presión en aire comprimido. Aire de 60 psi para mover mecanismos, enfriar moldura y servicios de limpieza. Aire de 80 psi para pilotaje de válvulas, pistones, etc. En el nivel de 60 psi hay una capacidad instalada de 18000scfm, compuesto por cuatro compresores centrífugos IR de 4500scfm, y en la de 80 psi es de 5000scfm, compuesto por dos compresores centrífugos IR de 2500scfm, estas cantidades contemplan el Horno B y el Horno C.

La calidad de aire requerido para la fabricación de envases de vidrio es muy exigente, por lo que cada compresor cuenta con un sistema de secado y filtración de partículas menores a 5um, la humedad se disminuye hasta por debajo del 5%. Es importante indicar que el aire generado por los compresores centrífugos es libre de aceite.

CAPITULO III

GENERALIDADES SOBRE MANTENIMIENTO DE COMPRESORES

Este capítulo dedicaremos para incorporar el fundamento teórico referente al mantenimiento de equipos, conceptos de compresores, sensores, etc.

3.1 Generalidades sobre Mantenimiento

El mantenimiento es un proceso que implica la interacción de tres entes: Equipamiento, Recursos Humanos y la Gestión o Administración, el cual se conoce como la trilogía del mantenimiento, así como se indica el gráfico 3.1.

Es importante indicar en este punto también el ciclo de vida de un equipo, el cual se inicia con la etapa de Mortalidad Infantil (MI), que es cuando el equipo nuevo entra en operación y esta propenso a fallas debido a posibles problemas de ensamble, ajustes iniciales, problemas de diseño, etc. Luego viene la etapa de vida útil estadísticamente normal (VU), que es donde el equipo ofrece la mayor confiabilidad, el mantenimiento adecuado debe maximizar este periodo. Finalmente viene la etapa de desgaste (D), que es un proceso en el cual el equipo va variar significativamente sus parámetros de operación, tales como temperatura, vibración, presión, ajustes, etc, acercándose cada vez más a la zona de riesgo. Estas tres etapas lo podemos presentar en una grafica al que se llama la "Curva de la Bañera", el cual se presenta el gráfico 3.2.

3.1.1 Tipos de Mantenimiento

Los tipos de mantenimiento que se van definir en esta parte del informe son: Mantenimiento Correctivo, Preventivo, Predictivo, Proactivo, TPM y RCM.

3.1.1.1 Mantenimiento Correctivo

El mantenimiento correctivo consiste en intervenir un equipo cuando esta ya presenta un problema que no le permite seguir operando, es decir cuando el equipo presenta una falla funcional, en la mayoría de los casos, antes de cumplir con su ciclo de vida.

Es el mantenimiento con el que las industrias del pasado encaraban los problemas de sus equipos. Este tipo de mantenimiento actualmente se reduce a su mínima expresión porque represente un costo elevado, que repercute en el precio final del producto, como tal, afecta la competitividad.

3.1.1.2 Mantenimiento Preventivo

El mantenimiento preventivo nace como la necesidad de planificar los trabajos de mantenimiento de acuerdo a la criticidad de los equipos, para realizar cambios de partes, lubricaciones, etc.; así prevenir que el equipo falle prematuramente. La programación de las tareas se realiza con frecuencias, tales que, estas, deben ser menores al tiempo, entre la falla potencial y la falla funcional o intervalo PF, así como se muestra en el gráfico 3.3.

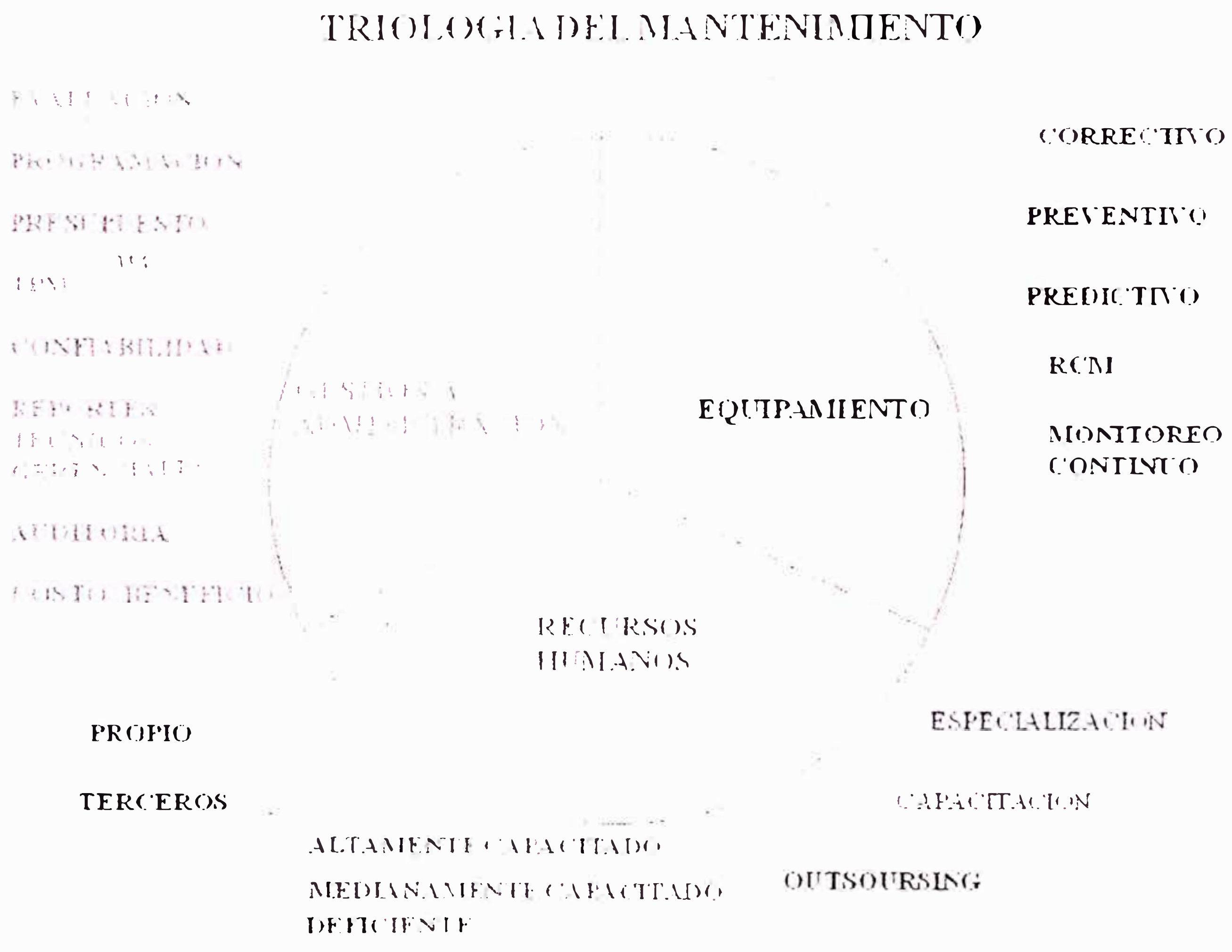
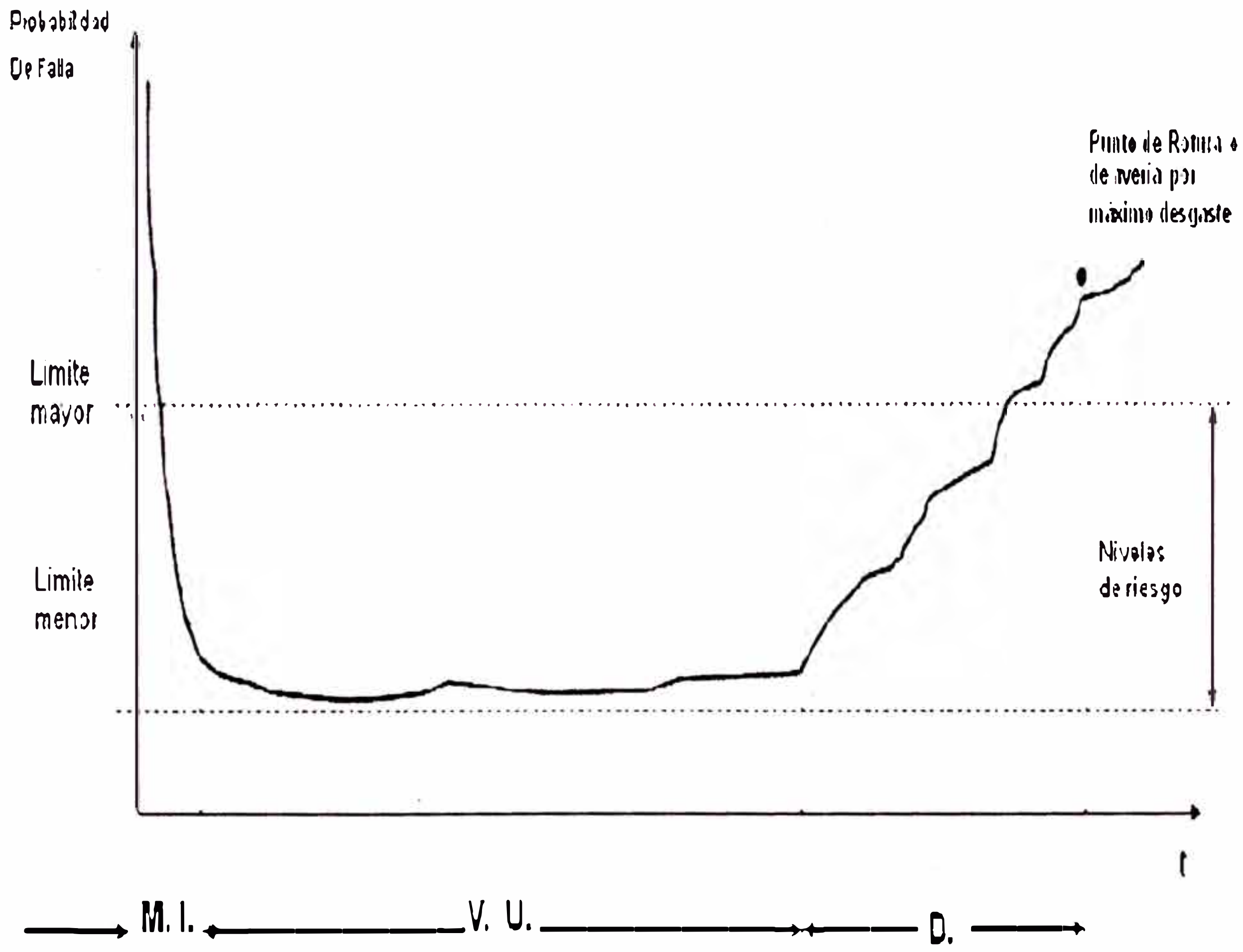


Gráfico 3.1. Trilogía del mantenimiento

EVOLUCION DE LA VIDA UTIL



M.I. = Etapa de Mortalidad Infantil
V. U. = Etapa de Vida Útil estadísticamente normal
D. = Etapa de Vida Util en Desgaste o zona de riesgo

Gráfico 3.2 Evolución de la vida útil de una maquina

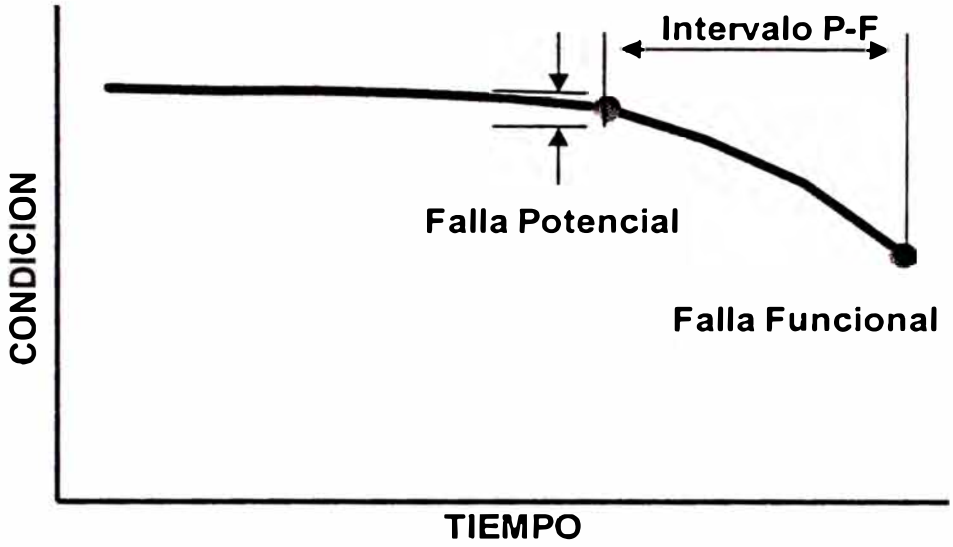


Gráfico 3.3 Intervalo PF de un equipo

3.1.1.3 Mantenimiento Predictivo

El mantenimiento predictivo es quizás una de las herramientas más efectivas en el mantenimiento, porque usa herramientas de última tecnología para predecir las fallas; es decir nos permite identificar fallas incipientes. El mantenimiento predictivo consiste en realizar: Análisis vibracional, termografias, análisis de aceites, ultrasonidos, análisis de gases de combustión, control de temperaturas, control de presiones, medición de salidas de corriente en sensores, etc. Mediante la medición de los parámetros indicados, en el tiempo, podemos ver tendencias que nos permita predecir fallas incipientes.

3.1.1.3.1 Análisis Vibracional

El interés de las Vibraciones Mecánicas llega al Mantenimiento Industrial de la mano del Mantenimiento Preventivo y Predictivo, con el interés de alerta que significa un elemento vibrante en una Maquina, y la necesaria prevención de las fallas que traen las vibraciones a mediano plazo.

El interés principal para el mantenimiento deberá ser la identificación de las amplitudes predominantes de las vibraciones detectadas en el elemento o máquina, la determinación de las causas de la vibración, y la corrección del problema que ellas representan. Las consecuencias de las vibraciones mecánicas son:

- El aumento de los esfuerzos y las tensiones.
- Pérdidas de energía, desgaste de materiales.
- Daños por fatiga de los materiales.
- Ruidos molestos en el ambiente laboral, etc.

Los parámetros a manejar dentro de las vibraciones son:

- Frecuencia: Es el tiempo necesario para completar un ciclo vibratorio. En los estudios de vibración se usan los CPM (ciclos por segundo) o Hz.
- Desplazamiento: Es la distancia total que describe el elemento vibrante, desde un extremo al otro de su movimiento.
- Velocidad y Aceleración: Como valor relacional de los anteriores.
- Dirección: Las vibraciones pueden producirse en 3 direcciones lineales y 3 rotacionales

Las razones más habituales por las que una máquina o elemento de la misma puede llegar a vibrar, son:

- Desequilibrios
- Desalineaciones
- Ejes Curvados
- Defectos en Cojinetes
- Defectos en Engranajes
- Correas de Accionamiento Excéntricas
- Resonancias
- Pernos con Apriete Insuficiente
- Grietas en Ejes
- Rozamientos por Fricción
- Rotores Excéntricos
- Barras de Rotores Rotas

3.1.1.3.2 Análisis de Aceites

Tiempos atrás, el análisis de aceites se usaba principalmente para detectar la condición del lubricante. Las técnicas modernas de análisis de aceites que se usan hoy en día no solo son para evaluar la condición del lubricante sino para evaluar también la condición de la maquinaria.

Debido a los ambientes industriales y a los diferentes procesos productivos pueden existir diversos tipos de desgaste dentro de las piezas de la maquinaria de la planta.

Sin embargo, se pueden distinguir claramente unas pocas fuentes primarias de desgaste. Los problemas relacionados con el tipo de aceite, su degradación, por contaminación o por problemas en la condición de la máquina, por ejemplo si esta desbalanceada, sobrecalentada, etc.

Entre los tipos de desgaste tenemos:

- **Desgaste abrasivo:** Es el resultado de partículas pesadas entrando en contacto con los componentes internos, tales partículas incluyen al polvo y diversos metales. Si se logra implementar un proceso de filtrado, es posible reducir la abrasión, que al final asegurara que los sellos como los respiraderos trabajen bien.

- **Desgaste adhesivo:** ocurre cuando dos superficies metálicas entran en contacto, permitiendo que se desprendan partículas de sus partes. Lubricación insuficiente o contaminada causa normalmente esta condición. Si se logra asegurar que el grado de viscosidad apropiado se mantenga, el desgaste adhesivo se reduce. El reducir contaminación en el aceite también ayuda a eliminarlo.

- **Cavitación:** ocurre cuando aire a presión o burbujas colapsan, esto forma que las superficies se piquen o se fisuren. La cavitación se reduce si se controla la característica espumosa del aceite con un aditivo especial.

- **Desgaste corrosivo:** es causado por una reacción química que mueve material de la superficie de un componente. Y generalmente es un resultado directo de la oxidación. Corrientes eléctricas aleatorias producen corrosión o picaduras en la superficie. También la presencia de agua o de productos de la combustión fomenta el desgaste corrosivo.

- **Desgaste por fatiga:** se produce cuando se fisura una superficie, lo que permite que se generen partículas de desgaste. El utilizar una lubricación adecuada, buenos equipos de filtrado y un buen mantenimiento reducen notablemente el desgaste dentro de los equipos. Ciertos problemas potenciales pueden ser identificados con otras técnicas como: vibraciones, termografía y análisis de motores. En muchos casos, el análisis de aceite logra detectar problemas antes de que otras técnicas lo hagan.

Al implementar un programa de análisis de aceite, es importante seleccionar las pruebas que permitan detectar anormalidades en el aceite. Entre las pruebas que se utilizan para detectar el desgaste tenemos:

- **Viscosidad:** Es la propiedad más crítica de cualquier aceite, es una medida de la resistencia del aceite a fluir. La viscosidad esta directamente afectada por la temperatura y presión del sistema. Conforme aumenta la temperatura, la viscosidad decrece, conforme la presión crece la viscosidad decrece. Cualquier cambio en la viscosidad (aumento / disminución) indica contaminación o degradación.

Tabla 3.1 Presencia de Metales y su posible origen en el análisis de aceites

Metal	Posible Origen
Aluminio	Cojinetes, blocks, roles, clutch, pistones, bombas, rotores, lavadoras
Cromo	Roles, bombas, anillos
Cobre	Roles, cojinetes, clutch, pistones, bombas
Hierro	Roles, blocks, cilindros, discos, cajas de engranajes, pistones, bombas, ejes
Níquel	Roles, ejes, válvulas
Plata	Roles, cojinetes

- **Número de ácido total (TAN):** Monitorea el nivel de ácidos orgánicos producidos por la oxidación del aceite. Todos los sistemas, en el cual existe el periodo de drenaje es prolongado o donde existe una potencial contaminación acídica deben ser monitoreados usando el TAN.

- **Contenido de Agua:** El contenido de agua debe ser monitoreado, no importa si el aceite es acuoso o de otro tipo. Exceso de agua reducirá la viscosidad del aceite, lo que lo inhabilita para lubricar apropiadamente. Insuficiente cantidad de agua en un aceite basado en agua puede permitir que el aceite pierda su capacidad de resistencia a la llama.

- **Características espumosas:** Se realizan a diferentes temperaturas, con esto se determina la tendencia espumosa y su estabilidad. La tendencia del aceite a formar espuma, le imposibilita a lubricar adecuadamente, lo que puede provocar una falla mecánica.

- **Gravedad específica:** Es una tasa de la masa del volumen de un material a la del agua. Aumentos en este índice indican la presencia de contaminantes o materiales oxidantes.

- **Análisis espectrométrico:** Es la tecnología más común para seguir la tendencia de concentraciones de metales. Esta tecnología solo monitorea las partículas más pequeñas en partes por millón. Cualquier partícula de mayor tamaño no es reportada o detectada.

- **Conteo de partículas:** Da seguimiento a la cantidad de partículas presentes en la muestra, no diferencia su composición o su material. Se utiliza para conocer la cantidad de partículas globales en la muestra solamente.

- **Ferrografía de lectura directa:** Monitorea y lleva la tendencia de la concentración relativa de partículas de desgaste ferrosas. Y provee una tasa de la cantidad de esas partículas, se usa en sistemas o equipos que generan muchas partículas.

- **Ferrografia analítica:** Usa el análisis microscópico, para detectar la composición del material presente. Esta tecnología diferencia el tipo de material y determina su fuente. Es usada para determinar las características de la maquinaria al evaluar el tamaño de la partícula, tipo, concentración, distribución y morfología. Esta información es vital para determinar la fuente y la posible solución al problema. En la formación de partículas de desgaste se notan 3 fases:

- **Desgaste inicial:** Ocurre cuando se arranca por primera vez una maquinaria. Y se generan muchas partículas de desgaste, las cuales serán removidas después de dos cambios de aceite normalmente.

- **Desgaste normal:** Ocurre después de la etapa inicial, durante esta etapa la maquinaria se estabiliza, la proporción de partículas se incrementa con el uso y se reduce al cambiársele el aceite.

- **Desgaste anormal:** Ocurre como resultado de fallas en la lubricación o problemas en la maquinaria. Durante esta etapa las partículas de desgaste aumentan significativamente.

Cuando el análisis de aceite se usa rutinariamente, es posible establecer un patrón para cada pieza de maquinaria. Conforme los datos de los análisis se desvían del patrón original se identifican patrones de desgaste anormales. Y se implementa la acción correctiva.

Una combinación de conocimiento en el análisis de aceites, equipo de análisis y bases de datos aseguran la mejor protección para su sistema hidráulico.

3.1.1.3.3 Termografía

La termografía es un método de inspección de equipos eléctricos y mecánicos mediante la obtención de imágenes de la distribución de su temperatura. Este método de inspección se basa en que, la mayoría de los componentes de un sistema muestran un incremento de temperatura cuando están en mal funcionamiento. El incremento de temperatura en un circuito eléctrico podría deberse a una mala conexión o problemas de lubricación en un rodamiento en caso de equipos mecánicos. Observando el comportamiento térmico de los componentes pueden detectarse defectos y evaluar su severidad.

La energía procedente de un objeto caliente se emite a distintos niveles en el espectro electromagnético. En la mayoría de las aplicaciones industriales se utiliza la energía radiada en el espectro infrarrojo para medir la temperatura del objeto. El gráfico 3.4 muestra los diferentes espectros electromagnéticos donde se emite energía incluyendo Rayos X, Ultra Violeta, Infrarrojo y Radio. Se emite en forma de onda y viaja a la velocidad de la luz. La única diferencia entre ellas es su longitud de onda que está relacionada con la frecuencia. El ojo humano responde a la luz visible en el rango de 0.4 a 0.75 micras. La gran mayoría de la medida de temperatura infrarroja se realiza en el rango de 0.2 a 20 micras. Aunque las emisiones no pueden detectarse por una cámara normal, la cámara térmica puede enfocar esta energía a través de un sistema óptico hacia el detector de forma similar a la luz visible.

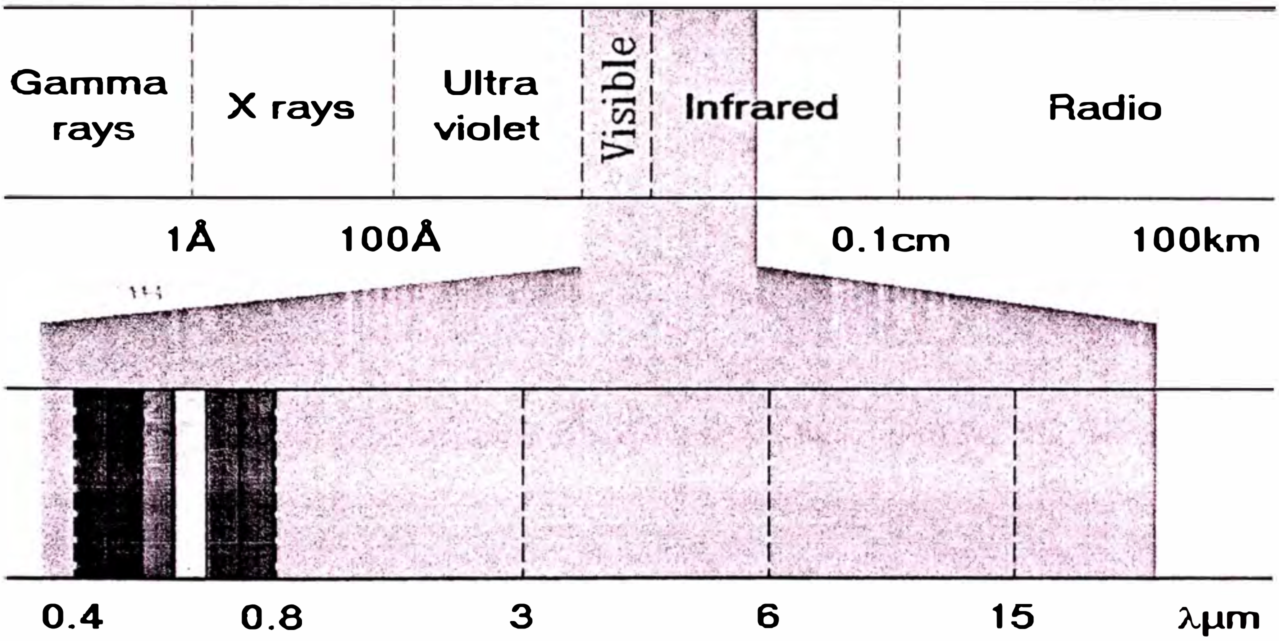


Gráfico 3.4. La región Infrarroja del espectro electromagnético

El detector convierte la energía infrarroja en tensión eléctrica, que después de amplificarse y de un complejo procesamiento de la señal, se utiliza para construir una imagen térmica en el visor del operador montado en la cámara de termografía.

El gráfico 3.5 muestra la energía emitida por un objeto a diferentes temperaturas. Como puede observarse a mayor temperatura mayor es el pico de energía. La longitud de onda a la que ocurre el pico de energía se vuelve progresivamente más corta a medida que se incrementa la temperatura.

A bajas temperaturas el pico de energía se produce en longitud de onda larga. La cantidad de energía radiada por un objeto depende de su temperatura y de su emisividad.

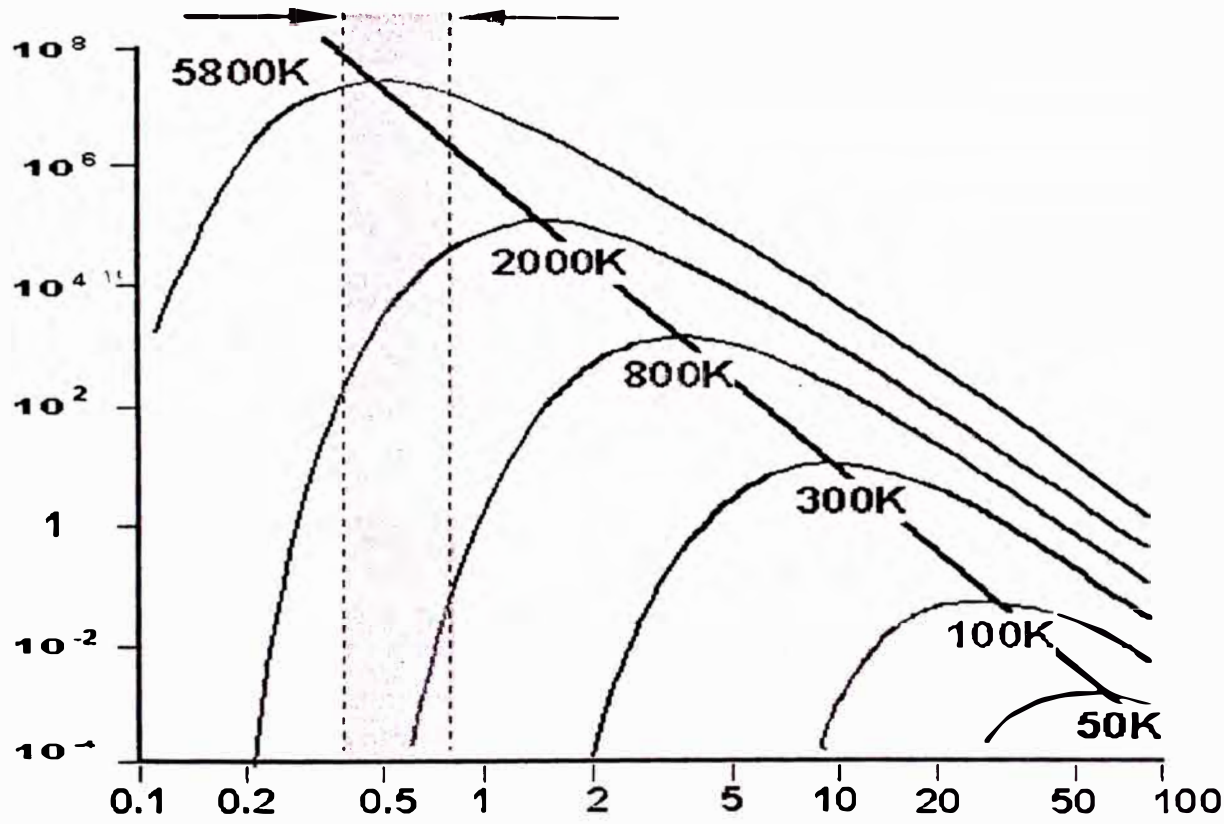


Gráfico 3.5. Energía Infrarroja y Distribución en el espectro electromagnético

Un objeto que emite el máximo posible de energía para su temperatura se conoce como Cuerpo Negro. En la práctica no hay emisores perfectos y las superficies suelen emitir menos energía que un Cuerpo Negro.

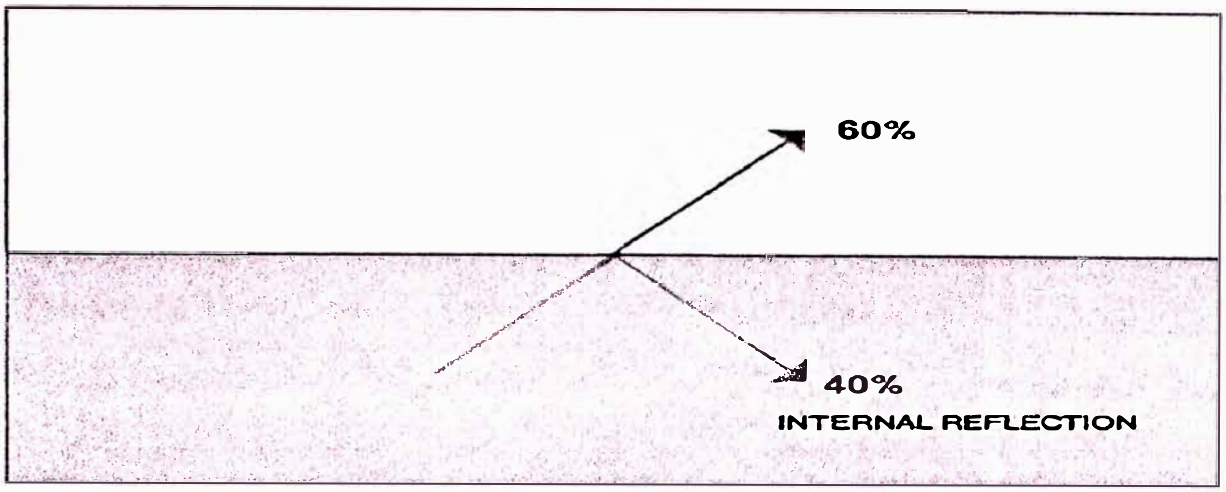


Gráfico 3.6. La energía Infrarroja reflejada en una superficie

El gráfico 3.6 muestra porque los objetos no son emisores perfectos de energía infrarroja. La energía se mueve hacia la superficie pero cierta cantidad se refleja hacia el interior y nunca sale. En este ejemplo se observa que sólo se emite el 60% de la energía disponible. La emisividad de un objeto es el cociente entre la energía emitida respecto de la emitida si fuera un Cuerpo Negro.

Así la emisividad se expresa como:

Emisividad = (Radiación emitida por un objeto a temperatura T)/(Radiación emitida por un Cuerpo Negro a temperatura T). La Emisividad es por lo tanto una expresión de la capacidad de un objeto a emitir energía infrarroja.

Dos leyes físicas nos permiten cuantificar la energía radiante, mediante las siguientes relaciones:

a. Ley de Stephan Boltzman: $W=\varepsilon\sigma T^4$

b. Ley de desplazamiento de Wien: $\lambda_m=b/T$

Donde:

W: Potencia radiante por unidad de área [W/m^2]

ε: Emisividad

σ: Constante de Stephan Botlzman=$5.673x10^{-12}W°Kcm^{-2}$

T: Temperatura absoluta del cuerpo [°K]

λ_m: Longitud de onda de radiación máxima (μ)

b: Constante de desplazamiento de Wein=2.897 μ°K

Los valores de emisividad varían de un material a otro. Los metales con una superficie áspera u oxidada tienen una mayor emisividad que una superficie pulida. Los valores de este parámetro para distintos metales se muestra en la tabla 3.2.

Tabla 3.2. Emisividad de algunos materiales

Material	Emisividad
Acero brillante	0.18
Acero oxidado	0.85
Latón brillante	0.10
Latón oxidado	0.61
Aluminio brillante	0.05
Aluminio oxidado	0.30
Cemento	0.90
Asfalto	0.90
Ladrillo Rojo	0.93
Grafito	0.85
Cobre oxidado	0.73

3.1.1.4 Mantenimiento Proactivo

El mantenimiento Proactivo consiste en el análisis de causa-efecto de un problema determinado en un equipo; es decir no se queda en el simple hecho de prevenir o predecir fallas sino analizar la razón por el cual se están presentando estos problemas, así entender y en el mejor de los casos eliminar la causa del problema. Es importante indicar que para identificar los problemas que más afectan a una planta se pueden usar el método de Ishikawa o Pareto.

3.1.1.5 Mantenimiento Productivo Total

El mantenimiento Productivo Total o TPM tiene por finalidad cuidar la efectividad global de un equipo, sistema o planta. La efectividad total, O.E.E., es función de la Confiabilidad y eficiencia del equipo, y la calidad de producto que entrega este equipo, sistema o planta. Para que una planta sea de clase mundial es necesario que la efectividad global sea superior al 85%.

$$\text{O.E.E.} = \text{Confiabilidad} \times \text{Eficiencia} \times \text{Calidad} > 85\%$$

3.1.1.6 Mantenimiento Centrado en Confiabilidad

El mantenimiento centrado en confiabilidad permite mejorar las funciones de un activo de una planta. El RCM, es una técnica que permite aplicar adecuadamente un tipo de mantenimiento ya sea el mantenimiento preventivo o predictivo. El RCM usa las siguientes siete preguntas:

1. ¿Cuáles son las funciones deseadas para el equipo que se está analizando?
2. ¿Cuáles son los estados de falla (fallas funcionales) asociados con estas funciones?
3. ¿Cuáles son las posibles causas de cada uno de estos estados de falla?
4. ¿Cuáles son los efectos de cada una de estas fallas?
5. ¿Cuál es la consecuencia de cada falla?
6. ¿Qué puede hacerse para predecir o prevenir la falla?
7. ¿Qué hacer si no puede encontrarse una tarea predictiva o preventiva adecuada?

3.2 Generalidades sobre compresores

Los compresores son equipos mecánicos que nos permiten el uso de fluidos compresibles a distintas presiones y caudales. El incremento de presiones altas y la operación eficiente, se logra con una configuración de múltiples etapas, los cuales incluyen intercambiadores de calor entre las mismas. Para un compresor de múltiples etapas la potencia estará dado por el grafico 3.7, cuya relación matemática es representada por la fórmula 3.1, de esta fórmula podemos establecer una grafica de la potencia, grafico 3.8, en función del número de etapas de un compresor, en el cual se ve que, a medida que se incrementa el número de etapas el ahorro por disminución de potencia decrece.

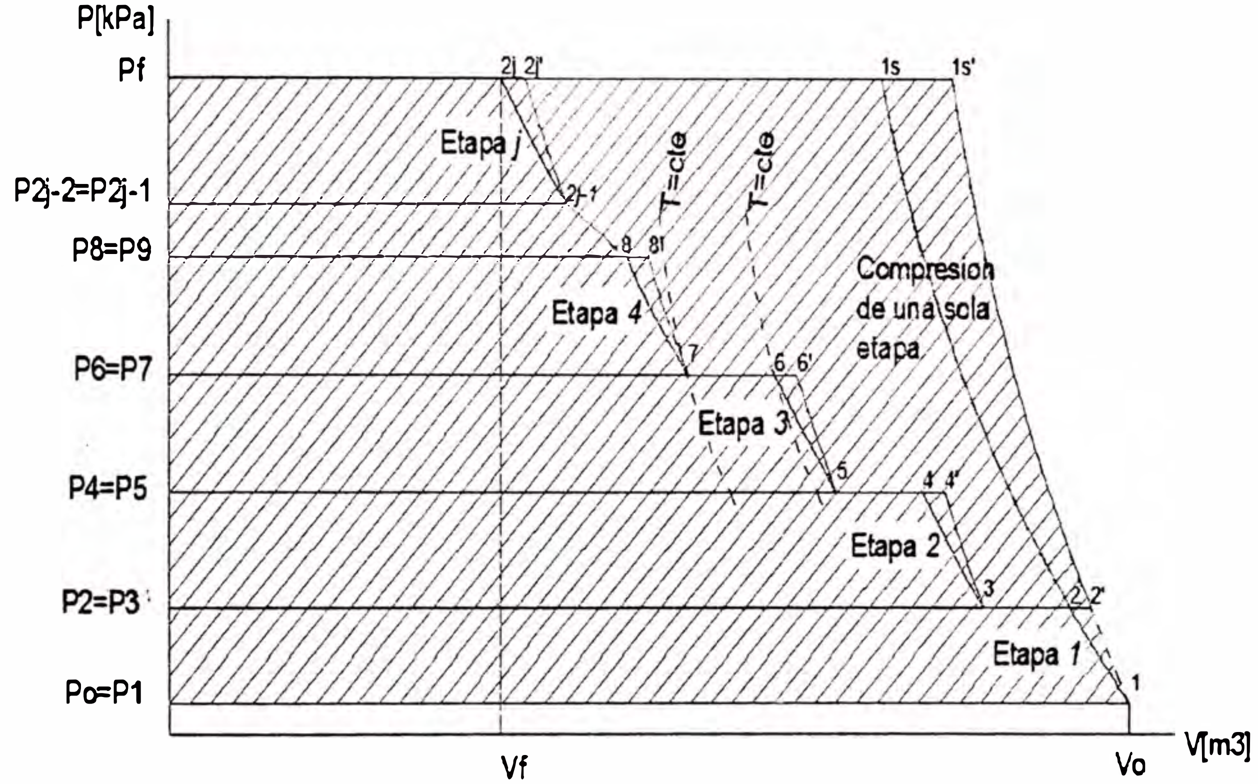


Grafico 3.7. Diagrama PV de un compresor de múltiples etapas

$$P = mR\left(\frac{n}{n-1}\right)\left[j\left(\prod_{i=1}^{j}\frac{T_{2i-1}}{\eta_i}\right)^{1/j}\left(\frac{p_f}{p_o}\right)^{(n-1)/(nj)} - \sum_{i=1}^{j}\frac{T_{2i-1}}{\eta_i}\right]$$

Formula 3.1 Relación de potencia de un compresor de múltiples etapas.

Donde:

P: Potencia necesaria para comprimir el aire en *kW*. La potencia total incorpora las perdidas mecánicas.

m: Masa de aire en *kg/s*

R: constante del aire 0.287 *kJ/kg.K*

j: Número total de etapas

T1, T3,..., T(2j-1): Temperatura en *K*, a la entrada de cada etapa

η_i: Eficiencia politrópica de la etapa *i*

n: Constante politrópica del aire, adimensional

p_f: Presión de descarga del compresor en *kPa*

p_0: Presión atmosférica al ingreso de la primera etapa, en *kPa*.

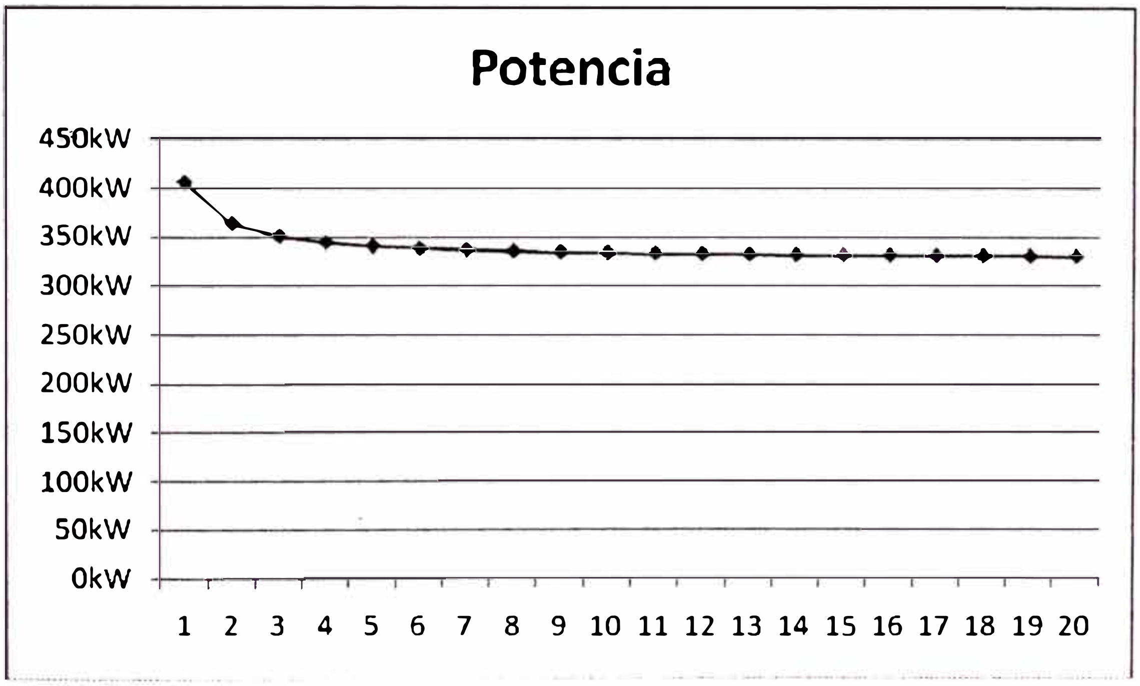


Grafico 3.8. Potencia simulada para un compresor de 550kPa,2.12kg/s.

3.2.1 Tipos de compresores

Existen dos grandes grupos de compresores, los volumétricos y los dinámicos, los primeros comprimen el fluido variando el volumen de la cavidad que los contiene, mientras que los dinámicos, comprimen mediante el incremento de la energía cinética y su posterior difusión. La clasificación para los compresores los podemos mostrar de la siguiente manera:

- Compresores
  - Volumétricos
    - Alternativos
    - Anillo Líquido
    - Lóbulos
    - Tornillo
  - Dinámicos
    - Centrífugos
    - Axiales

3.2.1.1 Compresores Volumétricos

Los compresores volumétricos son aquellas que varían el volumen de la cavidad que contiene al fluido, logrando de esta forma que el volumen disminuya y consecuentemente se incremente la presión, porque se acorta la distancia entre las moléculas. A continuación definiremos algunos de los compresores volumétricos mas usados en la actualidad.

3.2.1.1.1 Compresores Alternativos

Los compresores alternativo también son llamados reciprocantes o de embolo, cuyo movimiento del pistón, desde el punto muerto inferior al punto muerto superior permite comprimir el fluido. El sistema se describe en el grafico 3.9

3.2.1.1.2 Compresores tipo tornillo

Los compresores tipo tornillo son equipos que permiten la compresión de fluidos por la acción de los dientes de los tornillos uno hembra y otro macho que lo que hacen es disminuir el volumen de la cavidad.

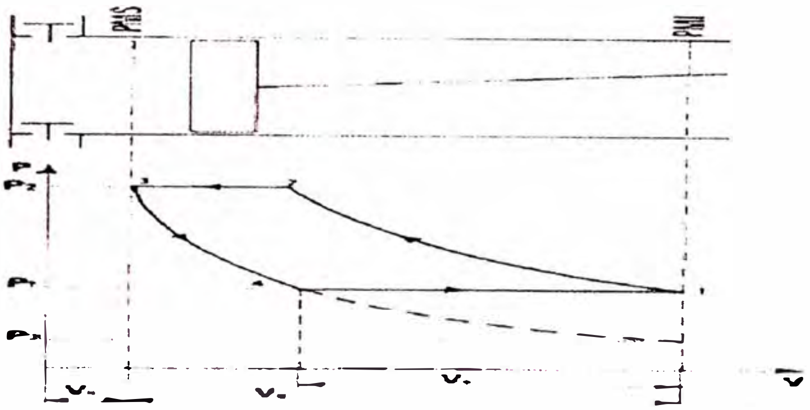


Grafico 3.9 Ciclo de compresión de un compresor alternativo

3.2.1.2 Compresores Dinámicos

3.2.1.2.1 Compresores Centrífugos

Los compresores centrífugos son turbomáquinas que incrementan la presión mediante el aumento de la energía cinética del fluido debido a la gran fuerza centrífuga de los impulsores sobre este, y su posterior paso por un difusor, el cual se muestra en la Gráfico 3.10. La velocidad angular de estos equipos esta en el orden de los 30000 rpm.

3.2.1.2.2 Compresores Axiales

Los compresores axiales son similares a los compresores centrífugos pero una de las características de estos equipos es que son usados para comprimir flujos mucho más elevados que los centrífugos, además el número de etapas es significativamente superior para alcanzar la misma presión de descarga. Uno de los usos más comunes de estos equipos se da en las turbinas de propulsión o de generación de energía eléctrica, conocido como el ciclo Joule-Brayton.

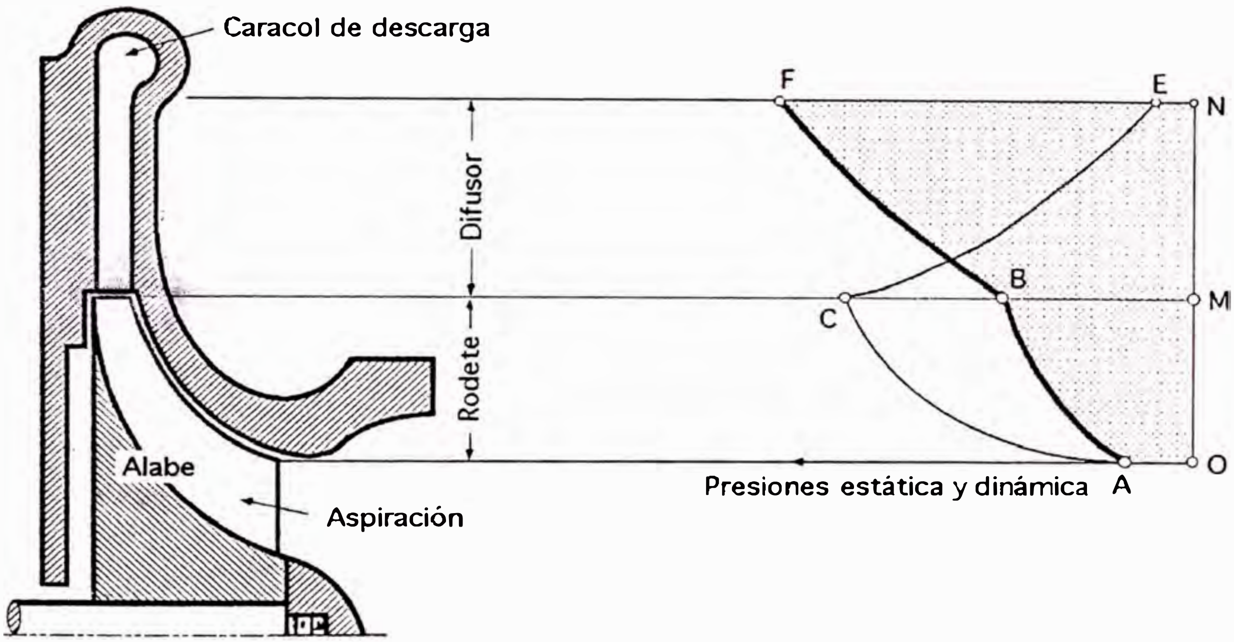


Grafico 3.10 Distribución de presión estática y dinámica a través de un compresor centrifugo.

CAPITULO IV

TIEMPOS DE PARADA DE LOS COMPRESORES

4.1 Tiempos perdidos

Definimos como tiempo de parada del compresor aquel evento que genere la detención intempestiva del equipo y cuya consecuencia es la perdida de producción, avería de equipos de moldura, etc.

Los tiempos de parada de compresores, en horas, en la planta Lurín se ajustan según la tabla 4.1.

Tabla 4.1. Tiempos perdidos por cada línea de producción

Compresor	**Tiempos de parada por Lineas de Produccion [horas]**				
	B1	**B2**	**B3**	**C1**	**C3**
1	2	2	2	3	3
2	0	0	0	0	0
3	2	2	2	2	2
5	1	1	1	1	1
6	10	1	1	8	8
Total/Linea	**15**	**6**	**6**	**14**	**14**

Según el cuadro podemos deducir rápidamente que los compresores que mayores paradas han registrado son el equipo 1 y el equipo 6, el primero de baja presión y el segundo de alta presión. Las causas de los problemas del primer equipo están ligadas al actuador de admisión y sensores de presión. El otro equipo tiene problemas con el arrancador, que ha tenido un tiempo muy prolongado en la detección de la causa del problema, debido a que el equipo aun esta en garantía.

La parada de los compresores en lo que va de estos tres años desde la instalación, ha tenido que ver básicamente con los siguientes problemas:

- Arrancador: Problemas por sobrecalentamiento y aperturas por desbalance de corriente entre las tres fases. Para monitorear el sobrecalentamiento se va implementar un plan de inspección termográfica de todo el sistema de arranque.
- Sensor de vibración: Estos equipos generalmente han fallado por descalibración, por lo que se va mitigar realizando medición periódica de la respuesta a señales de corriente de 4mA a 20mA.
- Actuador de válvula de admisión y by pass: Estos elementos han fallado básicamente por problemas de respuesta de los transductores a los señales de 4mA a 20mA. Se va mitigar realizando pruebas periódicas con la señal respectiva.
- Incremento de temperatura de aceite: Este problema básicamente está relacionado a la temperatura del agua de enfriamiento, por lo que se va mitigar implementando un control rutinario de la temperatura del refrigerante, al ingreso del intercambiador de calor.

CAPTULO V

DESARROLLO DE ACTIVIDADES PARA LA IMPLEMENTACION DEL MANTENIMIENTO PREDICTIVO

5.1 Criticidad de los compresores

Como las maquinas de formación de envases son básicamente neumáticas es muy importante establecer la criticidad de los equipos de compresión en relación a los otros equipos de la planta. Si bien es cierto que tenemos seis compresores para abastecer el consumo de cinco líneas, la parada de un compresor necesariamente va provocar la parada de más de una línea, porque la caída de presión que se genera en el instante de la parada de un compresor es muy considerable que activara los sistemas de protección de las maquinas. Los compresores son los equipos más críticos de la planta, el cual se muestra en la Grafico 5.1.

La evaluación de la criticidad de los compresores de la planta lo podemos ver en las Tablas 5.1 al 5.6.

5.2 Tipos de análisis predictiva a emplear

Los análisis predictiva a usarse en los compresores son: Análisis Vibracional, Termografías, Control de temperatura de refrigerantes, Análisis de aceites, Medición de señales de transductores.

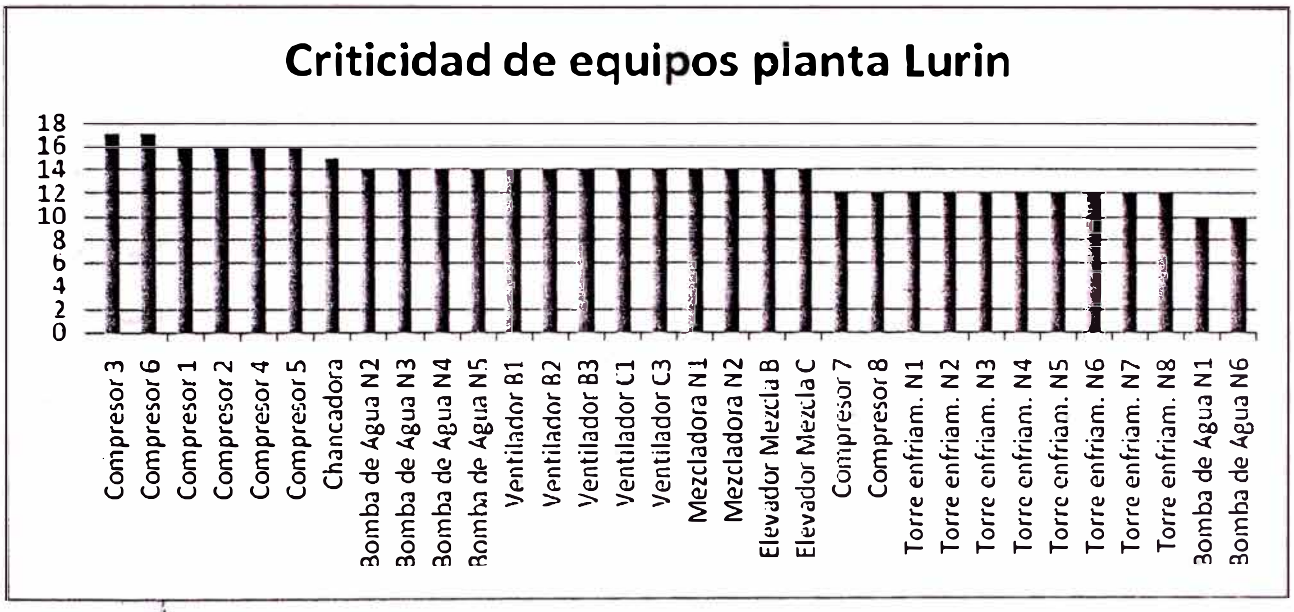


Grafico 5.1. Nivel de criticidad de equipos de la planta

Tabla 5.1 Criticidad compresor C1

Equipo:	Compresor Centac 1		Owens Illinois Peru
Codigo:	C00C1		Planta Lurin
1.- Efecto sobre la producción, operaciones o medio ambiente			
Grado de afectación que le ocasiona al proceso productivo	Paraliza	4	Genera interrupción a línea, proceso o afecta m. ambiente
	Reduce	2	
	No afecta	0	
2.- Probabilidad de Falla (aspecto de Confiabilidad funcional)			
En función de registros y antecedente histórico	Alta	3	No se puede asegurar que va a trabajar correctamente si se le necesita en forma continuada e intensa
	Media	2	
	Baja	1	
3.- Impacto Económico			
Comprende el costo de Operación y mantenimiento.	Elevado	3	Registra el mas alto valor que impacta en la estructura económica de la empresa.
	Intermedio	2	
	Bajo	1	
4.- La avería afecta a:			
4.1 A la maquina o equipo	Si	1	¿Deteriora otras partes, sistemas o componentes?
	No	0	
4.2 Al servicio	Si	1	¿Origina otros problemas a equipos colaterales?
	No	0	
4.3 Al operador	Si	1	¿Existe riesgo de afectar al operador?
	No	0	
4.4 A la seguridad	Si	1	¿ Hay posibilidad de expandir accidente a otras personas o equipos del proceso?
	No	0	
5.- Disposición en el sistema o proceso			
	Unico	2	No se tiene otro equipo igual o similar
	By pass	1	El sistema puede seguir funcionando
	Stand By	0	Existe otro igual o similar no instalado
6.- Facilidades de intervención (mantenibilidad)			
	Alta	1	Procedimiento de mantenimiento dificultoso
	Baja	0	Procedimiento de fácil accesibilidad
Puntaje Total		**16**	
Nivel Criticidad		**1**	

Tabla 5.2 Criticidad compresor C2

Equipo:	Compresor Centac 2		Owens Illinois Peru
Codigo:	C00C2		Planta Lurin
1.- Efecto sobre la producción, operaciones o medio ambiente			
Grado de afectación que le ocasiona al proceso productivo	Paraliza	4	Genera interrupción a línea, proceso o afecta m. ambiente
	Reduce	2	
	No afecta	0	
2.- Probabilidad de Falla (aspecto de Confiabilidad funcional)			
En función de registros y antecedente histórico	Alta	3	No se puede asegurar que va a trabajar correctamente si se le necesita en forma continuada e intensa
	Media	2	
	Baja	1	
3.- Impacto Económico			
Comprende el costo de Operación y mantenimiento.	Elevado	3	Registra el mas alto valor que impacta en la estructura económica de la empresa.
	Intermedio	2	
	Bajo	1	
4.- La averia afecta a:			
4.1 A la maquina o equipo	Si	1	¿Deteriora otras partes, sistemas o componentes?
	No	0	
4.2 Al servicio	Si	1	¿Origina otros problemas a equipos colaterales?
	No	0	
4.3 Al operador	Si	1	¿Existe riesgo de afectar al operador?
	No	0	
4.4 A la seguridad	Si	1	¿ Hay posibilidad de expandir accidente a otras personas o equipos del proceso?
	No	0	
5.- Disposición en el sistema o proceso			
	Unico	2	No se tiene otro equipo igual o similar
	By pass	1	El sistema puede seguir funcionando
	Stand By	0	Existe otro igual o similar no instalado
6.- Facilidades de intervención (mantenibilidad)			
	Alta	1	Procedimiento de mantenimiento dificultoso
	Baja	0	Procedimiento de fácil accesibilidad
Puntaje Total		**16**	
Nivel Criticidad		**1**	

Tabla 5.3 Criticidad compresor C3

Equipo:	Compresor Centac 3		Owens Illinois Peru
Codigo:	C00C3		Planta Lurin
1.- Efecto sobre la producción, operaciones o medio ambiente			
Grado de afectación que le ocasiona al proceso productivo	Paraliza	4	Genera interrupción a linea. proceso o afecta m. ambiente
	Reduce	2	
	No afecta	0	
2.- Probabilidad de Falla (aspecto de Confiabilidad funcional)			
En función de registros y antecedente histórico	Alta	3	No se puede asegurar que va a trabajar correctamente si se le necesita en forma continuada e intensa
	Media	2	
	Baja	1	
3.- Impacto Económico			
Comprende el costo de Operación y mantenimiento.	Elevado	3	Registra el mas alto valor que impacta en la estructura económica de la empresa.
	Intermedio	2	
	Bajo	1	
4.- La averia afecta a:			
4.1 A la maquina o equipo	Si	1	¿Deteriora otras partes, sistemas o componentes?
	No	0	
4.2 Al servicio	Si	1	¿Origina otros problemas a equipos colaterales?
	No	0	
4.3 Al operador	Si	1	¿Existe riesgo de afectar al operador?
	No	0	
4.4 A la seguridad	Si	1	¿ Hay posibilidad de expandir accidente a otras personas o equipos del proceso?
	No	0	
5.- Disposición en el sistema o proceso			
	Unico	2	No se tiene otro equipo igual o similar
	By pass	1	El sistema puede seguir funcionando
	Stand By	0	Existe otro igual o similar no instalado
6.- Facilidades de intervención (mantenibilidad)			
	Alta	1	Procedimiento de mantenimiento dificultoso
	Baja	0	Procedimiento de fácil accesibilidad
Puntaje Total		**17**	
Nivel Criticidad		**1**	

Tabla 5.4 Criticidad compresor C4

Equipo:	Compresor Centac 4		Owens Illinois Peru
Codigo:	C00C4		Planta Lurin
1.- Efecto sobre la producción, operaciones o medio ambiente			
Grado de afectación que le ocasiona al proceso productivo	Paraliza	4	Genera interrupción a línea, proceso o afecta m. ambiente
	Red ue	2	
	No afecta	0	
2.- Probabilidad de Falla (aspecto de Confiabilidad funcional)			
En función de registros y antecedente histórico	Alta	3	No se puede asegurar que va a trabajar correctamente si se le necesita en forma continuada e intensa
	Mediai	2	
	Baja	1	
3.- Impacto Económico			
Comprende el costo de Operación y mantenimiento.	Elevado	3	Registra el mas alto valor que impacta en la estructura económica de la empresa.
	Intermedio	2	
	Bajo	1	
4.- La avería afecta a:			
4.1 A la maquina o equipo	Si	1	¿Deteriora otras partes, sistemas o componentes?
	No	0	
4.2 Al servicio	Si	1	¿Origina otros problemas a equipos colaterales?
	No	0	
4.3 Al operador	Si	1	¿Existe riesgo de afectar al operador?
	No	0	
4.4 A la seguridad	Si	1	¿ Hay posibilidad de expandir accidente a otras personas o equipos del proceso?
	No	0	
5.- Disposición en el sistema o proceso			
	Unico	2	No se tiene otro equipo igual o similar
	By pass	1	El sistema puede seguir funcionando
	Stand By	0	Existe otro igual o similar no instalado
6.- Facilidades de intervención (mantenibilidad)			
	Alta	1	Procedimiento de mantenimiento dificultoso
	Baja	0	Procedimiento de fácil accesibilidad
Puntaje Total		**16**	
Nivel Criticidad		**1**	

Tabla 5.5 Criticidad compresor C5

Equipo:	Compresor Centac 5		Owens Illinois Peru
Codigo:	C00C5		Planta Lurin
1.- Efecto sobre la producción, operaciones o medio ambiente			
Grado de afectación que le ocasiona al proceso productivo	Paraliza	4	Genera interrupción a línea, proceso o afecta m. ambiente
	Reduce	2	
	No afecta	0	
2.- Probabilidad de Falla (aspecto de Confiabilidad funcional)			
En función de registros y antecedente histórico	Alta	3	No se puede asegurar que va a trabajar correctamente si se le necesita en forma continuada e intensa
	Media	2	
	Baja	1	
3.- Impacto Económico			
Comprende el costo de Operación y mantenimiento.	Elevado	3	Registra el mas alto valor que impacta en la estructura económica de la empresa.
	Intermedio	2	
	Bajo	1	
4.- La averia afecta a:			
4.1 A la maquina o equipo	Si	1	¿Deteriora otras partes, sistemas o componentes?
	No	0	
4.2 Al servicio	Si	1	¿Origina otros problemas a equipos colaterales?
	No	0	
4.3 Al operador	Si	1	¿Existe riesgo de afectar al operador?
	No	0	
4.4 A la seguridad	Si	1	¿ Hay posibilidad de expandir accidente a otras personas o equipos del proceso?
	No	0	
5.- Disposición en el sistema o proceso			
	Unico	2	No se tiene otro equipo igual o similar
	By pass	1	El sistema puede seguir funcionando
	Stand By	0	Existe otro igual o similar no instalado
6.- Facilidades de intervención (mantenibilidad)			
	Alta	1	Procedimiento de mantenimiento dificultoso
	Baja	0	Procedimiento de fácil accesibilidad
Puntaje Total		16	
Nivel Criticidad		1	

Tabla 5.6 Criticidad compresor C6

Equipo:	Compresor Centac 6		Owens Illinois Peru
Codigo:	C00C6		Planta Lurin
1.- Efecto sobre la producción, operaciones o medio ambiente			
Grado de afectación que le ocasiona al proceso productivo	Paraliza	4	Genera interrupción a línea, proceso o afecta m. ambiente
	Reduce	2	
	No afecta	0	
2.- Probabilidad de Falla (aspecto de Confiabilidad funcional)			
En función de registros y antecedente histórico	Alta	3	No se puede asegurar que va a trabajar correctamente si se le necesita en forma continuada e intensa
	Media	2	
	Baja	1	
3.- Impacto Económico			
Comprende el costo de Operación y mantenimiento.	Elevado	3	Registra el mas alto valor que impacta en la estructura económica de la empresa.
	Intermedio	2	
	Bajo	1	
4.- La avería afecta a:			
4.1 A la maquina o equipo	Si	1	¿Deteriora otras partes, sistemas o componentes?
	No	0	
4.2 Al servicio	Si	1	¿Origina otros problemas a equipos colaterales?
	No	0	
4.3 Al operador	Si	1	¿Existe riesgo de afectar al operador?
	No	0	
4.4 A la seguridad	Si	1	¿ Hay posibilidad de expandir accidente a otras personas o equipos del proceso?
	No	0	
5.- Disposición en el sistema o proceso			
	Unico	2	No se tiene otro equipo igual o similar
	By pass	1	El sistema puede seguir funcionando
	Stand By	0	Existe otro igual o similar no instalado
6.- Facilidades de intervención (mantenibilidad)			
	Alta	1	Procedimiento de mantenimiento dificultoso
	Baja	0	Procedimiento de fácil accesibilidad
Puntaje Total		17	
Nivel Criticidad		1	

5.2.1 Análisis Vibracional

La medición de vibración se tomará en los distintos puntos de apoyo de los elementos rodantes del compresor. Los puntos en donde se va tomar las mediciones verticales, horizontales y axiales, son:

Motor: Lado ventilador y lado acople

Reductor: Lado acople

Compresor: Primera Etapa, Segunda Etapa y Tercera Etapa

Los parámetros de vibración a medir son: Velocidad, aceleración y espectros, cuyos límites se ajustaran de acuerdo a la tabla 5.7. Algunas mediciones los podemos ver en los anexos.

Tabla 5.7. Rangos de severidad de vibración según ISO 2372

<table>
<tr><td>45</td><td rowspan="6">No Permisible</td><td rowspan="5">No Permisible</td><td rowspan="4">No Permisible</td><td rowspan="3">No Permisible</td></tr>
<tr><td>28</td></tr>
<tr><td>18</td></tr>
<tr><td>11.2</td><td rowspan="2">Limite</td></tr>
<tr><td>7.1</td><td rowspan="2">Limite</td></tr>
<tr><td>4.5</td><td rowspan="2">Limite</td><td rowspan="2">Admisible</td></tr>
<tr><td>2.8</td><td rowspan="2">Limite</td><td rowspan="2">Admisible</td></tr>
<tr><td>1.8</td><td rowspan="2">Admisible</td><td rowspan="6">Normal</td></tr>
<tr><td>1.12</td><td rowspan="2">Admisible</td><td rowspan="5">Normal</td></tr>
<tr><td>0.71</td><td rowspan="4">Normal</td></tr>
<tr><td>0.45</td><td rowspan="3">Normal</td></tr>
<tr><td>0.28</td></tr>
<tr><td>0.18</td></tr>
<tr><td>Vel. [mm/s]</td><td>Maquinas Pequeñas

(< 15kW)</td><td>Maquinas Mediana

(15kW-75kW)
300kW soporte especial</td><td>Maquinas Grandes

(> 75kW)

Base Rigida</td><td>Maquinas Grandes

(> 75kW)

Alta Velocidad</td></tr>
</table>

5.2.2 Termografías

La termografía se aplicara a las conexiones de potencia, desde el interruptor que alimenta al equipo, las conexiones de los contactores y los apoyos de rodamientos del motor y las bocinas del compresor.

La severidad de los puntos medidos se catalogará de acuerdo al siguiente rango de temperaturas:

Tabla 5.1. Rangos de temperatura para el análisis termográfico

Parte\Nivel	**Bueno**	**Regular**	**Crítico**
Motor	< 60°C	Entre 60°C y 80°C	>80°C
Reductor	< 60°C	Entre 60°C y 80°C	>80°C
Asiento de impulsor	< 50°C	Entre 50°C y 80°C	>80°C
Empalme eléctrico	< 50°C	Entre 50°C y 80°C	>80°C

5.2.3 Análisis de Aceites

El aceite que utilizan los compresores centrífugos es el Thectro Gold, el cual es un lubricante sintético. El fabricante garantiza este lubricante para un uso continuo de 16000 horas en condiciones óptimas. El análisis de aceite se realizara por el método de cromatografía, el cual se llevará a cabo trimestralmente, según recomendación del fabricante. Los rangos de concentración de los agentes de desgaste y contaminantes se categorizaran de acuerdo a la tabla 5.1.

Tabla 5.1. Valores típicos para análisis de aceites

Parámetro	Valor Nominal	Valor Vigilar	Valor Peligro
Viscosidad a 40C	Aceite nuevo	+/-10%	+/-15%
Viscosidad a 100C	Aceite nuevo	+/-10%	+/-15%
Índice de acidez	Aceite nuevo	+ 0.2	+ 1
Índice de viscosidad	Aceite nuevo	+/-10%	+/-15%
Agua (ASTMD6304)	<50 ppm	200 ppm	400 ppm
Nitración (FTIR)	<1 abs/cm	<5 abs/cm	<10 abs/cm
Oxidación (FTIR)	<1 abs/cm	<5 abs/cm	<10 abs/cm
Conteo de partículas	17/15/12	19/17/14	20/18/15
PQI	<50	<80	>80
Silicio (ASTMD 5185)	<10 ppm	<20 ppm	>20 ppm
Hierro (ASTMD 5185)	<40 ppm	<60 ppm	>60 ppm
Cobre (ASTMD 5185)	<10 ppm	<20 ppm	>20 ppm
Cromo (ASTMD 5185)	<10 ppm	<20 ppm	>20 ppm
Plomo (ASTMD 5185)	<10 ppm	<20 ppm	>20 ppm
Estaño (ASTMD 5185)	<10 ppm	<20 ppm	>20 ppm
Aluminio (ASTMD 5185)	<10 ppm	<20 ppm	>20 ppm
Niquel (ASTMD 5185)	<10 ppm	<20 ppm	>20 ppm
Metales aditivacion (ASTMD 5185)	>50% valor inicial	<50%	<40%
Espuma	75/10 75/10 75/10	100/10 200/20 100/10	>100/10 >200/20 >100/10
Aire retenido	<15 min	+20% aceite nuevo	+25% aceite nuevo
Vida remanente (RULER)	>50% aceite nuevo	>25% aceite nuevo	<25% aceite nuevo
Lasernet Fines	No partículas	Moderado	Alto
Ferrografía analítica	No partículas	No partículas	No partículas

5.2.4 Medición de señales de transductores

La medición de señales de los transductores de vibración, presión y temperatura consiste en verificar mensualmente que el rango de corriente este dentro de 4mA a 20mA. Para tener una buena proporcionalidad como mínimo se tomara medidas en tres puntos, es decir a 4mA, el mínimo, 12mA, valor medio, y 20mA valor máximo. Para cada uno de los valores de corriente, la respuesta del sensor deber ser también equivalente según el parámetro que esto represente. Por ejemplo podemos hacer pruebas en el sensor de presión, cuyo rango de medición es de 0 PSI a 100 PSI, entonces la respuesta será como lo mostrado en la tabla 5.2.

Tabla 5.2. Prueba recomendada a un sensor de presión. Rango 0PSI a 100PSI

Corriente alimentada al sensor	Respuesta del sensor
4 mA	0 PSI
12 mA	50 PSI
20 mA	100 PSI

5.2.5 Mediciones Rutinarias

- Medición de temperatura de aire en cada etapa.- Estas mediciones se tomaran del panel del equipo para las tres etapas. La temperatura máxima admisible es de 125°F por recomendación del fabricante.

- Medición de vibración de los impulsores de cada etapa.- La medición se tomara del panel del equipo para las tres etapas. El límite máximo tolerable es de 1.05 mils, por especificación del fabricante.

- Medición de presión del aire de las etapas.- La medición se va tomar del panel del equipo para las tres etapas. El límite máximo en la tercera etapa será igual al set point o no pasar de los 65PSI.

- Medición de presión y temperatura de aceite.- Estas mediciones se van realizar del panel principal y el manómetro que está instalado en la entrada a la lubricación del motor. La presión mínima es de 20PSI. La temperatura máxima es de 125°F y la mínima es de 90°F.

- Medición de vacío en la admisión.- El vacio se va tomar del vacuómetro instalado en la admisión del compresor. El máximo valor para cambiar el filtro es de -45mbar para los compresores de baja y -30mbar para los compresores de alta.

5.3 Frecuencia de análisis predictivas

La frecuencia de las distintas actividades están establecidas de acuerdo a las recomendaciones del fabricante, estas frecuencias pueden ir variando a medida, que en el tiempo, los resultados de las mediciones puedan establecer ciertas tendencia. Las distintas actividades y sus respectivas frecuencias iniciales se muestran en la tabla 5.2

Tabla 5.2 Actividades predictivas y sus respectivas frecuencias

Actividad	Frecuencia
Análisis Vibracional	Mensual
Análisis de aceite	Trimestral
Termografia	Trimestral
Temperatura de aire	Diario
Presión de aire	Diario
Temperatura de aceite	Diario
Presión de aceite	Diario
Vacio en la admisión	Diario

CAPITULO VI

ESTRUCTURA DE COSTOS

6.1 Costos por parada de compresores

Los costos que involucran las paradas de los compresores son muy representativos. Según lo indicado en el capítulo 4, los tiempos de parada de cada máquina son de 14 horas en promedio. Sabemos que la planta en promedio produce 500 Toneladas métricas por día, con lo cual podemos establecer la magnitud de las pérdidas que representa cada parada de un compresor, siendo este monto alrededor de los US$80000 por año. Es importante indicar que los equipos no superan los 4 años de uso, eso significa que si no se aplica un programa de mantenimiento predictivo estricto las paradas podrían aumentar significativamente, con el consecuente incremento de las pérdidas económicas.

6.2 Costos de implementación de mantenimiento predictivo

Los costos fijos en que la compañía va incurrir como consecuencia de la implementación de un plan de mantenimiento predictivo están relacionados con los costos de los servicios de análisis vibracional, termografía, análisis de aceites y los honorarios del personal técnico para las labores de inspección rutinaria. Los costos lo podemos apreciar en el cuadro 6.1.

Cuadro 6.1 Costo por ejecución de mantenimiento predictivo

COSTO ANUAL POR LA EJECUCION DEL MANTENIMIENTO PREDICTIVO	
ACTIVIDADES	US$
Análisis Vibracional	1500
Termografía	3500
Análisis de aceite	1500
Personal técnico	3500
Total costo de mantenimiento Predictivo	10000

6.3 Análisis Financiero

El análisis Financiero se va realizar considerando una tasa de interés bancario del 12%, y un periodo de recuperación de la inversión óptima que fija la compañía debe ser inferior a los dos años.

6.3.1 Cálculo del Retorno de la inversión (ROI)

El retorno de la inversión, está calculado considerandos dos factores muy importantes, que son: La pérdida de producción por la parada no programada de los compresores y los gastos en repuestos y personal para solucionar el problema del equipo.

El ROI y el periodo de retorno de la inversión lo determinamos usando las siguientes formulas:

ROI = (Oportunidad de ahorro total)/(Inversión inicial)*100

Periodo de retorno = 12/ROI

Mediante el uso de las dos formulas anteriores y la grafica 6.1 se puede concluir que el ROI es del 175% y el tiempo de retorno es de 6.86 meses.

Cuadro 6.2. Inversión y oportunidades de ahorro con la implementación de mantenimiento predictivo.

Años	0	1	2	3
Inversión en Software, capacitación.	US$40000	US$0	US$0	US$0
Costo de Reparación excedente por falla	0	US$10000	US$20000	30000
Perdida producción	0	US$60000	US$120000	180000
Total oportunidad de ahorro	**US$0**	**US$70000**	**US$140000**	**US$210000**

6.3.2 Cálculo del Valor Actual Neto (VAN)

Para el cálculo del VAN usaremos el interés compuesto, a una tasa bancaria del 12%. La fórmula que emplearemos para este fin será:

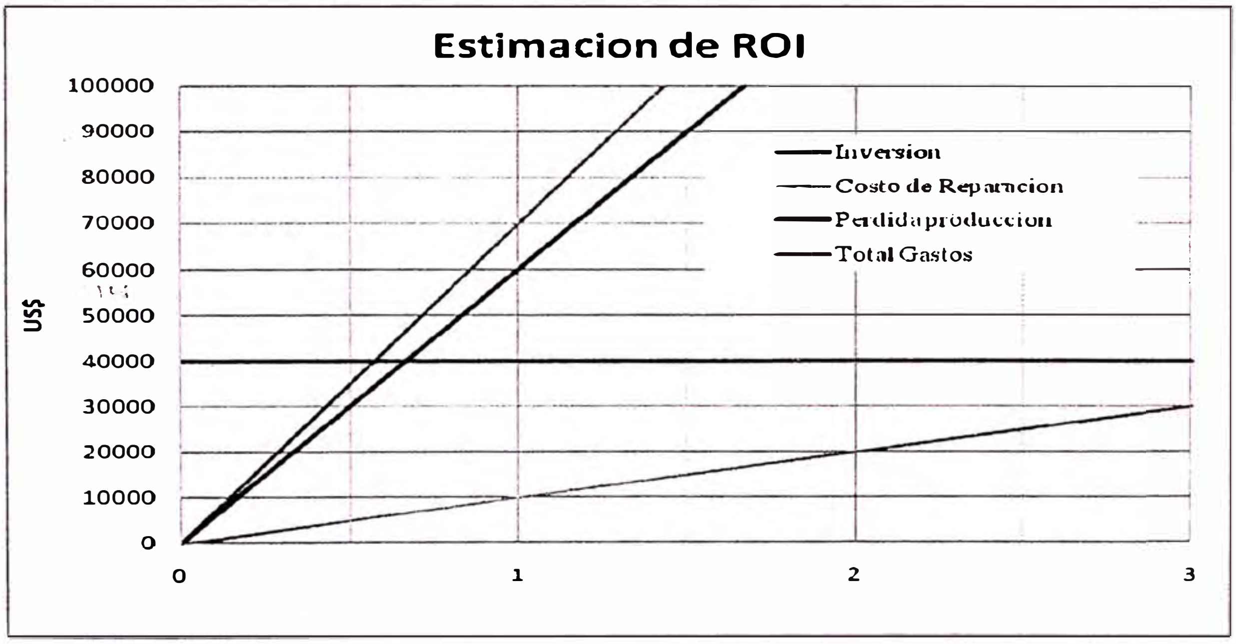
$$\mathbf{VAN = -I_0 + P(1+i)^{-1} + P(1+i)^{-2} + \cdots + P(1+i)^{-n}}$$

El valor actual neto para una inversión inicial (I_0) de US$40000 y una oportunidad de ahorro (P) de US$70000 por evitar pérdidas de producción y gastos de mantenimiento, (este monto es la suma de los US$60000 por perdida de producción y el resultado de la diferencia de los US$20000 de mantenimiento por parada imprevista y los US$10000 de costo de mantenimiento predictivo), en un periodo (n) de dos años es de US$78304, por lo que la inversión es rentable.

6.3.3 Cálculo de la tasa interna de retorno (TIR)

La tasa interna de retorno para una inversión de US$40000, en un periodo de dos años es de 146%. Este resultado indica que el proyecto es viable.

La tasa interna de retorno hemos calculado usando la fórmula del VAN, con el detalle de que hemos hecho lo siguiente: VAN=0 y n=2años.



Grafica 6.1. Representación del retorno de la inversión (ROI)

CONCLUSIONES

- El mantenimiento predictivo se ha aplicado a los compresores centrífugos, de una manera factible, sin recurrir a inversiones elevadas que involucren adquisición de equipos costosos porque tenemos servicios de terceros a costos razonables. Las inversiones iniciales que se han desembolsado serán recuperadas en un tiempo prudente.

- Mediante la implementación de un plan de mantenimiento predictivo disciplinado podemos eliminar los tiempos de parada imprevistas, así podemos garantizar la operación de la planta de manera continua y que los productos tengan la calidad requerida por el cliente.

- Las paradas imprevistas de los compresores generan pérdidas económicas que ascienden a los US$80000 anuales, mientras que los costos por la ejecución del mantenimiento predictivo es de US$10000 anuales, con lo cual hay una oportunidad de ahorro de US$70000.

- El análisis financiero de la inversión, para la implementación del mantenimiento predictivo, llámese TIR (146%), VAN (US$78304) y ROI (176%), muestran valores muy atractivos, en un periodo menor a los dos años que la compañía establece, por lo que el proyecto es viable.

- El mantenimiento predictivo contemplaría las siguientes actividades: Análisis Vibracional, Termografía, Análisis de aceites, mediciones rutinarias de temperatura, vacio y presión en cada etapa del compresor.

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2) Catalogo de operación de compresores centrífugos
   Ingersoll Rand, 2007

3) Gestión de mantenimiento
   Curso actualización profesional, UNI FIM, 2010

4) Páginas de internet consultadas:
   http://es.scribd.com/doc/1008576/EL-COMPRESOR
   http://www.unioviedo.es/Areas/Mecanica.Fluidos/docencia/_asignaturas/mecanica_de_fluidos/05_06/10.TURBOMAQUINAS.pdf
   http://www.landinst.es/infrarroja/descarga_de_ficheros/pdf/Termografia_Guia_Basica.pdf
   http://www.guemisa.com/articul/pdf/vibraciones.pdf

ANEXOS

A: Análisis de Aceites

SIGNUM
OIL ANALYSIS

No. de Cuenta :	216636
Nombre de la Cuenta :	OWENS ILLINOIS PERU S.A.
	MEGAREPRESENTACIONES1 S.A.
Fecha :	28-feb-2011
Número Signum :	31216029

CENTAC N°1

Alerta

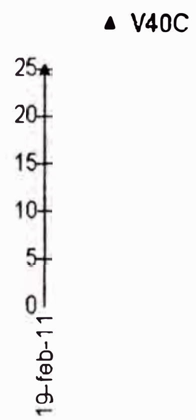
Descripción :	COMPRESOR INGERSOLL RAND
Componente :	Sistema de Circulación
Fabricante :	INGERSOLL RAND
Modelo :	NOT LISTED
Lubricante registrado :	MOBIL RARUS 827

Por favor consulte la página siguiente para obtener comentarios completos.

Información de la Muestra

ID de Muestra	1055420356
Fecha Muestra	19-feb-2011
Fecha del Informe	28-feb-2011
Marca	MOBIL
Lub. Analizado	RARUS 827
Equipo. Meses	42
Aceite Meses	19
Temp. del Dep.	
Relleno	
Aceite cambiado	N
Filtro Cambiado	N

Viscosidad



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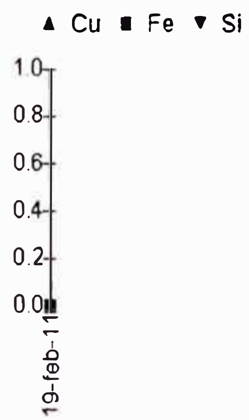
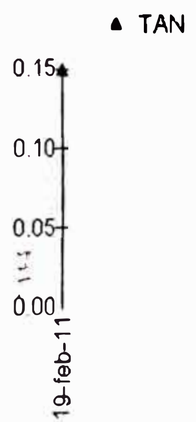


Datos del lubricante

Ev. de Contamin.	Normal
Evaluación Equipo	Normal
Ev. del Aceite	Alerta
Viscosidad @ 40C	24.9
TAN (mg KOH/g)	0.15
Agua(Plancha Cal.)	NoDetectado

Lubricante



Información de la Muestra

ID de Muestra	1055420356
Fecha Muestra	19-feb-2011

Elementos de desgaste - ppm (mg/kg)

Al (Aluminio)	0
Cr (Cromo)	0
Cu (Cobre)	0
Fe (Hierro)	0
Mo (Molibdeno)	0
Ni (Níquel)	0
Pb (Plomo)	0
Sn (Estaño)	0

Elementos contaminantes - ppm (mg/kg)

B (Boro)	2
K (Potasio)	0
Na (Sodio)	0
Si (Silicio)	0

Elementos aditivos - ppm (mg/kg)

Ba (Barium)	398
Ca (Calcio)	0
Mg (Magnesio)	0
P (Fósforo)	2
Zn (Zinc)	0

MEGAREPRESENTACIONES1 S.A.

Fecha : 28-feb-2011

Número Signum : 31216029

Fabricante : INGERSOLL RAND

Modelo : NOT LISTED

Lubricante registrado : MOBIL RARUS 827

ACCION REQUERIDA; BAJA VISCOSIDAD DEL ACEITE: Determine la fuente de baja viscosidad y tome acciones correctivas. - Una baja viscosidad puede reducir la protección por lubricación - Fuentes posibles de baja viscosidad incluyen: 1. Llenado inicial o dilución con aceite de menor viscosidad; 2. contaminación con combustible o solvente; 3. muestra mal etiquetada remitida para analizar

ACCION REQUERIDA; ACEITE O CONDICIÓN DE FUNCIONAMIENTO INSATISFACTORIA: Algunos resultados de ensayos exceden los limites de control. - Retome la muestra para confirmar la condición del aceite. - Si se confirma la condición, tome una acción correctiva adecuada.

Normal + Precaución Alerta

Mobil

MEGAREPRESENTACIONES1 S.A.

Fecha : 28-feb-2011

Número Signum : 31216028

Fabricante . INGERSOLL RAND

Modelo : NOT LISTED

Lubricante registrado : MOBIL RARUS 827

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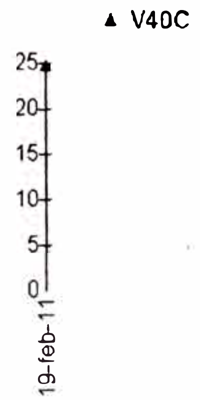
Información de la Muestra

ID de Muestra	1055420355
Fecha Muestra	19-feb-2011
Fecha del Informe	28-feb-2011
Marca	MOBIL
Lub. Analizado	RARUS 827
Equipo. Meses	42
Aceite Meses	19
Temp. del Dep.	
Relleno	
Aceite cambiado	N
Filtro Cambiado	N

Viscosidad



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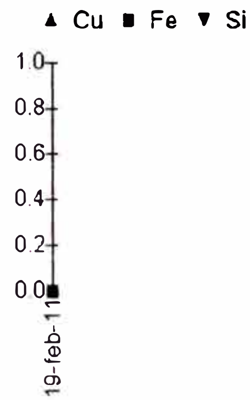


Información de la Muestra

ID de Muestra	1055420355
Fecha Muestra	19-feb-2011

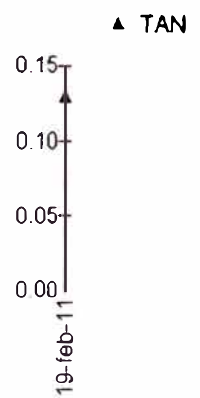
Elementos de desgaste - ppm (mg/kg)

Al (Aluminio)	0
Cr (Cromo)	0
Cu (Cobre)	0
Fe (Hierro)	0
Mo (Molibdeno)	0
Ni (Níquel)	0
Pb (Plomo)	0
Sn (Estaño)	0

Datos del lubricante

Ev. de Contamin.	Normal
Evaluación Equipo	Normal
Ev. del Aceite	*Alerta*
Viscosidad @ 40C	[illegible]
TAN (mg KOH/g)	0.13
Agua(Plancha Cal.)	NoDetectado

Lubricante



Elementos contaminantes - ppm (mg/kg)

B (Boro)	2
K (Potasio)	0
Na (Sodio)	0
Si (Silicio)	0

Elementos aditivos - ppm (mg/kg)

Ba (Barium)	402
Ca (Calcio)	0
Mg (Magnesio)	0
P (Fósforo)	3
Zn (Zinc)	0

Normal + Precaución * Alerta *

Mobil

MEGAREPRESENTACIONES1 S.A.

Fecha : 28-feb-2011

Número Signum : 31216028

Fabricante : INGERSOLL RAND

Modelo : NOT LISTED

Lubricante registrado : MOBIL RARUS 827

ACCION REQUERIDA; BAJA VISCOSIDAD DEL ACEITE: Determine la fuente de baja viscosidad y tome acciones correctivas. - Una baja viscosidad puede reducir la protección por lubricación - Fuentes posibles de baja viscosidad incluyen: 1. Llenado inicial o dilución con aceite de menor viscosidad; 2. contaminación con combustible o solvente; 3. muestra mal etiquetada remitida para analizar
ACCION REQUERIDA; ACEITE O CONDICIÓN DE FUNCIONAMIENTO INSATISFACTORIA: Algunos resultados de ensayos exceden los limites de control. - Retome la muestra para confirmar la condición del aceite. - Si se confirma la condición, tome una acción correctiva adecuada.

Normal + Precaución Alerta

Mobil

MEGAREPRESENTACIONES1 S.A.

Fecha :	28-feb-2011
Número Signum :	31216030
Fabricante :	INGERSOLL RAND
Modelo :	NOT LISTED
Lubricante registrado :	MOBIL RARUS 827

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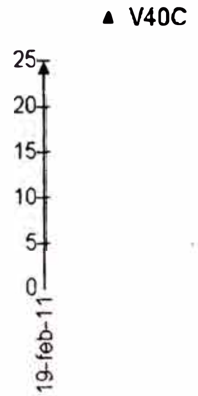
Información de la Muestra

ID de Muestra	1055420350
Fecha Muestra	19-feb-2011
Fecha del Informe	28-feb-2011
Marca	MOBIL
Lub. Analizado	RARUS 827
Equipo. Meses	42
Aceite Meses	19
Temp. del Dep.	
Relleno	
Aceite cambiado	N
Filtro Cambiado	N

Viscosidad



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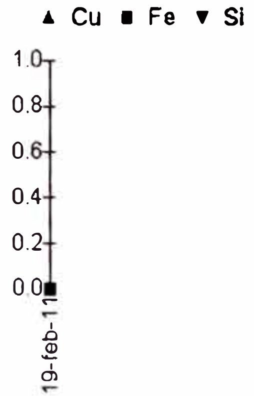


Información de la Muestra

ID de Muestra	1055420350
Fecha Muestra	19-feb-2011

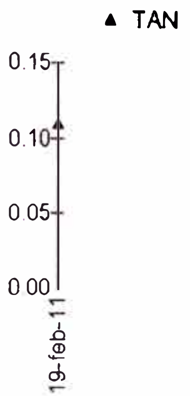
Elementos de desgaste - ppm (mg/kg)

Al (Aluminio)	0
Cr (Cromo)	0
Cu (Cobre)	0
Fe (Hierro)	0
Mo (Molibdeno)	0
Ni (Níquel)	0
Pb (Plomo)	0
Sn (Estaño)	0

Datos del lubricante

Ev. de Contamin.	Normal
Evaluación Equipo	Normal
Ev. del Aceite	*Alerta
Viscosidad @ 40C	[illegible]
TAN (mg KOH/g)	0.11
Agua(Plancha Cal.)	NoDetectado

Lubricante



Elementos contaminantes - ppm (mg/kg)

B (Boro)	2
K (Potasio)	0
Na (Sodio)	4
Si (Silicio)	0

Elementos aditivos - ppm (mg/kg)

Ba (Barium)	413
Ca (Calcio)	2
Mg (Magnesio)	0
P (Fósforo)	1
Zn (Zinc)	0

Normal + Precaución *Alerta

Mobil

Nombre de la Cuenta : OWENS ILLINOIS PERU S.A.
MEGAREPRESENTACIONES1 S.A.

Fecha : 28-feb-2011

Número Signum : 31216030

Componente Sistema de Circulación

Fabricante : INGERSOLL RAND

Modelo : NOT LISTED

Lubricante registrado : MOBIL RARUS 827

ACCION REQUERIDA; BAJA VISCOSIDAD DEL ACEITE: Determine la fuente de baja viscosidad y tome acciones correctivas. - Una baja viscosidad puede reducir la protección por lubricación - Fuentes posibles de baja viscosidad incluyen: 1. Llenado inicial o dilución con aceite de menor viscosidad; 2. contaminación con combustible o solvente; 3. muestra mal etiquetada remitida para analizar
ACCION REQUERIDA; ACEITE O CONDICIÓN DE FUNCIONAMIENTO INSATISFACTORIA: Algunos resultados de ensayos exceden los limites de control. - Retome la muestra para confirmar la condición del aceite. - Si se confirma la condición, tome una acción correctiva adecuada.

Normal + Precaución + Alerta

Mobil

Nombre de la Cuenta : OWENS ILLINOIS PERU S.A.
MEGAREPRESENTACIONES1 S.A.

Fecha : 28-feb-2011
Número Signum : 31216032

Componente :
Fabricante INGERSOLL RAND
Modelo : NOT LISTED
Lubricante registrado : MOBIL RARUS 827

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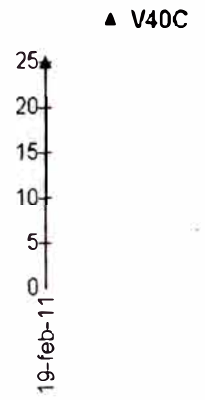
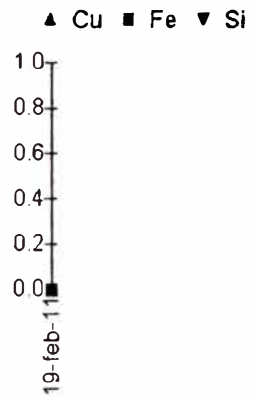
Información de la Muestra

ID de Muestra	1055420345
Fecha Muestra	19-feb-2011
Fecha del Informe	28-feb-2011
Marca	MOBIL
Lub. Analizado	RARUS 827
Equipo. Meses	17
Aceite Meses	17
Temp. del Dep.	
Relleno	
Aceite cambiado	N
Filtro Cambiado	N

Viscosidad



Elementos



Información de la Muestra

ID de Muestra	1055420345
Fecha Muestra	19-feb-2011

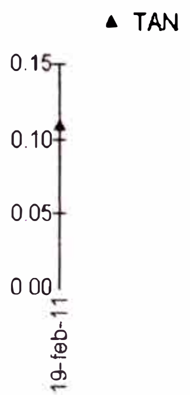
Elementos de desgaste - ppm (mg/kg)

Al (Aluminio)	0
Cr (Cromo)	0
Cu (Cobre)	0
Fe (Hierro)	0
Mo (Molibdeno)	0
Ni (Niquel)	0
Pb (Plomo)	0
Sn (Estaño)	0

Datos del lubricante

Ev. de Contamin.	Normal
Evaluación Equipo	Normal
Ev. del Aceite	*Alerta
Viscosidad @ 40C	*25.0
TAN (mg KOH/g)	0.11
Agua(Plancha Cal.)	NoDetectado

Lubricante



Elementos contaminantes - ppm (mg/kg)

B (Boro)	0
K (Potasio)	0
Na (Sodio)	1
Si (Silicio)	0

Elementos aditivos - ppm (mg/kg)

Ba (Barium)	392
Ca (Calcio)	3
Mg (Magnesio)	0
P (Fosforo)	7
Zn (Zinc)	3

Normal + Precaución *Alerta

Mobil

Nombre de la Cuenta : OWENS ILLINOIS PERU S.A.
MEGAREPRESENTACIONES1 S.A.

Fecha : 28-feb-2011
Número Signum : 31216032

Componente :
Fabricante : INGERSOLL RAND
Modelo : NOT LISTED
Lubricante registrado : MOBIL RARUS 827

ACCION REQUERIDA; BAJA VISCOSIDAD DEL ACEITE: Determine la fuente de baja viscosidad y tome acciones correctivas. - Una baja viscosidad puede reducir la protección por lubricación - Fuentes posibles de baja viscosidad incluyen: 1. Llenado inicial o dilución con aceite de menor viscosidad; 2. contaminación con combustible o solvente; 3. muestra mal etiquetada remitida para analizar

ACCION REQUERIDA; ACEITE O CONDICIÓN DE FUNCIONAMIENTO INSATISFACTORIA: Algunos resultados de ensayos exceden los limites de control. - Retome la muestra para confirmar la condición del aceite. - Si se confirma la condición, tome una acción correctiva adecuada.

Normal + Precaución * Alerta *

Mobil

Nombre de la Cuenta : OWENS ILLINOIS PERU S.A.
MEGAREPRESENTACIONES1 S.A.

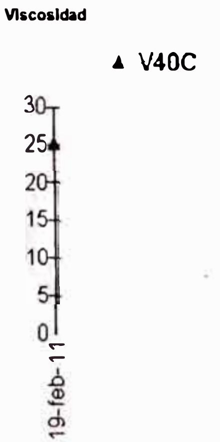
Fecha : 28-feb-2011
Número Signum : 31216034

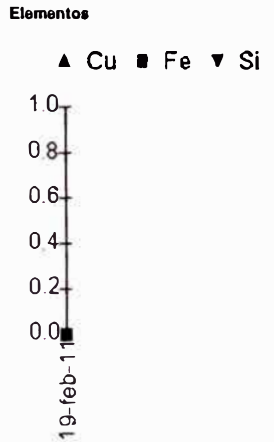
Componente : Sistema de Circulación
Fabricante . INGERSOLL RAND
Modelo : NOT LISTED
Lubricante registrado : MOBIL RARUS 827

Por favor consulte la página siguiente para obtener comentarios completos.

Información de la Muestra

ID de Muestra	1055420357
Fecha Muestra	19-feb-2011
Fecha del Informe	28-feb-2011
Marca	MOBIL
Lub. Analizado	RARUS 827
Equipo. Meses	17
Aceite Meses	17
Temp. del Dep.	
Relleno	
Aceite cambiado	N
Filtro Cambiado	N





Información de la Muestra

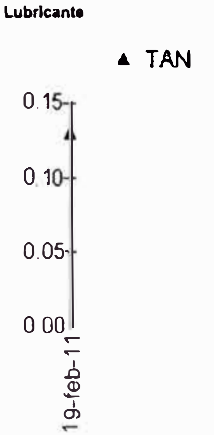
ID de Muestra	1055420357
Fecha Muestra	19-feb-2011

Elementos de desgaste - ppm (mg/kg)

Al (Aluminio)	0
Cr (Cromo)	0
Cu (Cobre)	0
Fe (Hierro)	0
Mo (Molibdeno)	0
Ni (Níquel)	0
Pb (Plomo)	0
Sn (Estaño)	0

Datos del lubricante

Ev. de Contamin.	Normal
Evaluación Equipo	Normal
Ev. del Aceite	Alerta
Viscosidad @ 40C	[illegible]
TAN (mg KOH/g)	0.13
Agua(Plancha Cal.)	NoDetectado



Elementos contaminantes - ppm (mg/kg)

B (Boro)	1
K (Potasio)	1
Na (Sodio)	0
Si (Silicio)	0

Elementos aditivos - ppm (mg/kg)

Ba (Barium)	405
Ca (Calcio)	0
Mg (Magnesio)	0
P (Fósforo)	1
Zn (Zinc)	0

Normal + Precaución Alerta

Mobil

Nombre de la Cuenta : OWENS ILLINOIS PERU S.A.
MEGAREPRESENTACIONES1 S.A.

Fecha : 28-feb-2011
Número Signum : 31216034

Componente: Sistema de Circulación
Fabricante : INGERSOLL RAND
Modelo : NOT LISTED
Lubricante registrado : MOBIL RARUS 827

ACCION REQUERIDA; BAJA VISCOSIDAD DEL ACEITE: Determine la fuente de baja viscosidad y tome acciones correctivas. - Una baja viscosidad puede reducir la protección por lubricación - Fuentes posibles de baja viscosidad incluyen: 1. Llenado inicial o dilución con aceite de menor viscosidad; 2. contaminación con combustible o solvente; 3. muestra mal etiquetada remitida para analizar
ACCION REQUERIDA; ACEITE O CONDICIÓN DE FUNCIONAMIENTO INSATISFACTORIA: Algunos resultados de ensayos exceden los limites de control. - Retome la muestra para confirmar la condición del aceite. - Si se confirma la condición, tome una acción correctiva adecuada.

Normal + Precaución * Alerta

Mobil

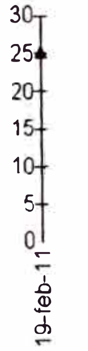
Nombre de la Cuenta :	OWENS ILLINOIS PERU S.A.	Componente	Sistema de Circulación
	MEGAREPRESENTACIONES1 S.A.	Fabricante	INGERSOLL RAND
		Modelo :	NOT LISTED
Fecha :	28-feb-2011	Lubricante registrado :	MOBIL RARUS 827
Número Signum :	31216036		

Por favor consulte la página siguiente para obtener comentarios completos.

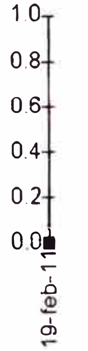
Información de la Muestra

ID de Muestra	1055420354
Fecha Muestra	19-feb-2011
Fecha del Informe	28-feb-2011
Marca	MOBIL
Lub. Analizado	RARUS 827
Equipo. Meses	17
Aceite Meses	17
Temp. del Dep.	
Relleno	
Aceite cambiado	N
Filtro Cambiado	N

Viscosidad



Elementos



Información de la Muestra

ID de Muestra	1055420354
Fecha Muestra	19-feb-2011

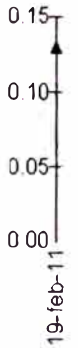
Elementos de desgaste - ppm (mg/kg)

Al (Aluminio)	0
Cr (Cromo)	0
Cu (Cobre)	0
Fe (Hierro)	0
Mo (Molibdeno)	0
Ni (Niquel)	0
Pb (Plomo)	0
Sn (Estaño)	0

Datos del lubricante

Ev. de Contamin.	Normal
Evaluación Equipo	Normal
Ev. del Aceite	*Alerta
Viscosidad @ 40C	*28.3
TAN (mg KOH/g)	0.13
Agua(Plancha Cal.)	NoDetectado

Lubricante



Elementos contaminantes - ppm (mg/kg)

B (Boro)	4
K (Potasio)	0
Na (Sodio)	2
Si (Silicio)	0

Elementos aditivos - ppm (mg/kg)

Ba (Barium)	381
Ca (Calcio)	2
Mg (Magnesio)	0
P (Fósforo)	14
Zn (Zinc)	1

Normal + Precaución *Alerta

Mobil

Nombre de la Cuenta :	OWENS ILLINOIS PERU S.A.	Componente	Sistema de Circulación
	MEGAREPRESENTACIONES1 S.A.	Fabricante :	INGERSOLL RAND
		Modelo :	NOT LISTED
Fecha :	28-feb-2011	Lubricante registrado :	MOBIL RARUS 827
Número Signum :	31216036		

ACCION REQUERIDA; BAJA VISCOSIDAD DEL ACEITE: Determine la fuente de baja viscosidad y tome acciones correctivas. - Una baja viscosidad puede reducir la protección por lubricación - Fuentes posibles de baja viscosidad incluyen: 1. Llenado inicial o dilución con aceite de menor viscosidad; 2. contaminación con combustible o solvente; 3. muestra mal etiquetada remitida para analizar

ACCION REQUERIDA; ACEITE O CONDICIÓN DE FUNCIONAMIENTO INSATISFACTORIA: Algunos resultados de ensayos exceden los limites de control. - Retome la muestra para confirmar la condición del aceite. - Si se confirma la condición, tome una acción correctiva adecuada.

Normal + Precaución * Alerta

Mobil

B: Termografía

Técnicas Predictivas.sac

INFORME TECNICO DE INSPECCION POR TERMOGRAFIA

OWENS ILLINOIS PERU S.A.

PLANTA: LURIN

EQUIPO: COMPRESOR CENTRIFUGO CENTAC

Inspector: Arquimedes Campos - ASNT TC-1A INFRARED – Level II

16/03/2011

Lima, 17 de Marzo del 2011

<u>Señores:</u>
OWENS ILLINOIS PERU S.A. – PLANTA LURIN
ATN.: ING. CESAR ICHO
Area de Mantenimiento Mecánico.

<u>Presente:</u>

<u>REF.- INFORME TÉCNICO DE TERMOGRAFIA</u>

Estimado Ing. Icho,

Apreciaremos encontrar adjunto, el Informe Técnico del servicio de inspección por Termografía Infrarroja efectuado al compresor centrifugo CENTAC.

Asimismo las recomendaciones para mejorar el estado de condición de equipo.

En la confianza de seguir atendiéndolos, quedamos de Ustedes.

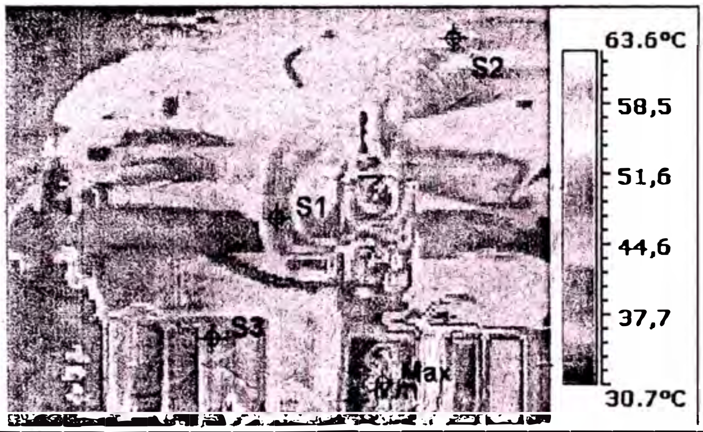
Atentamente

ARQUIMEDES CAMPOS
ASNT TC-1A INFRARED – Level II

Técnicas Predictivas sac

liente: OWENS ILLINOIS PERU S.A.			**Planta: LURIN**		
quipo: (Compresor Centac)			**Circuito:** (Tablero de control- Bornera L1 y L2)		
° Imagen:	IR000696.JPG	**Fecha:**	16/03/2011	**Hora:**	23:42:03
misividad:	0,98	**Temp Max:**	69,5℃	**Temp Min:**	32,4℃

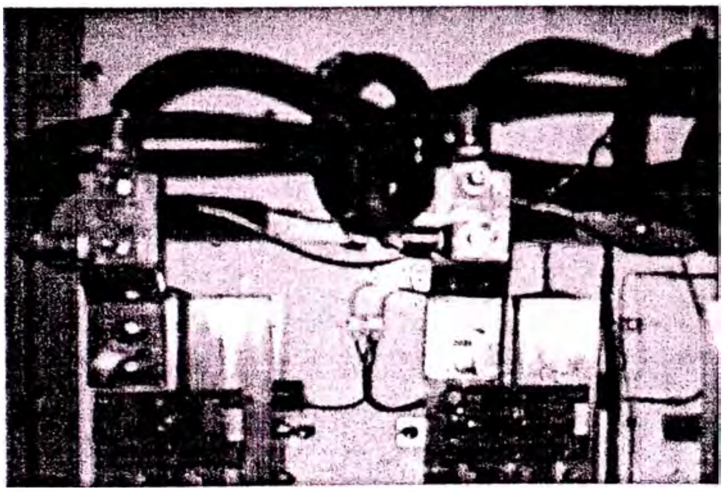
mágen érmica



Parámetro del Objeto	Valores
Max	69,5℃
Min	32,4℃
S1	50,2℃
S2	47,2℃
S3	48,1℃

ΔT (S1-S2)=3℃
ΔT (S2-S3)=0.9 ℃

mágen Visual



Relevancia:

NORMAL	X	LEVE		GRAVE		CRITICA	

Observaciones / Tipo de defecto encontrado

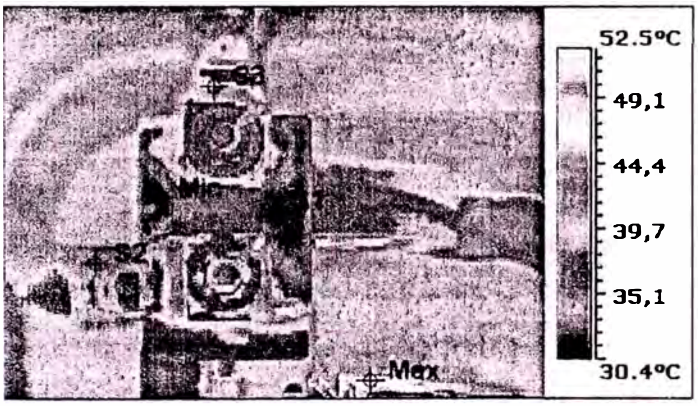
- No se observa anormalidades o recalentamiento en las conexiones mecánicas

Recomendaciones:

- Realizar próximo predictivo a 120 días de operación

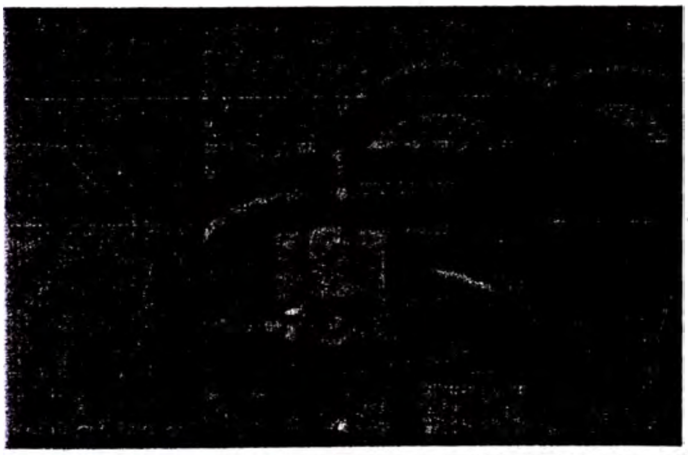
Cliente: OWENS ILLINOIS PERU S.A.			**Planta: LURIN**		
Equipo: (Compresor Centac)			**Circuito:** (Tablero - Conexión L1)		
Nº Imagen:	IR000707.JPG	**Fecha:**	16/03/2011	**Hora:**	23:46:15
Emisividad:	0,98	**Temp Max:**	53,6℃	**Temp Min:**	31,5℃

Imágen Térmica



Parametro del Objeto	Valores
Max	53,6℃
Min	31,5℃
S1	32,5℃
S2	43,0℃
S3	40,7℃

Imágen Visual



Relevancia:

NORMAL	X	LEVE		GRAVE		CRITICA	

Observaciones / Tipo de defecto encontrado

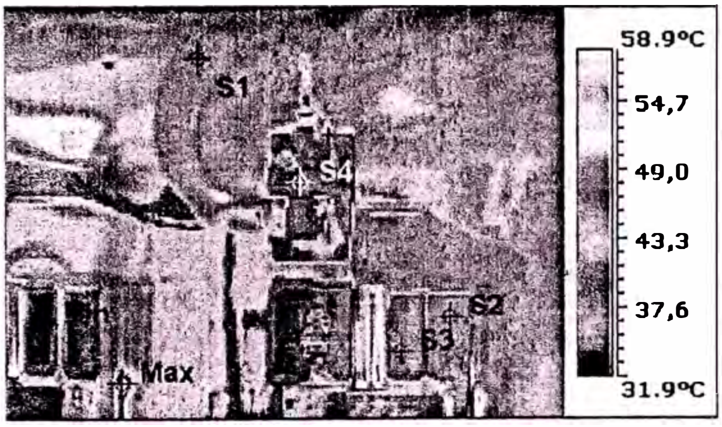
- No se observa anormalidades o recalentamiento en las conexiones mecánicas

Recomendaciones:

- Realizar próximo predictivo a 120 días de operación

Cliente: OWENS ILLINOIS PERU S.A.			**Planta: LURIN**		
Equipo: (Compresor Centac)			**Circuito:** (Tablero de control- Bornera L2 y L3)		
Nº Imagen:	IR000697.JPG	**Fecha:**	16/03/2011	**Hora:**	23:42:16
Emisividad:	0,98	**Temp Max:**	59,3℃	**Temp Min:**	32,8℃

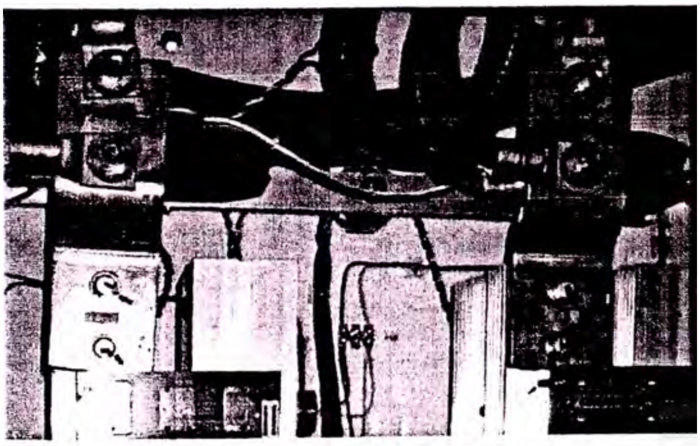
Imágen Térmica



Parametro del Objeto	Valores
Max	59,3℃
Min	32,8℃
S1	48,6℃
S2	36,0℃
S3	36,8℃
S4	35,6℃

ΔT (S2-S4)=0.4 ℃

Imágen Visual



Relevancia:

NORMAL	LEVE	GRAVE	CRITICA
X			

Observaciones / Tipo de defecto encontrado

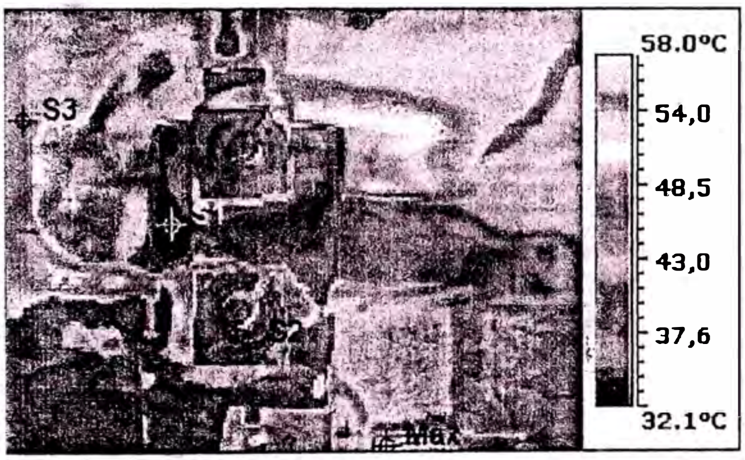
- No se observa anormalidades o recalentamiento en las conexiones mecánicas

Recomendaciones:

- Realizar próximo predictivo a 120 días de operación

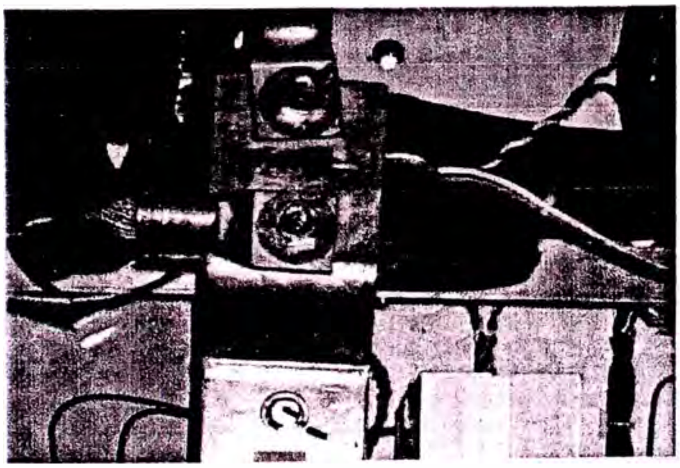
Cliente: OWENS ILLINOIS PERU S.A.			**Planta: LURIN**		
Equipo: (Compresor Centac)			**Circuito:** (Tablero - Conexión L2)		
Nº Imagen:	IR000708.JPG	**Fecha:**	16/03/2011	**Hora:**	23:46:24
Emisividad:	0,98	**Temp Max:**	57,3℃	**Temp Min:**	32,7℃

Imágen Térmica



Parametro del Objeto	Valores
Max	57,3℃
Min	32,7℃
S1	32,7℃
S2	35,0℃
S3	46,2℃

Imágen Visual



Relevancia:

NORMAL	LEVE	GRAVE	CRITICA
X			

Observaciones / Tipo de defecto encontrado

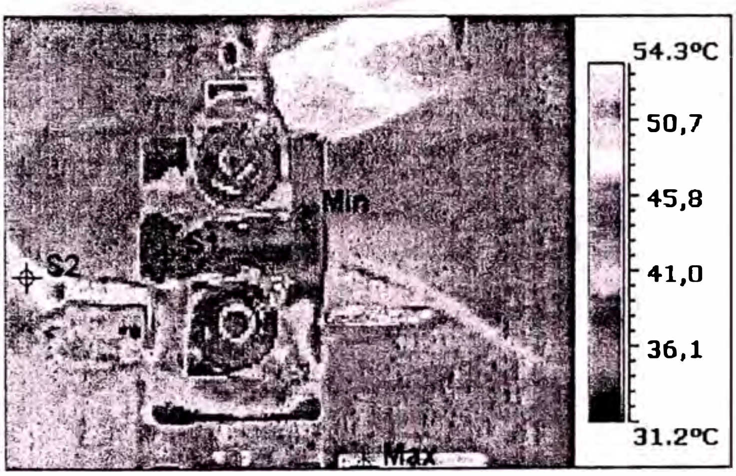
- No se observa anormalidades o recalentamiento en las conexiones mecánicas

Recomendaciones:

- Realizar próximo predictivo a 120 días de operación

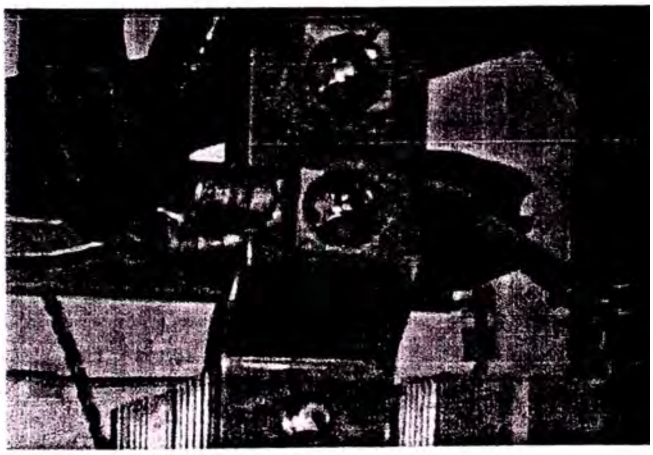
Cliente: OWENS ILLINOIS PERU S.A.			**Planta: LURIN**		
Equipo: (Compresor Centac)			**Circuito:** (Tablero - Conexión L3)		
Nº Imagen:	IR000709.JPG	**Fecha:**	16/03/2011	**Hora:**	23:46:34
Emisividad:	0,98	**Temp Max:**	55,2℃	**Temp Min:**	32,9℃

Imágen Térmica



Parametro del Objeto	Valores
Max	55,2℃
Min	32,9℃
S1	35,0℃
S2	48,3℃

Imágen Visual



Relevancia:

NORMAL	X	LEVE		GRAVE		CRITICA	

Observaciones / Tipo de defecto encontrado

- No se observa anormalidades o recalentamiento en las conexiones mecánicas

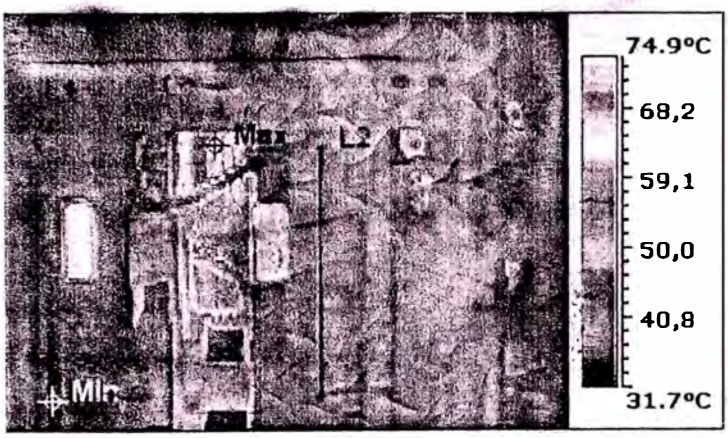
Recomendaciones:

- Realizar próximo predictivo a 120 días de operación

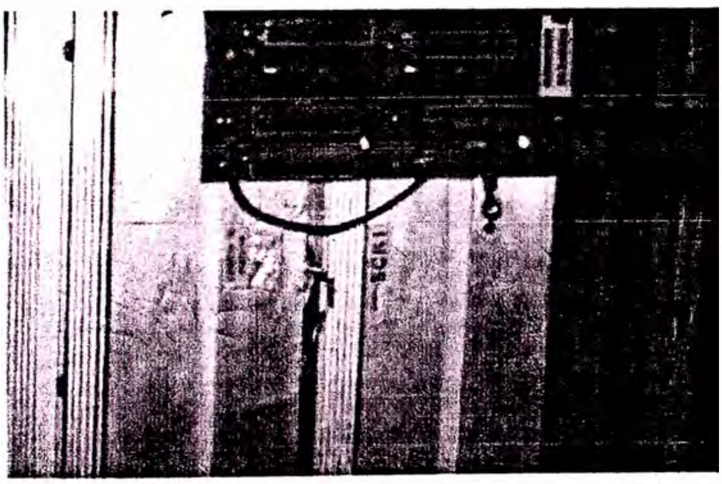
Cliente: OWENS ILLINOIS PERU S.A.		**Planta: LURIN**	
Equipo: (Compresor Centac)		**Circuito:** (Tablero de control- SCR1)	

Nº Imagen:	IR000698.JPG	**Fecha:**	16/03/2011	**Hora:**	23:43:20
Emisividad:	0,98	**Temp Max:**	72,9℃	**Temp Min:**	35,1℃

Imágen Térmica



Imágen Visual



Parametro del Objeto	Valores
Max	**72,9℃**
Min	35,1℃
L1:Temp, Promedio	38,9℃
L1:Temp Max	40,1℃
L1:Temp Min	37,5℃
L1:Emisividad	0,98
L2:Temp, Promedio	39,8℃
L2:Temp Max	40,8℃
L2:Temp Min	39,0℃
L2:Emisividad	0,98

SCR1	**72.9℃**
SCR2	81.2℃
SCR3	74.6℃
SCR4	60.1℃
SCR5	62.2℃
SCR6	59.7℃

Relevancia:

NORMAL	X	LEVE		GRAVE		CRITICA	

Observaciones / Tipo de defecto encontrado

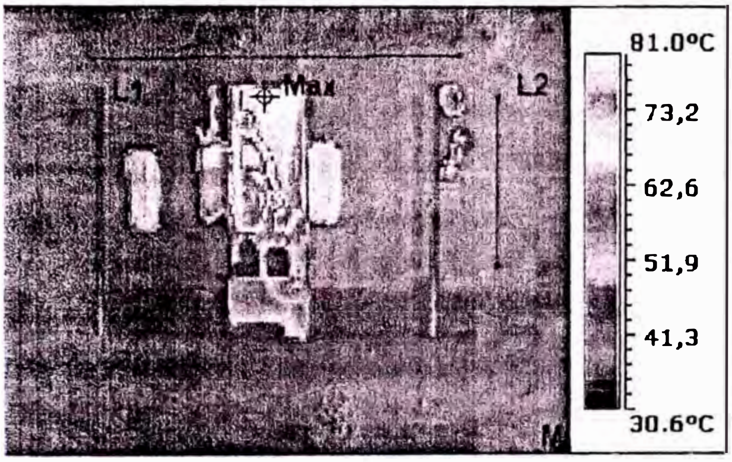
- No se observa anormalidades

Recomendaciones:

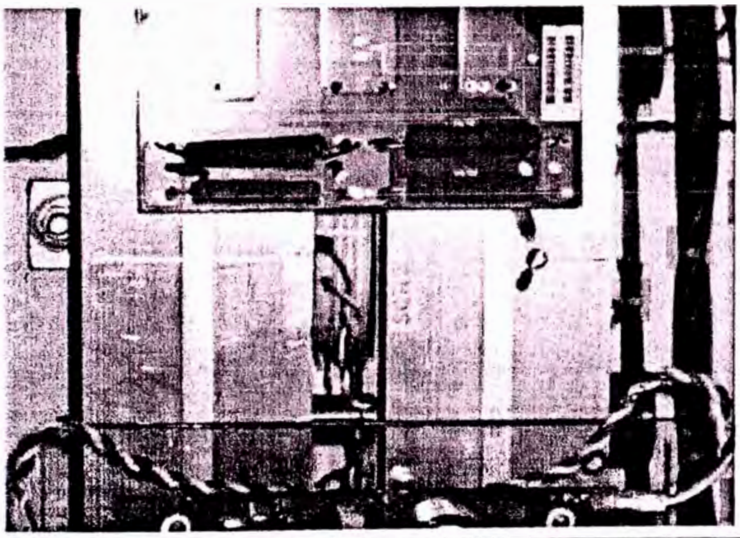
- Realizar próximo predictivo a 120 días de operación

Cliente: OWENS ILLINOIS PERU S.A.			**Planta: LURIN**		
Equipo: (Compresor Centac)			**Circuito:** (Tablero de control- SCR2)		
Nº Imagen:	IR000700.JPG	**Fecha:**	16/03/2011	**Hora:**	23:43:43
Emisividad:	0,98	**Temp Max:**	81,2℃	**Temp Min:**	36,0℃

Imágen Térmica



Imágen Visual



Parametro del Objeto	Valores
Max	**81,2℃**
Min	36,0℃
L2:Temp, Promedio	39,1℃
L2:Temp Max	41,1℃
L2:Temp Min	38,3℃
L2:Emisividad	0,98
L1:Temp, Promedio	39,9℃
L1:Temp Max	42,0℃
L1:Temp Min	38,9℃
L1:Emisividad	0,98

SCR1	72.9℃
SCR2	**81.2℃**
SCR3	74.6℃
SCR4	60.1℃
SCR5	62.2℃
SCR6	59.7℃

Relevancia:

NORMAL	X	LEVE		GRAVE		CRITICA	

Observaciones / Tipo de defecto encontrado

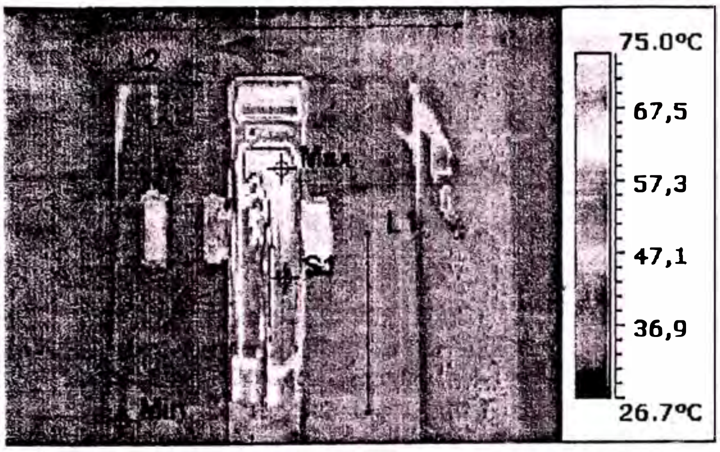
- No se observa anormalidades

Recomendaciones:

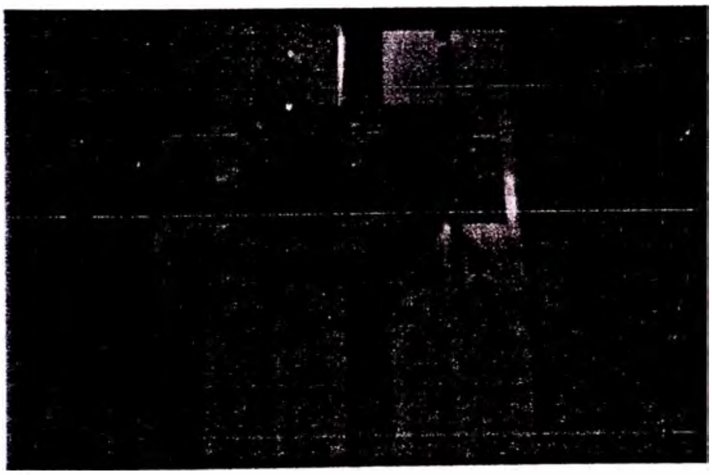
- Realizar próximo predictivo a 120 días de operación

Cliente: OWENS ILLINOIS PERU S.A.			**Planta: LURIN**		
Equipo: (Compresor Centac)			**Circuito:** (Tablero de control- SCR3)		
Nº Imagen:	IR000702.JPG	**Fecha:**	16/03/2011	**Hora:**	23:44:06
Emisividad:	0,98	**Temp Max:**	74,6℃	**Temp Min:**	32,7℃

Imágen Térmica



Imágen Visual



Parametro del Objeto	Valores
Max	74,6℃
Min	32,7℃
S1	69,4℃
L1:Temp, Promedio	35,3℃
L1:Temp Max	36,4℃
L1:Temp Min	34,4℃
L1:Emisividad	0,98
L2:Temp, Promedio	36,5℃
L2:Temp Max	37,6℃
L2:Temp Min	34,7℃
L2:Emisividad	0,98

SCR1	72.9℃
SCR2	81.2℃
SCR3	**74.6℃**
SCR4	60.1℃
SCR5	62.2℃
SCR6	59.7℃

Relevancia:

NORMAL	X	LEVE		GRAVE		CRITICA	

Observaciones / Tipo de defecto encontrado

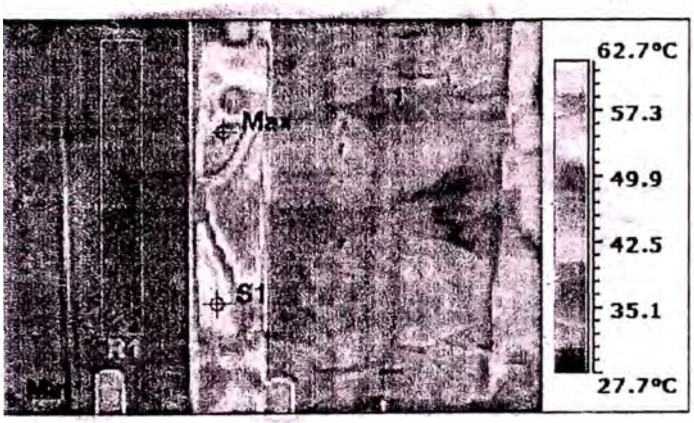
- No se observa anormalidades

Recomendaciones:

- Realizar próximo predictivo a 120 días de operación

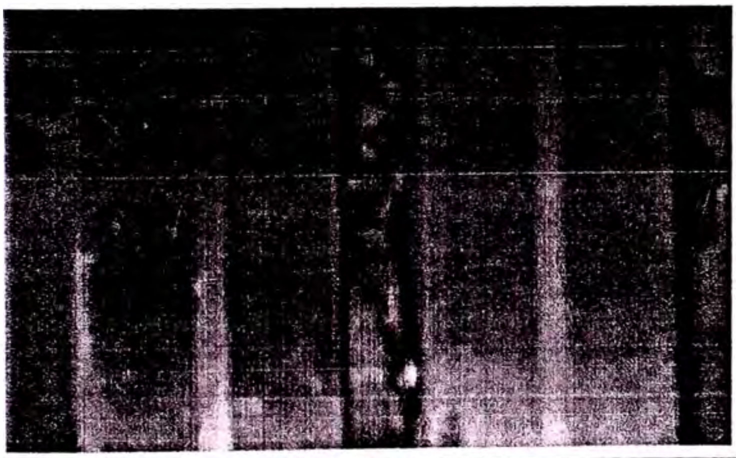
Cliente: OWENS ILLINOIS PERU S.A.			**Planta: LURIN**		
Equipo: (Compresor Centac)			**Circuito:** (Tablero de control- SCR4)		
Nº Imagen:	IR000699	**Fecha:**	16/03/2011	**Hora:**	11:43:30 p.m.
Emisividad:	0.98	**Temp Max:**	60.1℃	**Temp Min:**	33.6℃

Imágen Térmica



Parametro del Objeto	Valores
Max	60.1℃
Min	33.6℃
R1:Temp. Promedio	35.1℃
R1:Temp Max	36.7℃
R1:Temp Min	34.0℃
R1:Emisividad	0.98
S1	54.0℃

Imágen Visual



SCR1	72.9℃
SCR2	81.2℃
SCR3	74.6℃
SCR4	**60.1℃**
SCR5	62.2℃
SCR6	59.7℃

Relevancia:

NORMAL	X	LEVE		GRAVE		CRITICA	

Observaciones / Tipo de defecto encontrado

- No se observa anormalidades

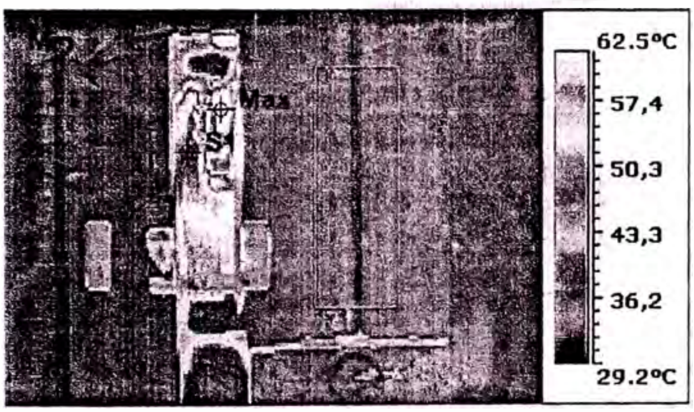
Recomendaciones:

- Realizar próximo predictivo a 180 días de operacion

Técnicas Predictivas.sac

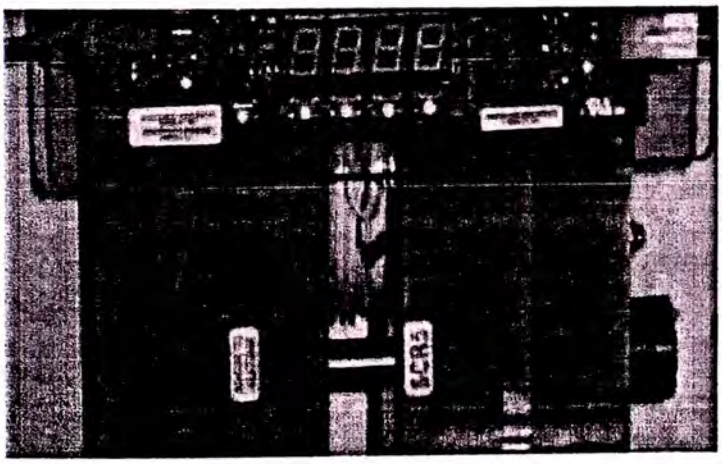
Cliente: OWENS ILLINOIS PERU S.A.			**Planta: LURIN**		
Equipo: (Compresor Centac)			**Circuito:** (Tablero de control- SCR5)		
Nº Imagen:	IR000701.JPG	**Fecha:**	16/03/2011	**Hora:**	23:43:54
Emisividad:	0,98	**Temp Max:**	62,2℃	**Temp Min:**	32,3℃

Imágen Térmica



Parametro del Objeto	Valores
Max	62,2℃
Min	32,3℃
S1	58,6℃
R1:Temp, Promedio	35,5℃
R1:Temp Max	40,6℃
R1:Temp Min	33,7℃
R1:Emisividad	0,98

Imágen Visual



SCR1	72.9℃
SCR2	81.2℃
SCR3	74.6℃
SCR4	60.1℃
SCR5	**62.2℃**
SCR6	59.7℃

Relevancia:

NORMAL	X	LEVE		GRAVE		CRITICA	

Observaciones / Tipo de defecto encontrado

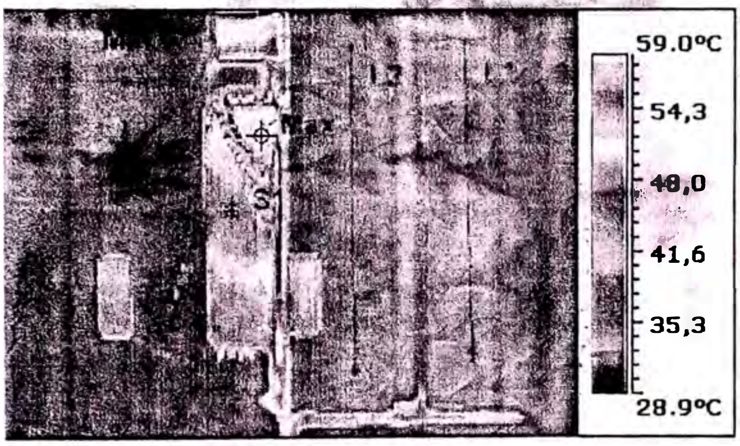
- No se observa anormalidades

Recomendaciones:

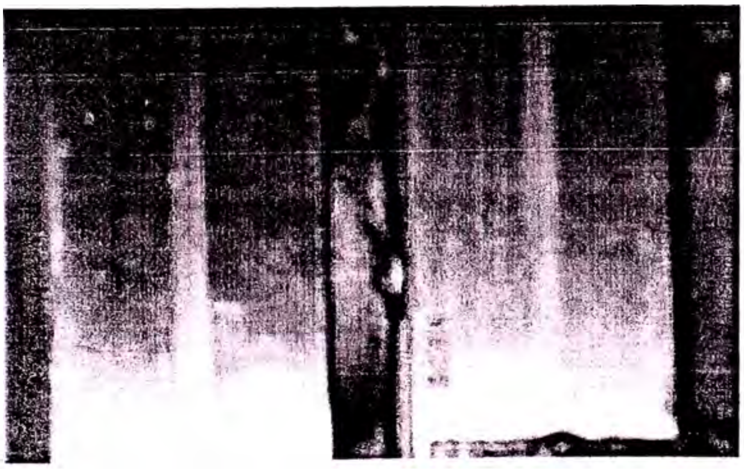
- Realizar próximo predictivo a 120 días de operación

Cliente: OWENS ILLINOIS PERU S.A.			**Planta: LURIN**		
Equipo: (Compresor Centac)			**Circuito:** (Tablero de control- SCR6)		
Nº Imagen:	IR000703.JPG	**Fecha:**	16/03/2011	**Hora:**	23:44:15
Emisividad:	0,98	**Temp Max:**	59,7℃	**Temp Min:**	32,4℃

Imágen Térmica



Imágen Visual



Parametro del Objeto	Valores
Max	59,7℃
Min	32,4℃
L1:Temp, Promedio	34,8℃
L1:Temp Max	36,1℃
L1:Temp Min	33,3℃
L1:Emisividad	0,98
L2:Temp, Promedio	35,7℃
L2:Temp Max	36,6℃
L2:Temp Min	35,1℃
L2:Emisividad	0,98
S1	55,2℃

SCR1	72.9℃
SCR2	81.2℃
SCR3	74.6℃
SCR4	60.1℃
SCR5	62.2℃
SCR6	**59.7℃**

Relevancia:

NORMAL	X	LEVE		GRAVE		CRITICA	

Observaciones / Tipo de defecto encontrado

- No se observa anormalidades

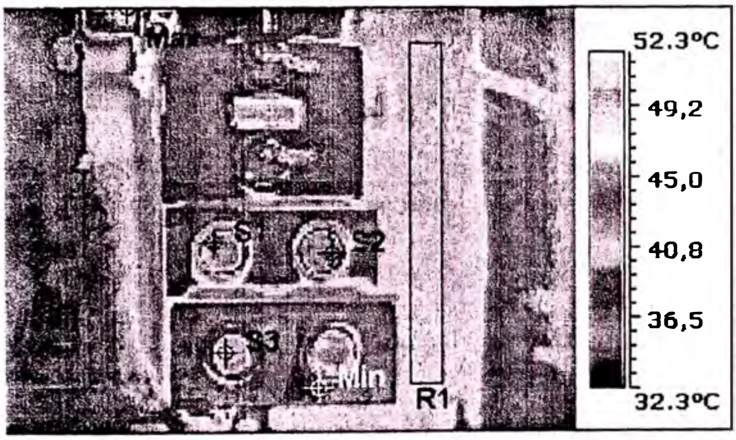
Recomendaciones:

- Realizar próximo predictivo a 120 días de operación

Técnicas Predictivas s.a.c

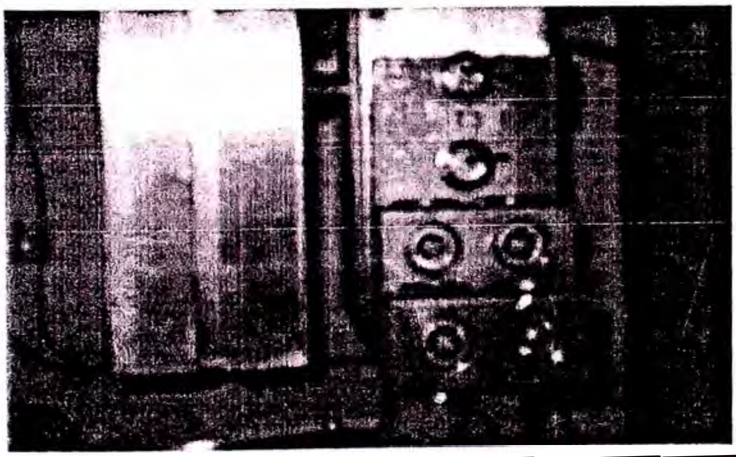
Cliente: OWENS ILLINOIS PERU S.A.			**Planta: LURIN**		
Equipo: (Compresor Centac)			**Circuito:** (Bornera OUT- T3)		
Nº Imagen:	IR000706.JPG	**Fecha:**	16/03/2011	**Hora:**	23:44:48
Emisividad:	0,98	**Temp Max:**	51,8℃	**Temp Min:**	33,7℃

Imágen Térmica



Parametro del Objeto	Valores
Max	51,8℃
Min	33,7℃
S1	44,0℃
S2	45,0℃
S3	42,1℃
R1:Temp, Promedio	41,4℃
R1:Temp Max	42,4℃
R1:Temp Min	40,6℃
R1:Emisividad	0,98

Imágen Visual



Relevancia:

NORMAL	X	LEVE		GRAVE		CRITICA	

Observaciones / Tipo de defecto encontrado

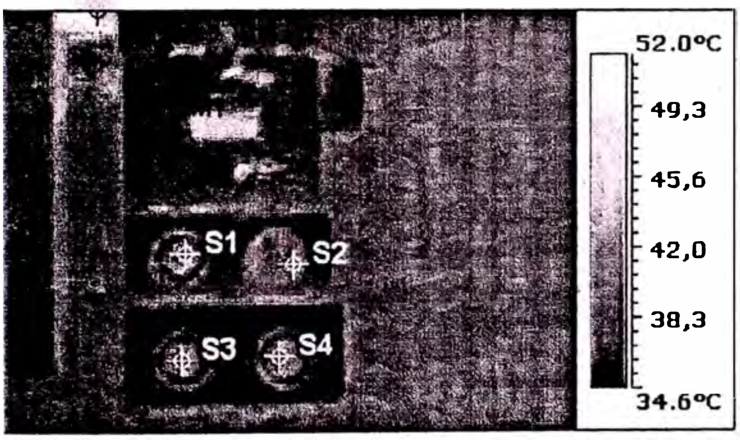
- No se observa recalentamientos a causa de solturas en los elementos de conexión.

Recomendaciones:

- Realizar próximo predictivo a 120 días de operación

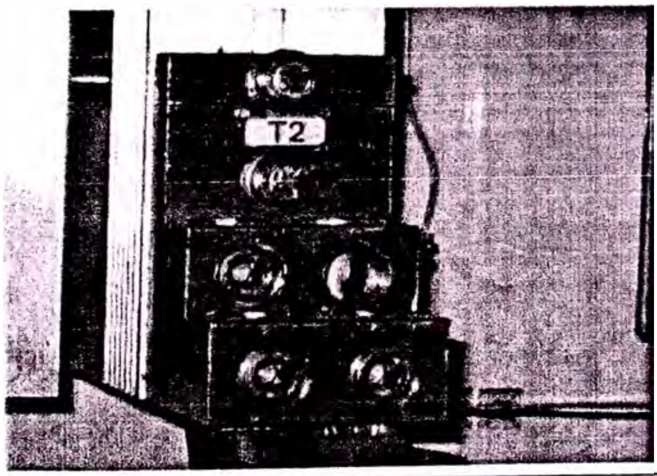
Cliente: OWENS ILLINOIS PERU S.A.			**Planta: LURIN**		
Equipo: (Compresor Centac)			**Circuito:** (Bornera OUT- T2)		
Nº Imagen:	IR000705.JPG	**Fecha:**	16/03/2011	**Hora:**	23:44:40
Emisividad:	0,98	**Temp Max:**	52,8℃	**Temp Min:**	32,8℃

Imágen Térmica



Parametro del Objeto	Valores
Max	52,8℃
Min	32,8℃
S1	42,7℃
S2	42,3℃
S3	41,5℃
S4	40,3℃

Imágen Visual



Relevancia:

NORMAL	X	LEVE		GRAVE		CRITICA	

Observaciones / Tipo de defecto encontrado

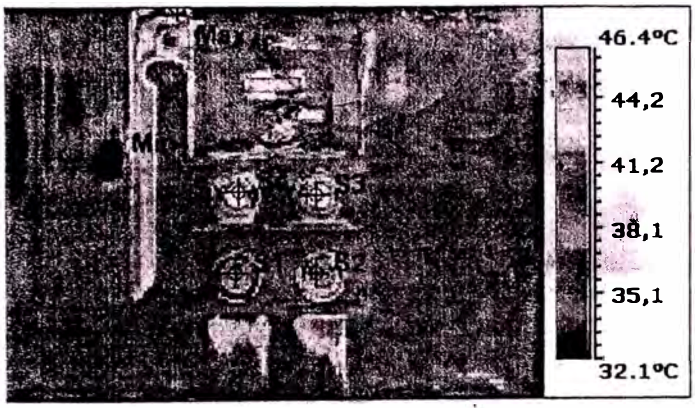
- No se observa recalentamientos a causa de solturas en los elementos de ajuste o similar.

Recomendaciones:

- Realizar próximo predictivo a 120 días de operación

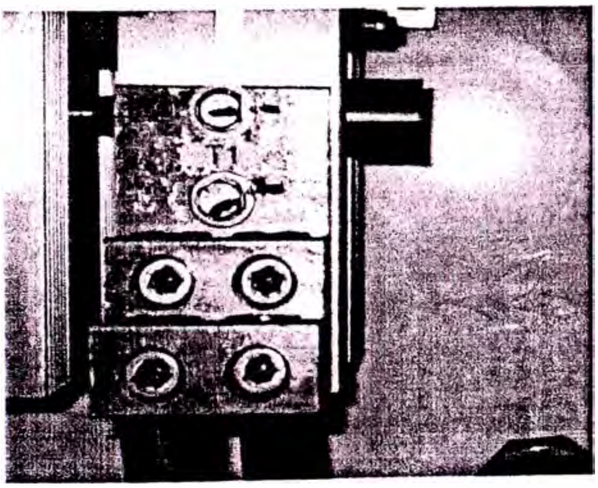
Cliente: OWENS ILLINOIS PERU S.A.			**Planta: LURIN**		
Equipo: (Compresor Centac)			**Circuito:** (Bornera OUT- T1)		
Nº Imagen:	IR000704.JPG	**Fecha:**	16/03/2011	**Hora:**	23:44:29
Emisividad:	0,98	**Temp Max:**	46,6℃	**Temp Min:**	31,8℃

Imágen Térmica



Parametro del Objeto	Valores
Max	46,6℃
Min	31,8℃
S1	40,7℃
S2	40,5℃
S3	41,8℃
S4	43,0℃

Imágen Visual



Relevancia:

NORMAL	LEVE	GRAVE	CRITICA
X			

Observaciones / Tipo de defecto encontrado

- No se observa recalentamientos a causa de solturas en los elementos de ajuste o similar.

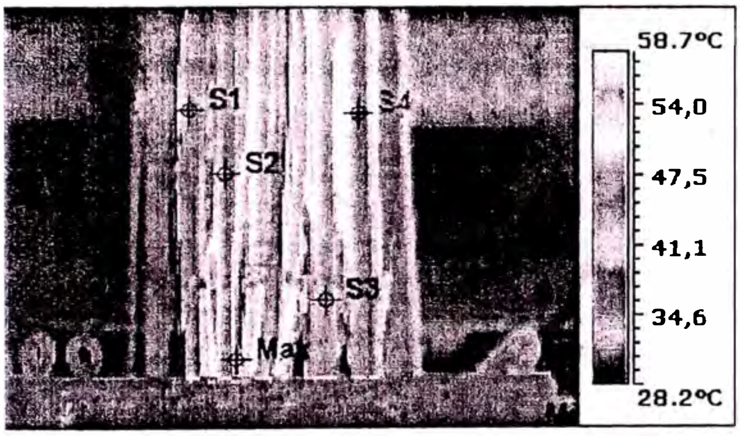
Recomendaciones:

- Realizar próximo predictivo a 120 días de operación

Técnicas Predictivas.sac

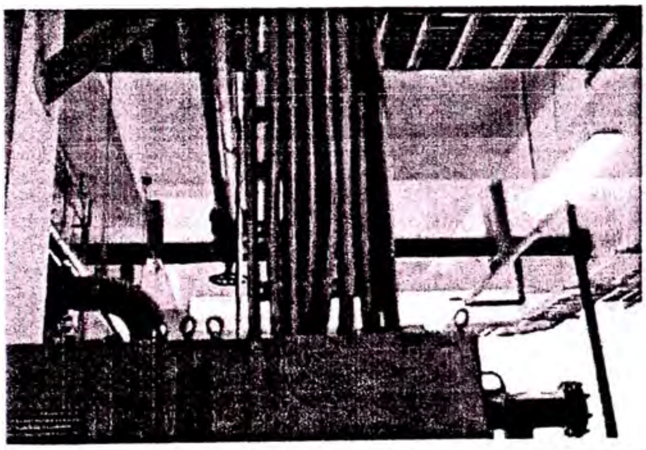
Cliente: OWENS ILLINOIS PERU S.A.			Planta: LURIN		
Equipo: (Compresor Centac)			**Circuito:** (Canaleta entrada al tablero)		
Nº Imagen:	IR000711.JPG	**Fecha:**	16/03/2011	**Hora:**	23:47:37
Emisividad:	0,98	**Temp Max:**	55,8℃	**Temp Min:**	28,3℃

Imágen Térmica



Parametro del Objeto	Valores
Max	55,8℃
Min	28,3℃
S1	45,2℃
S2	46,8℃
S3	47,8℃
S4	46,8℃

Imágen Visual



Relevancia:

NORMAL	X	LEVE		GRAVE		CRITICA	

Observaciones / Tipo de defecto encontrado

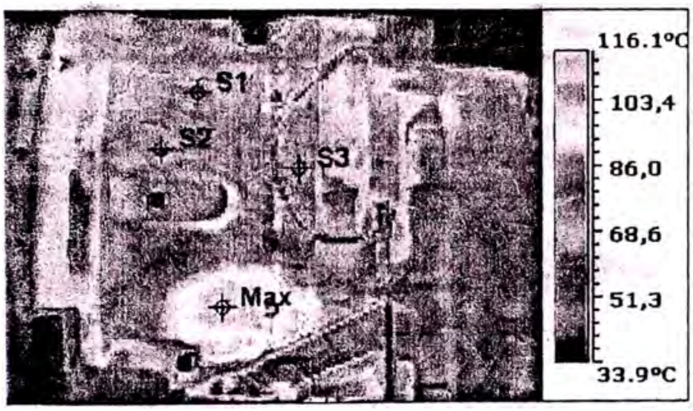
- No se observa anormalidades en los conductores

Recomendaciones:

- Realizar próximo predictivo a 120 días de operación

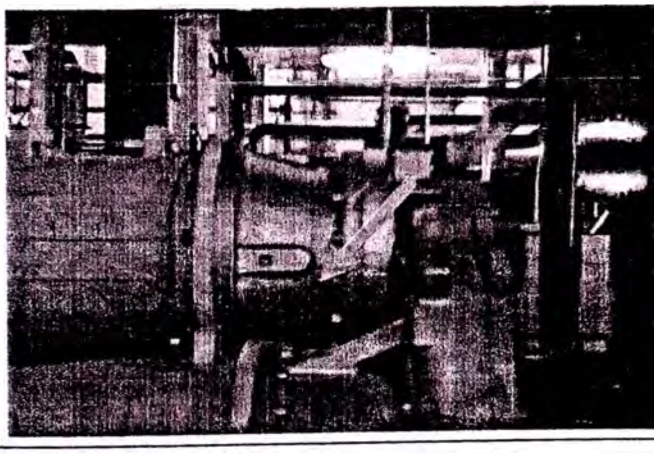
Cliente: OWENS ILLINOIS PERU S.A.			**Planta: LURIN**		
Equipo: (Compresor Centac)			**Parte:** (Impulsor central - I-2)		
Nº Imagen:	IR000712.JPG	**Fecha:**	16/03/2011	**Hora:**	23:48:56
Emisividad:	0,98	**Temp Max:**	102,3℃	**Temp Min:**	32,6℃

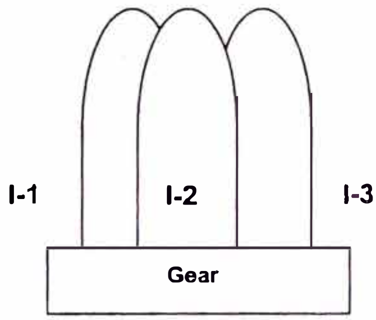
Imágen Térmica



Parametro del Objeto	Valores
Max	102,3℃
Min	32,6℃
S1	84,8℃
S2	79,7℃
S3	79,6℃

Imágen Visual





Relevancia:

NORMAL	LEVE	GRAVE	CRITICA
X			

Observaciones / Tipo de defecto encontrado

- Se observa una ligera acumulación de calor en la parte inferior de la carcasa del rotor del impulsor I-2

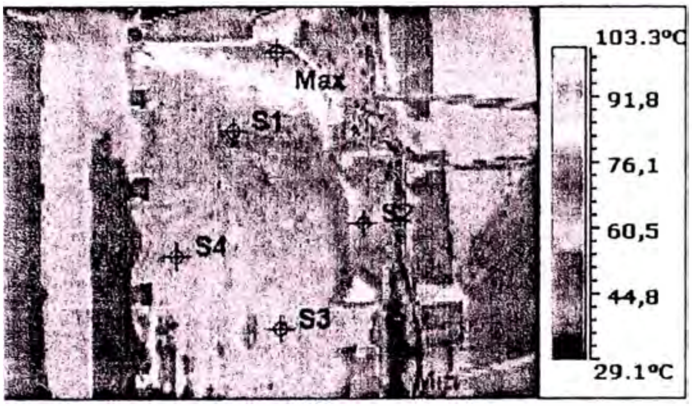
Recomendaciones:

- Hacer seguimiento termográfico y/o comparación con equipos similares para determinar la severidad y/o normalidad de la observación.
- Realizar próximo predictivo a 120 días de operación

Técnicas Predictivas.sac

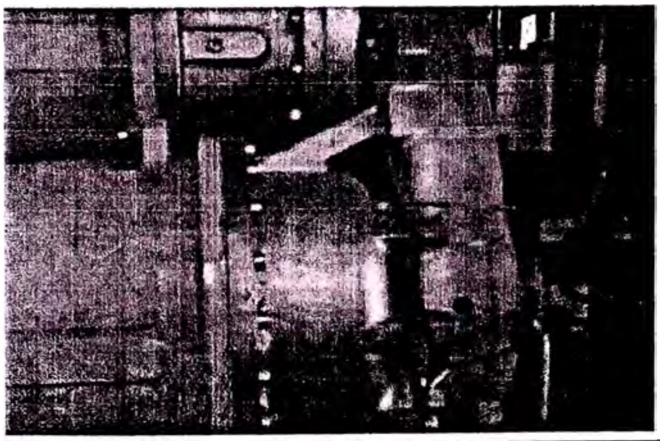
Cliente: OWENS ILLINOIS PERU S.A.			**Planta: LURIN**		
Equipo: (Compresor Centac)			**Parte:** (Impulsor inferior I-1)		
Nº Imagen:	IR000713.JPG	**Fecha:**	16/03/2011	**Hora:**	23:49:11
Emisividad:	0,98	**Temp Max:**	98,8℃	**Temp Min:**	34,0℃

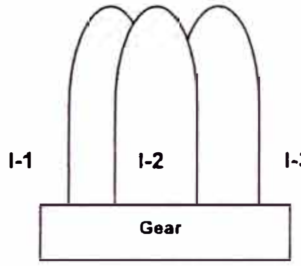
Imágen Térmica



Parametro del Objeto	Valores
Max	98,8℃
Min	34,0℃
S1	75,8℃
S2	79,4℃
S3	60,6℃
S4	64,5℃

Imágen Visual





Relevancia:

NORMAL	LEVE	GRAVE	CRITICA
X			

Observaciones / Tipo de defecto encontrado

- Se observa una ligera acumulación de calor en la parte superior de la carcasa del rotor I-1

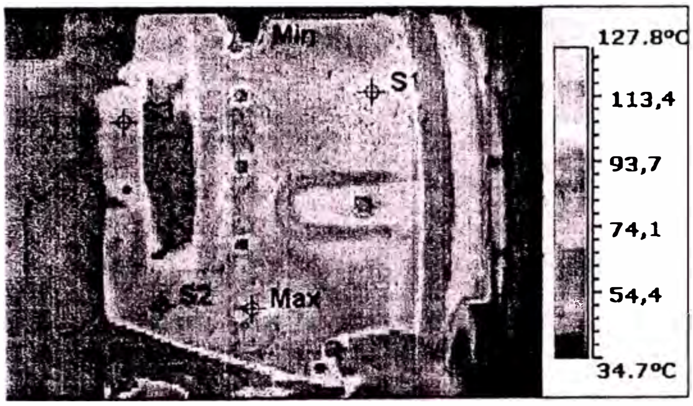
Recomendaciones:

- Hacer seguimiento termográfico y/o comparación con equipos similares para determinar la severidad y/o normalidad de la observación.
- Realizar próximo predictivo a 120 días de operación

Técnicas Predictivas sac

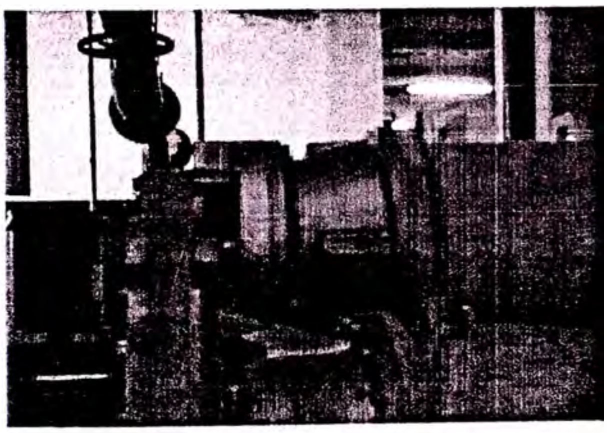
Cliente: OWENS ILLINOIS PERU S.A.			**Planta: LURIN**		
Equipo: (Compresor Centac)			**Parte:** (Impulsor inferior I-1 - Vista posterior)		
Nº Imagen:	IR000720.JPG	**Fecha:**	16/03/2011	**Hora:**	23:52:36
Emisividad:	0,98	**Temp Max:**	103,7℃	**Temp Min:**	32,8℃

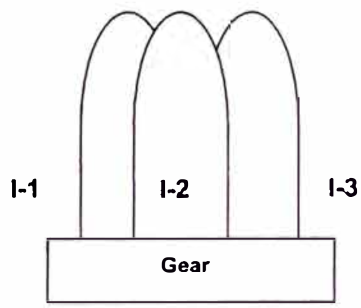
Imágen Térmica



Parametro del Objeto	Valores
Max	103,7℃
Min	32,8℃
S1	81,9℃
S2	94,8℃
S3	83,9℃

Imágen Visual





Relevancia:

NORMAL	X	LEVE		GRAVE		CRITICA	

Observaciones / Tipo de defecto encontrado

- Se observa una ligera acumulación de calor en la parte Inferior de ia carcasa del rotor I-2 (vista posterior), ver imagen IR000720.JPG

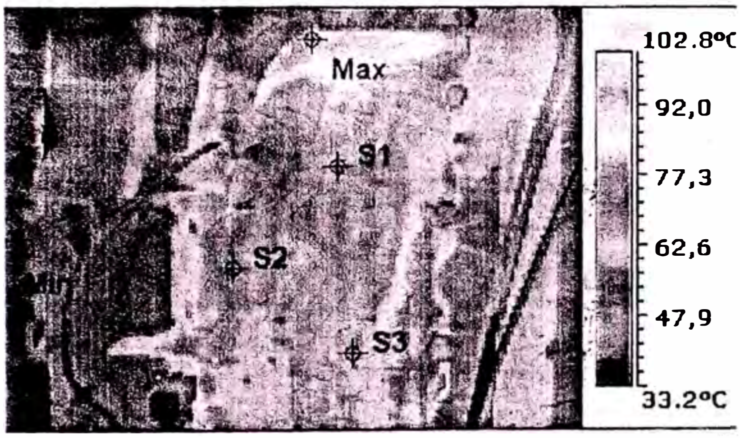
Recomendaciones:

- Hacer seguimiento termográfico y/o comparación con equipos similares para determinar la severidad y/o normalidad de la observación.
- Realizar próximo predictivo a 120 días de operación

Técnicas Predictivas sac

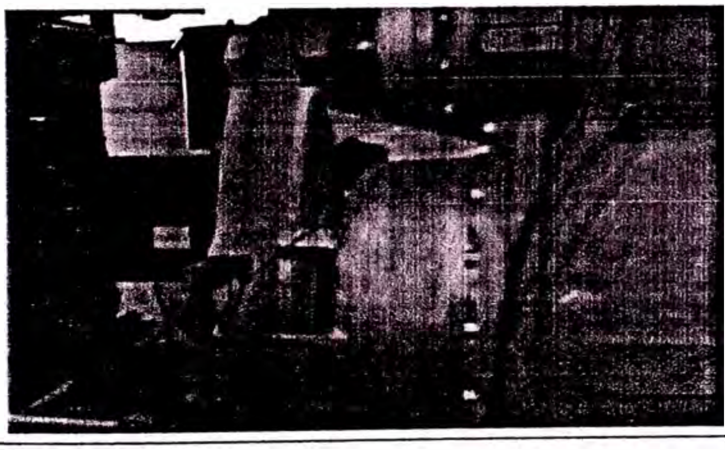
Cliente: OWENS ILLINOIS PERU S.A.			**Planta: LURIN**		
Equipo: (Compresor Centac)			**Parte:** (Impulsor inferior I-3 - Vista posterior)		
Nº Imagen:	IR000721.JPG	**Fecha:**	16/03/2011	**Hora:**	23:52:59
Emisividad:	0,98	**Temp Max:**	92,8℃	**Temp Min:**	32,6℃

Imágen Térmica



Parametro del Objeto	Valores
Max	92,8℃
Min	32,6℃
S1	80,0℃
S2	71,2℃
S3	69,6℃

Imágen Visual



Relevancia:

NORMAL X	LEVE	GRAVE	CRITICA

Observaciones / Tipo de defecto encontrado

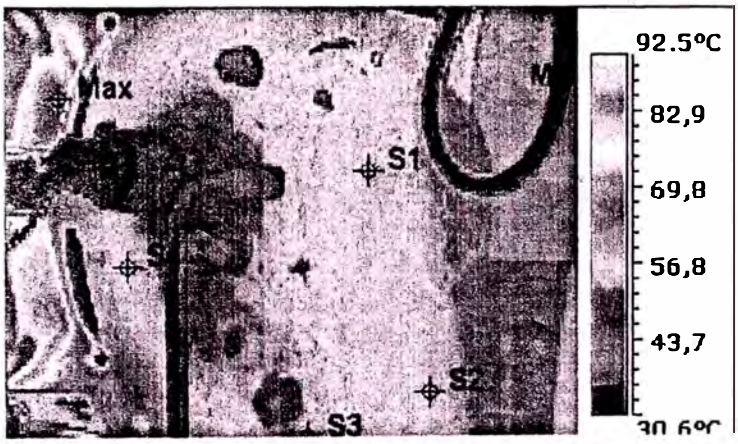
- Se observa una ligera acumulación de calor en la parte superior de la carcasa del rotor I-3
- La parte caliente (Max) es la zona de compresión del impulsor que normalmente genera calor

Recomendaciones:

- Hacer seguimiento termográfico y/o comparación con equipos similares para determinar la severidad y/o normalidad de la observación.
- Realizar próximo predictivo a 120 días de operación

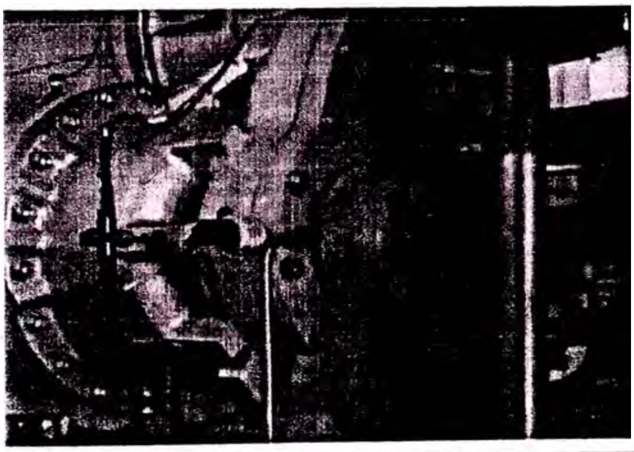
Cliente: OWENS ILLINOIS PERU S.A.			**Planta: LURIN**		
Equipo: (Compresor Centac)			**Parte:** (Impulsor inferior I-1)		
Nº Imagen:	IR000715.JPG	**Fecha:**	16/03/2011	**Hora:**	23:49:49
Emisividad:	0,98	**Temp Max:**	83,7℃	**Temp Min:**	34,1℃

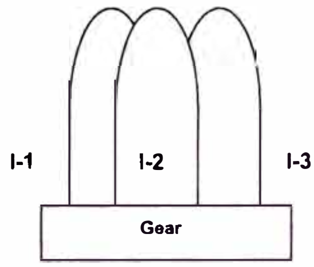
Imágen Térmica



Parametro del Objeto	Valores
Max	83,7℃
Min	34,1℃
S1	56,8℃
S2	57,8℃
S3	55,7℃
S4	58,0℃

Imágen Visual





Relevancia:

NORMAL	LEVE	GRAVE	CRITICA
X			

Observaciones / Tipo de defecto encontrado

- No se observa anormalidades en el acople piñón – corona
- La parte caliente (Max) es la zona de compresión del impulsor que normalmente genera calor

Recomendaciones:

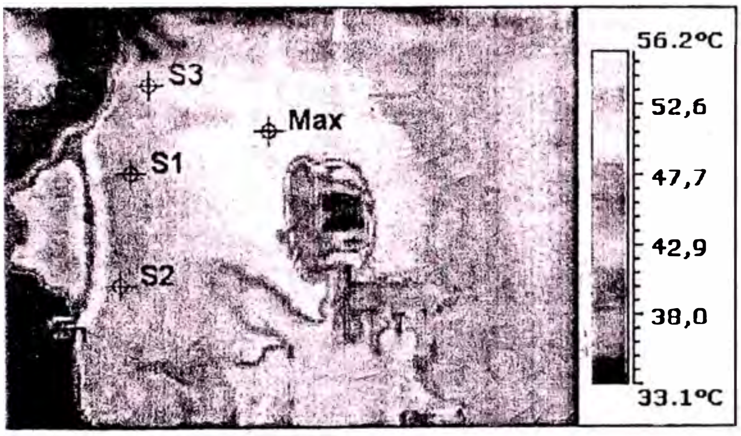
- Hacer seguimiento termográfico y/o comparación con equipos similares para determinar la severidad y/o normalidad de la observación.
- Realizar próximo predictivo a 120 días de operación

Técnicas Predictivas S.A.C.

Cliente: OWENS ILLINOIS PERU S.A.		**Planta: LURIN**	
Equipo: (Compresor Centac)		**Parte:** (Cojinete lado acople)	

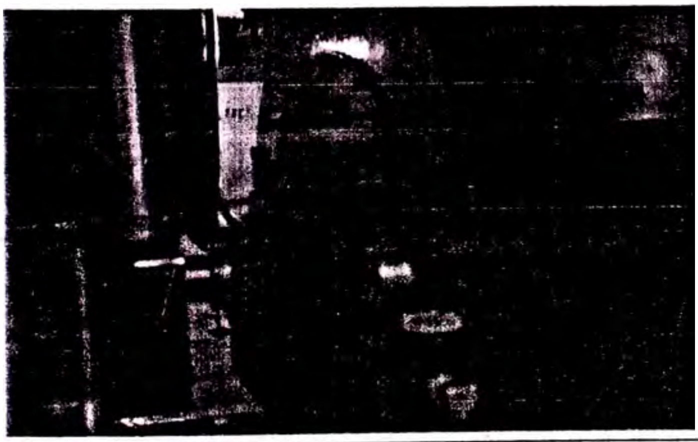
Nº Imagen:	IR000716.JPG	**Fecha:**	16/03/2011	**Hora:**	23:50:26
Emisividad:	0,98	**Temp Max:**	50,6℃	**Temp Min:**	26,3℃

Imágen Térmica



Parametro del Objeto	Valores
Max	50,6℃
Min	26,3℃
S1	48,7℃
S2	48,7℃
S3	48,9℃

Imágen Visual



Relevancia:

NORMAL	X	LEVE		GRAVE		CRITICA	

Observaciones / Tipo de defecto encontrado

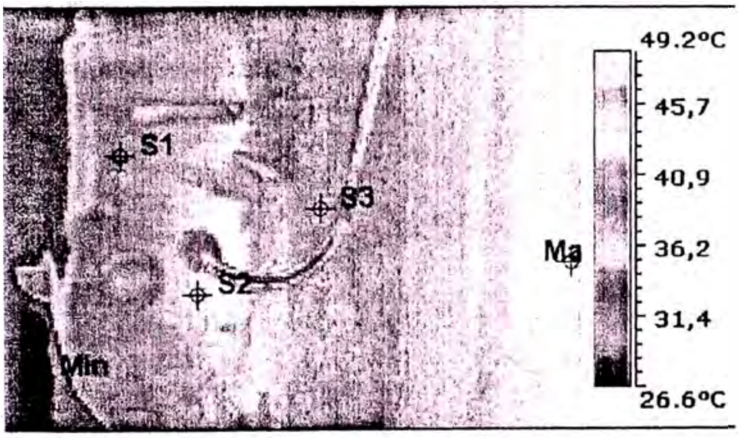
- No se observa anormalidades

Recomendaciones:

- Realizar próximo predictivo a 120 días de operación

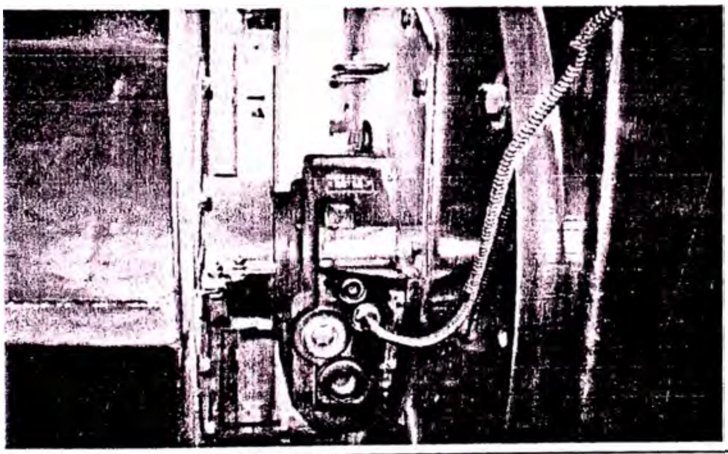
Cliente: OWENS ILLINOIS PERU S.A.			Planta: LURIN		
Equipo: (Compresor Centac)			**Parte:** (Cojinete lado Libre)		
Nº Imagen:	IR000718.JPG	**Fecha:**	16/03/2011	**Hora:**	23:51:29
Emisividad:	0,98	**Temp Max:**	43,4℃	**Temp Min:**	26,6℃

Imágen Térmica



Parametro del Objeto	Valores
Max	43,4℃
Min	26,6℃
S1	40,2℃
S2	42,6℃
S3	42,1℃

Imágen Visual



Relevancia:

NORMAL	X	LEVE		GRAVE		CRITICA	

Observaciones / Tipo de defecto encontrado

- No se observa anormalidades

Recomendaciones:

- Realizar próximo predictivo a 120 días de operación

C: Análisis Vibracional

INFORME ANÁLISIS VIBRACIONAL

OWENS ILLINOIS

PLANTA LURIN

LIMA, DICIEMBRE 2010

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ISO 10816-3

Estándar de evaluación para supervisión de vibraciones

El valor eficaz de la velocidad de la vibración se utiliza para determinar la condición de la máquina. Este valor se puede determinar con casi todos los instrumentos convencionales para la medición de vibración.

DIN ISO 10816-3 clasifica las máquinas en diferentes grupos y toma en cuenta el tipo de instalación.

Verde: Zona A

Valores de vibración de máquina recién puestas en funcionamiento.

Amarillo: Zona B

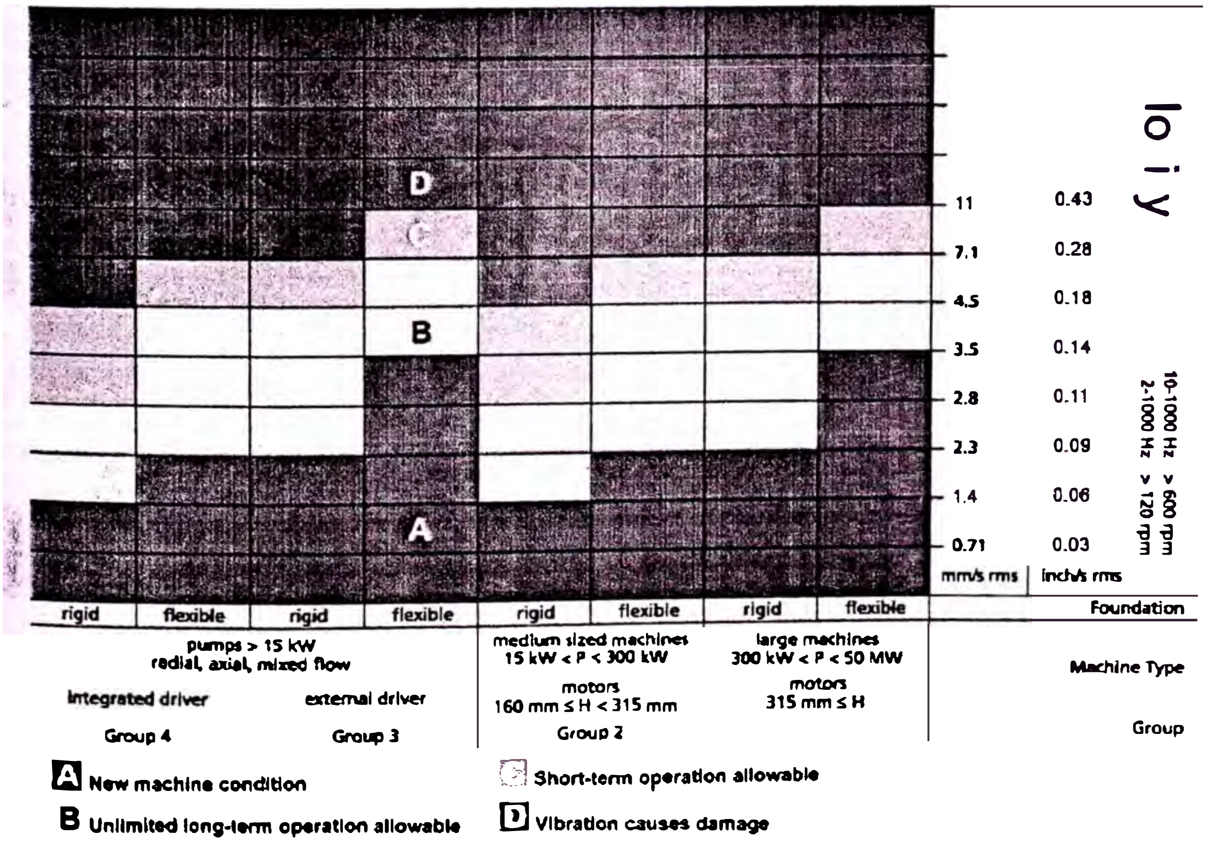
Máquinas pueden funcionar en operación continua sin restricciones.

Naranja: Zona C

Valores de vibración en amarillo indican que la condición de la máquina no es conveniente para una operación continua, sinó solamente para un período de tiempo limitado. Medida de corrección deberían ser tomadas en la siguiente oportunidad.

Rojo: Zona D

Valores de vibración peligrosos – la máquina puede sufrir daños.

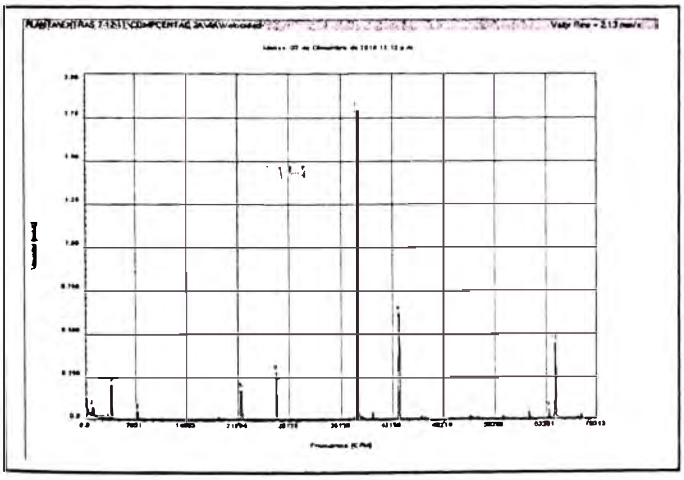


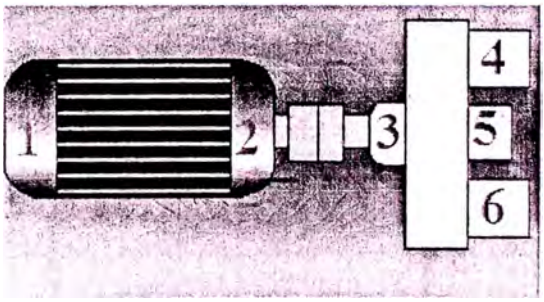
REPORTE DE ANALISIS VIBRACIONAL

Nº ESI-10808-10

EMPRESA	OWENS ILLINOIS	**NORMAS ISO 10816-3**	**NIVEL TOTAL**		**ESTADO**	
AREA	PLANTA LURIN					
MAQUINA	COMPRESORA CENTAC N°2	**VIBRACION EN UNIDADES DE VELOCIDAD**	**2.13 mm/s**		**ACEPTABLE**	
VELOCIDAD	3559 RPM / **POTENCIA** HP				**TOLERABLE**	
REALIZADO POR	ING. TEC. JONATHAN GAMIO	**REVISADO POR** ING. VICTOR ENCINAS BELTRAN	**FECHA**	08/12/2010	**NO PERMISIBLE**	

Punto 4A en Velocidad





Pico	CPM	Ordenes	mm/s
1	263.7	0.2X	0.068
2	966.8	0.6X	0.074
3	3603.5	2.1X	0.204
4	7207.0	4.1X	0.053
5	21533.2	12.3X	0.173
6	26367.2	15.1X	0.280
7	37353.5	21.3X	1.791
8	43066.4	24.6X	0.616
9	63764.6	36.4X	0.061
10	64555.7	36.9X	0.440

STATUS MACHINE

CONDITION

DIAGNOSTICO

- *Motor* : *Buen estado, vibración inducida del compresor, falla incipiente de rodamientos.*
- *Compresor* : *Buen estado, falla incipiente de rodamientos.*

RECOMENDACIONES

- *Motor* : *Monitoreo vibracional cada 30 días.*
- *Compresor* : *Monitoreo vibracional cada 30 días.*

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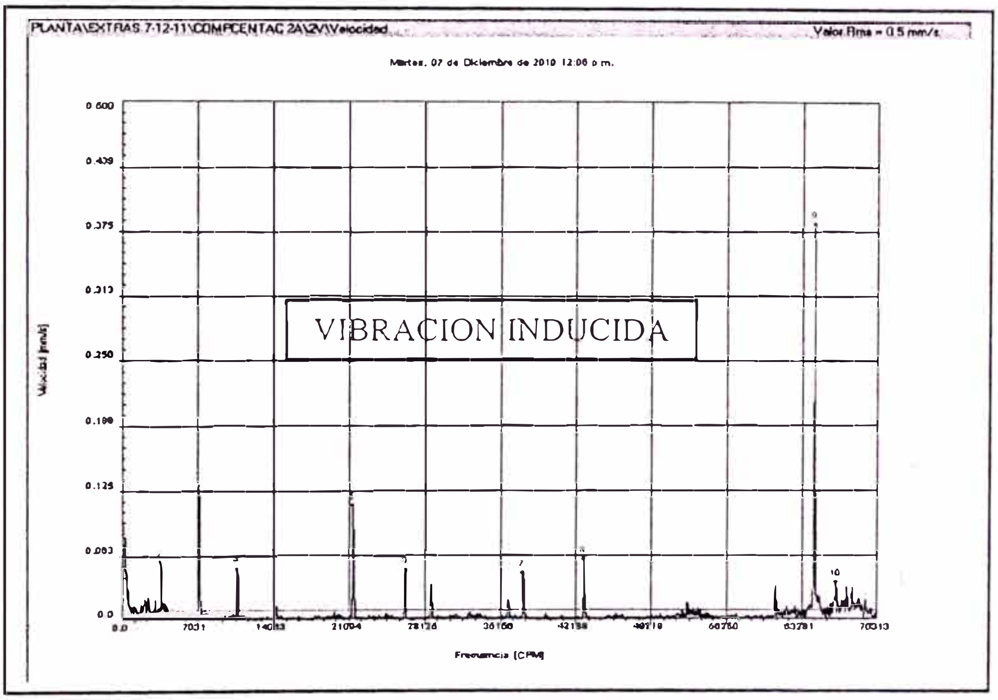
Espectros Vibracionales

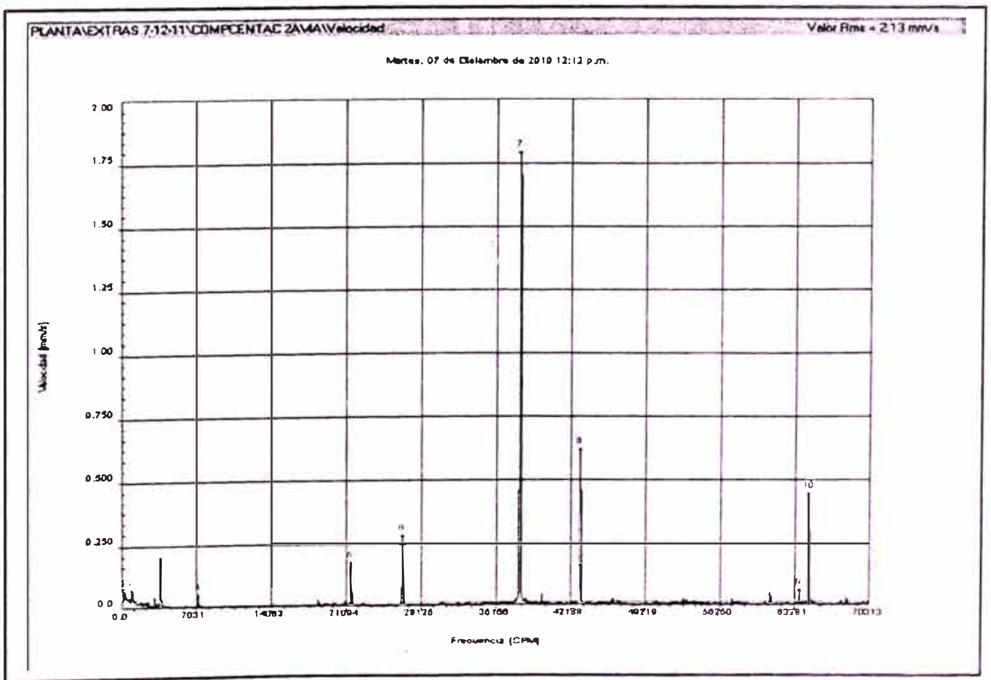
Punto 2V Valor RMS 0.5 mm/s

CPM	Ordenes	mm/s
263.7	0.2X	0.079
3559.6	2.0X	0.056
7163.1	4.1X	0.130
10722.7	6.1X	0.050
21489.3	12.3X	0.110
26323.2	15.0X	0.049
37265.6	21.3X	0.045
42934.6	24.5X	0.058
64423.8	36.8X	0.382
66489.3	38.0X	0.037



Punto 4A Valor RMS 2.13 mm/s

CPM	Ordenes	mm/s
263.7	0.2X	0.068
966.8	0.6X	0.074
3603.5	2.1X	0.204
7207.0	4.1X	0.053
21533.2	12.3X	0.173
26367.2	15.1X	0.280
37353.5	21.3X	1.791
43066.4	24.6X	0.616
63764.6	36.4X	0.061
64555.7	36.9X	0.440



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REPORTE DE ANALISIS VIBRACIONAL

Nº ESI-10809-10

<table>
<tr><td>EMPRESA</td><td colspan="3">OWENS ILLINOIS</td><td colspan="2" rowspan="2">NORMAS ISO 10816-3</td><td colspan="2" rowspan="2">NIVEL TOTAL</td><td colspan="2" rowspan="2">ESTADO</td></tr>
<tr><td>AREA</td><td colspan="3">PLANTA LURIN</td></tr>
<tr><td>MAQUINA</td><td colspan="3">COMPRESORA CENTAC N°3</td><td colspan="2" rowspan="2">VIBRACION EN UNIDADES DE VELOCIDAD</td><td colspan="2" rowspan="2">2.53 mm/s</td><td>ACEPTABLE</td><td></td></tr>
<tr><td>VELOCIDAD</td><td>3559 RPM</td><td>POTENCIA</td><td>HP</td><td>TOLERABLE</td><td></td></tr>
<tr><td>REALIZADO POR</td><td colspan="3">ING. TEC. JONATHAN GAMIO</td><td>REVISADO POR</td><td>ING. VICTOR ENCINAS BELTRAN</td><td>FECHA</td><td>07/12/2010</td><td>NO PERMISIBLE</td><td></td></tr>
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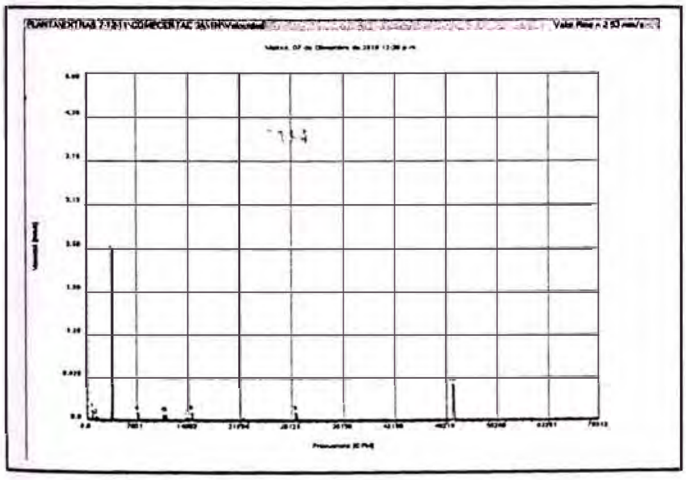
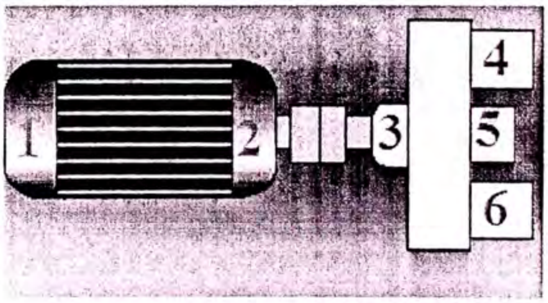
Punto 1H en Velocidad

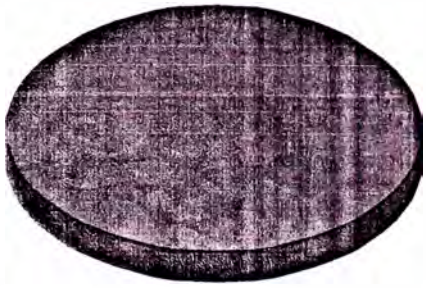




Pico	CPM	Ordenes	mm/s
1	835.0	0.5X	0.147
2	1362.3	0.8X	0.063
3	3559.6	2.0X	2.420
4	7163.1	4.1X	0.120
5	10678.7	6.1X	0.091
6	11030.3	6.3X	0.093
7	13886.7	7.9X	0.057
8	14589.8	8.3X	0.123
9	28740.2	16.4X	0.115
10	50141.6	28.7X	0.528

STATUS MACHINE

CONDITION



BUEN ESTADO

DIAGNOSTICO

- *Motor : Buen estado, falla incipiente de rodamientos.*
- *Compresor : Buen estado.*

RECOMENDACIONES

- *Motor : Monitoreo vibracional cada 30 días.*
- *Compresor : Monitoreo vibracional cada 30 días.*

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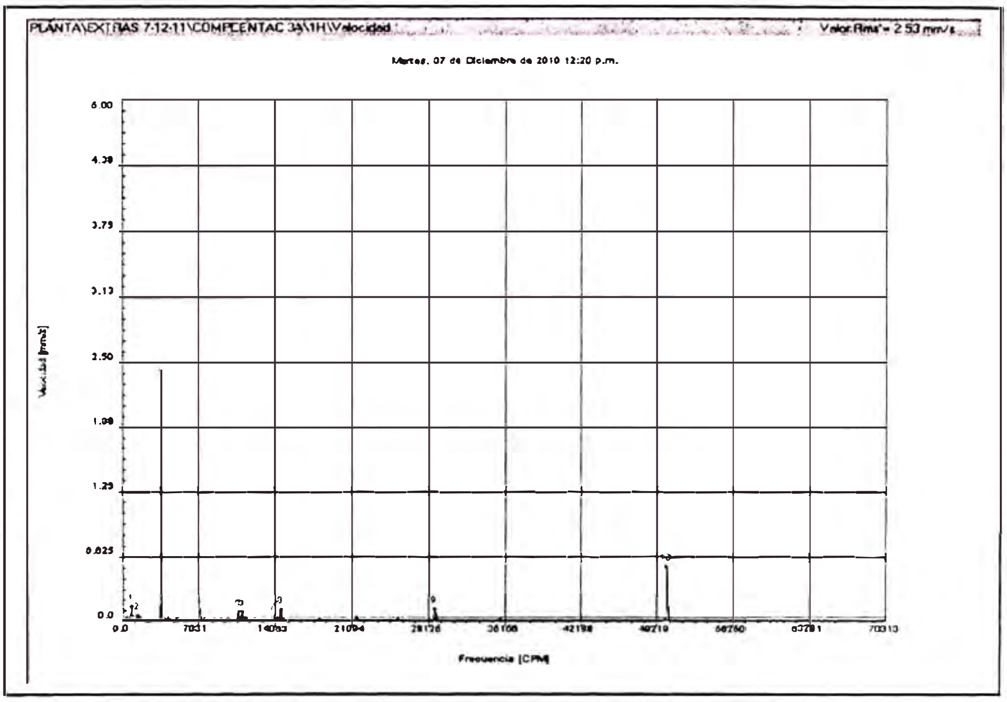
Espectros Vibracionales

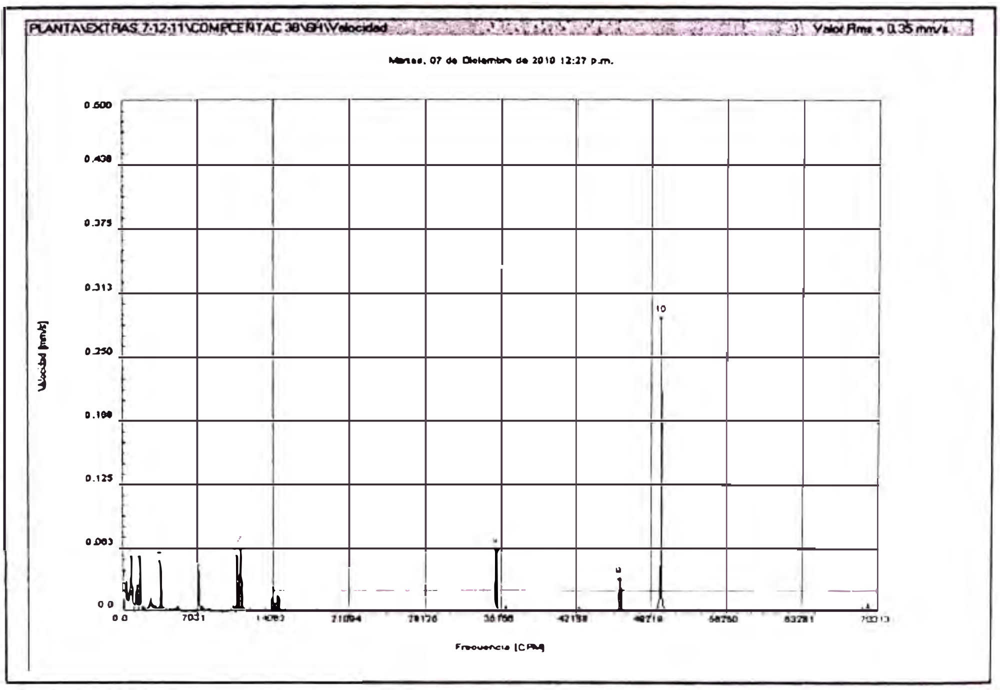
Punto 1H Valor RMS 2.53 mm/s

ico	CPM	Ordenes	mm/s
1	835.0	0.5X	0.147
2	1362.3	0.8X	0.063
3	3559.6	2.0X	2.420
4	7163.1	4.1X	0.120
5	10678.7	6.1X	0.091
6	11030.3	6.3X	0.093
7	13886.7	7.9X	0.057
8	14589.8	8.3X	0.123
9	28740.2	16.4X	0.115
10	50141.6	28.7X	0.528



Punto 6H Valor RMS 0.35 mm/s

Pico	CPM	Ordenes	mm/s
1	307.6	0.2X	0.029
2	835.0	0.5X	0.054
3	1626.0	0.9X	0.053
4	3559.6	2.0X	0.050
5	7163.1	4.1X	0.046
6	10678.7	6.1X	0.054
7	11030.3	6.3X	0.062
8	34716.8	19.8X	0.060
9	46318.4	26.5X	0.032
10	50141.6	28.7X	0.288



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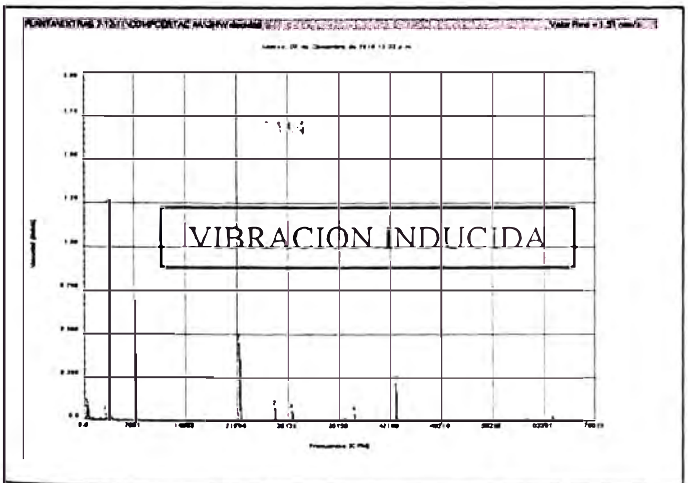
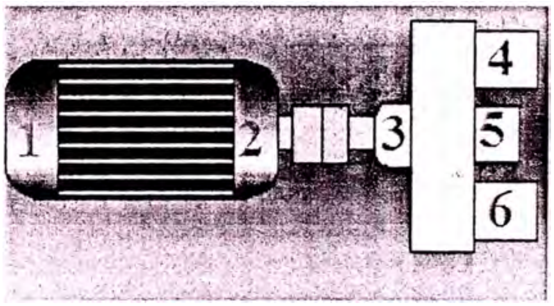
REPORTE DE ANALISIS VIBRACIONAL

Nº ESI-10810-10

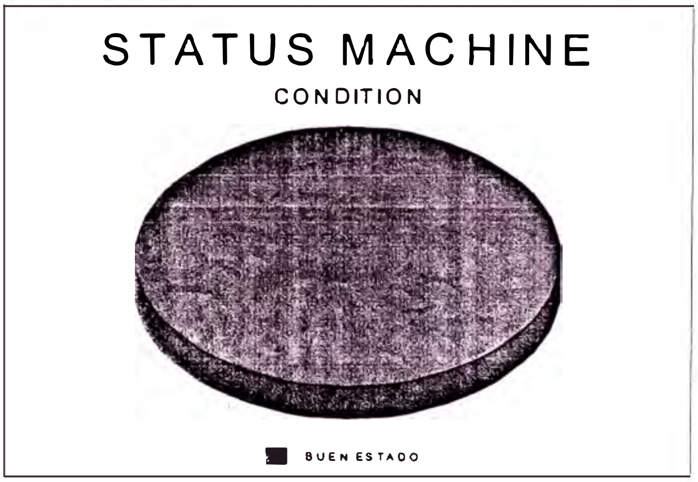
<table>
<tr><td>EMPRESA</td><td colspan="3">OWENS ILLINOIS</td><td colspan="2" rowspan="2">NORMAS ISO 10816-3</td><td colspan="2" rowspan="2">NIVEL TOTAL</td><td colspan="2" rowspan="2">ESTADO</td></tr>
<tr><td>AREA</td><td colspan="3">PLANTA LURIN</td></tr>
<tr><td>MAQUINA</td><td colspan="3">COMPRESORA CENTAC N°4</td><td colspan="2" rowspan="2">VIBRACION EN UNIDADES DE VELOCIDAD</td><td colspan="2" rowspan="2">1.51 mm/s.</td><td>ACEPTABLE</td><td></td></tr>
<tr><td>VELOCIDAD</td><td>3559 RPM</td><td>POTENCIA</td><td>HP</td><td>TOLERABLE</td><td></td></tr>
<tr><td>REALIZADO POR</td><td colspan="3">ING. TEC. JONATHAN GAMIO</td><td>REVISADO POR</td><td>ING. VICTOR ENCINAS BELTRAN</td><td>FECHA</td><td>07/12/2010</td><td>NO PERMISIBLE</td><td></td></tr>
</table>

Punto 2H en Velocidad





Pico	CPM	Ordenes	mm/s
1	483.4	0.3X	0.082
2	571.3	0.3X	0.062
3	3076.2	1.8X	0.041
4	3559.6	2.0X	1.225
5	7207.0	4.1X	0.375
6	21489.3	12.3X	0.444
7	26323.2	15.0X	0.070
8	28740.2	16.4X	0.054
9	37309.6	21.3X	0.040
10	42978.5	24.5X	0.214



DIAGNOSTICO

- *Motor* : *Buen estado, vibración inducida de compresor.*
- *Compresor* : *Buen estado.*

RECOMENDACIONES

- *Motor* : *Monitoreo vibracional cada 30 días.*
- *Compresor* : *Monitoreo vibracional cada 30 días.*

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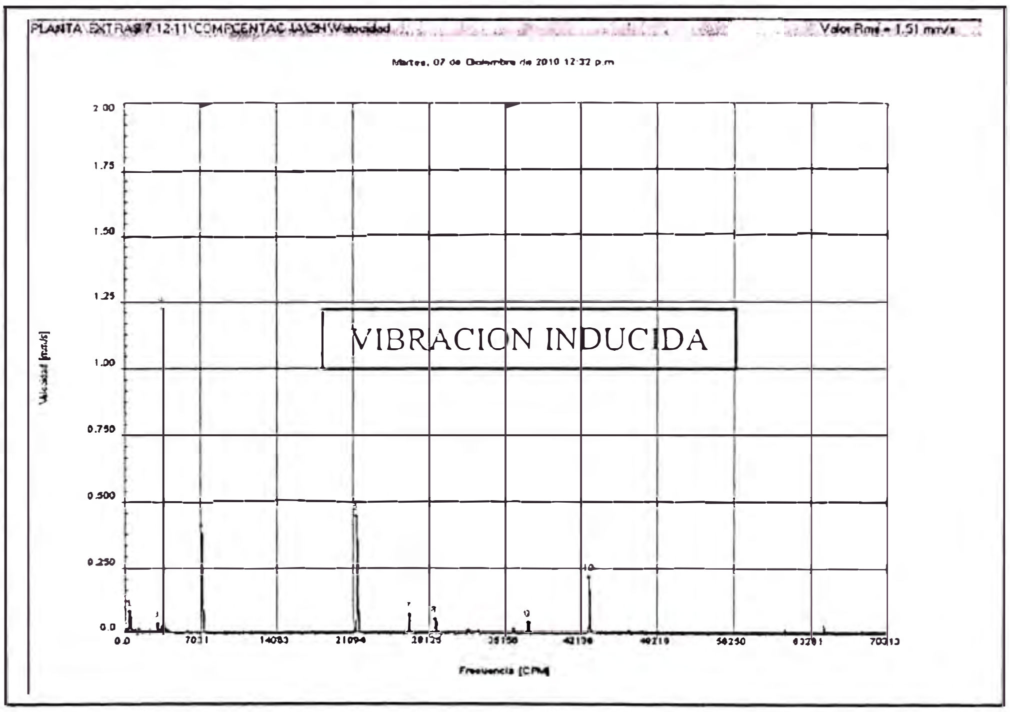
Espectros Vibracionales

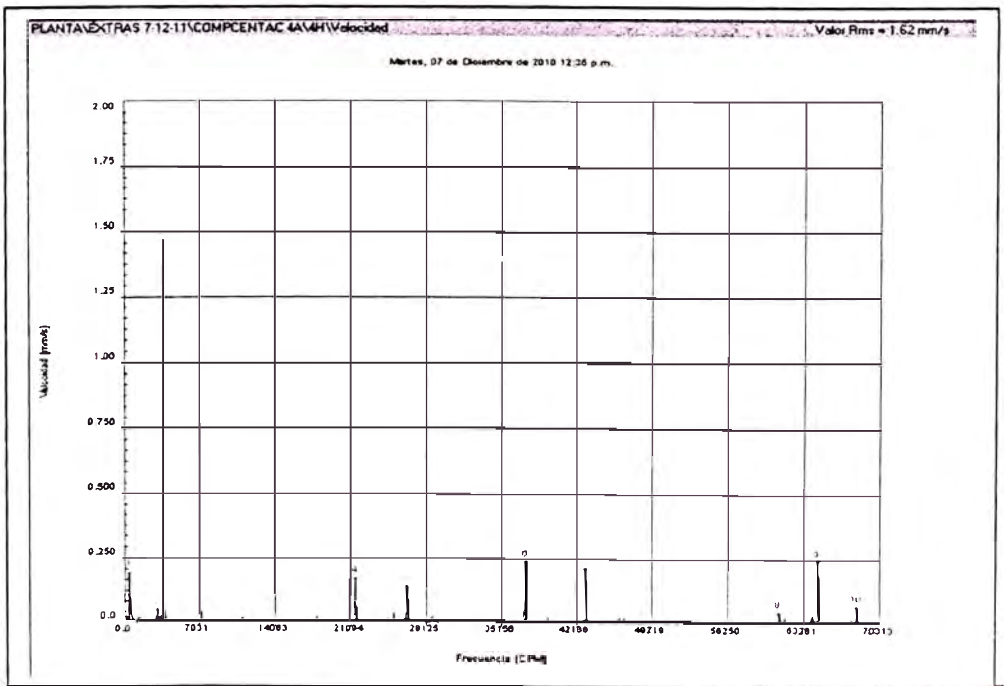
Punto 2H Valor RMS 1.51 mm/s

Pico	CPM	Ordenes	mm/s
1	483.4	0.3X	0.082
2	571.3	0.3X	0.062
3	3076.2	1.8X	0.041
4	3559.6	2.0X	1.225
5	7207.0	4.1X	0.375
6	21489.3	12.3X	0.444
7	26323.2	15.0X	0.070
8	28740.2	16.4X	0.054
9	37309.6	21.3X	0.040
10	42978.5	24.6X	0.214



Punto 4H Valor RMS 1.62 mm/s

Pico	CPM	Ordenes	mm/s
1	483.4	0.3X	0.191
2	3076.2	1.8X	0.048
3	3603.5	2.1X	1.463
4	21533.2	12.3X	0.167
5	26367.2	15.1X	0.135
6	37397.5	21.4X	0.233
7	43066.4	24.6X	0.208
8	60996.1	34.9X	0.041
9	64599.6	36.9X	0.237
10	68159.2	38.9X	0.062



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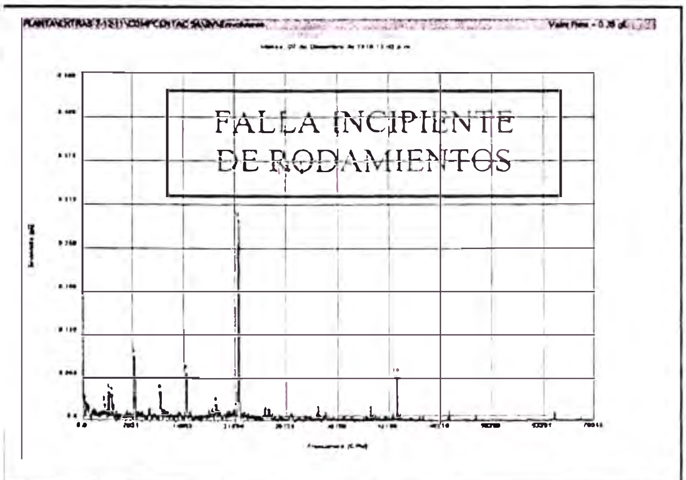
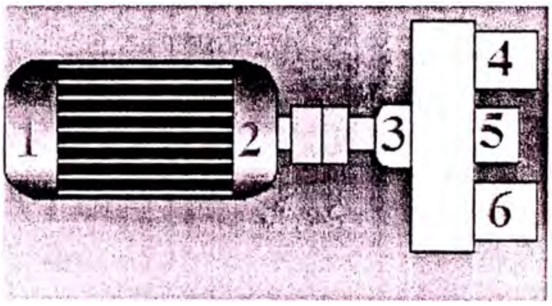
REPORTE DE ANALISIS VIBRACIONAL

Nº ESI-10811-10

EMPRESA	OWENS ILLINOIS		**NORMAS ISO 10816-3**		**NIVEL TOTAL**	**ESTADO**
AREA	PLANTA LURIN					
MAQUINA	COMPRESORA CENTAC N°5		**VIBRACION EN UNIDADES DE ENVOLVENTE**		0.39 gE.	**ACEPTABLE**
VELOCIDAD	3559 RPM	**POTENCIA** HP				**TOLERABLE**
REALIZADO POR	ING. TEC. JONATHAN GAMIO		**REVISADO POR**	ING. VICTOR ENCINAS BELTRAN	**FECHA** 07/12/2010	**NO PERMISIBLE**

Punto 2V en Envolvente

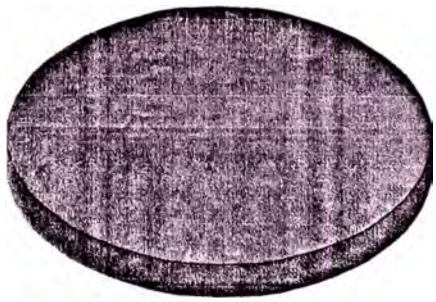




Pico	CPM	Ordenes	gE
1	527.3	0.3X	0.026
2	3076.2	1.8X	0.024
3	3603.5	2.1X	0.041
4	4086.9	2.3X	0.038
5	7207.0	4.1X	0.093
6	10810.5	6.2X	0.041
7	14458.0	8.3X	0.069
8	18544.9	10.6X	0.023
9	21621.1	12.4X	0.289
10	43198.2	24.7X	0.065

STATUS MACHINE

CONDITION



DIAGNOSTICO

- *Motor* : *Buen estado, falla incipiente de rodamientos.*
- *Compresor* : *Buen estado, falla incipiente de rodamientos.*

RECOMENDACIONES

- *Motor* : *Monitoreo vibracional cada 30 días.*
- *Compresor* : *Monitoreo vibracional cada 30 días.*

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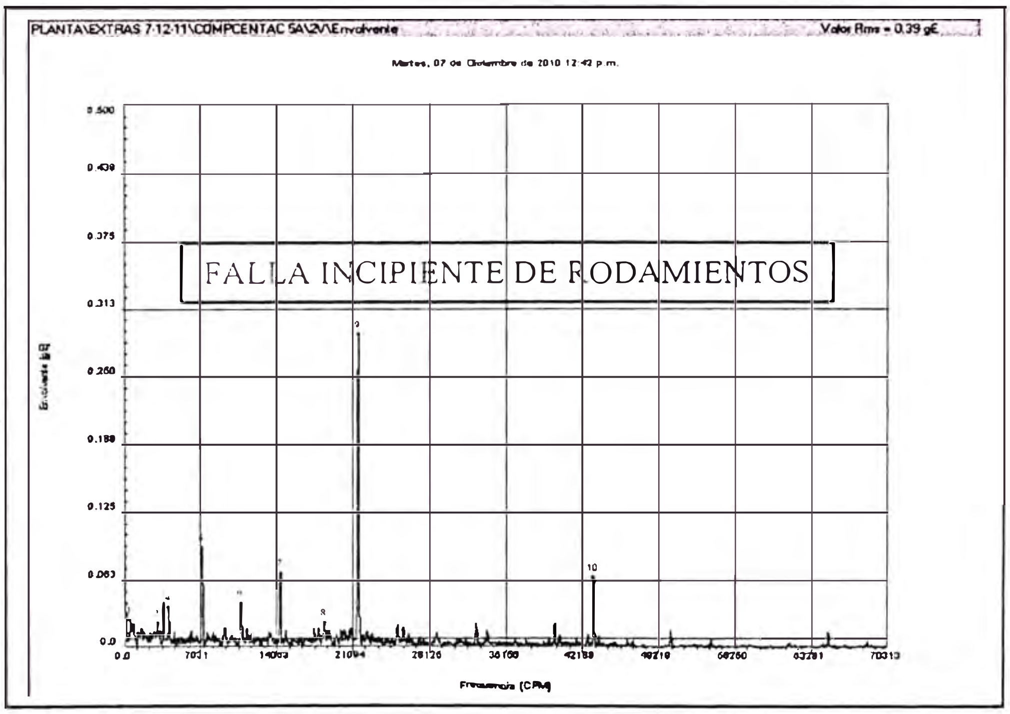
Espectros Vibracionales

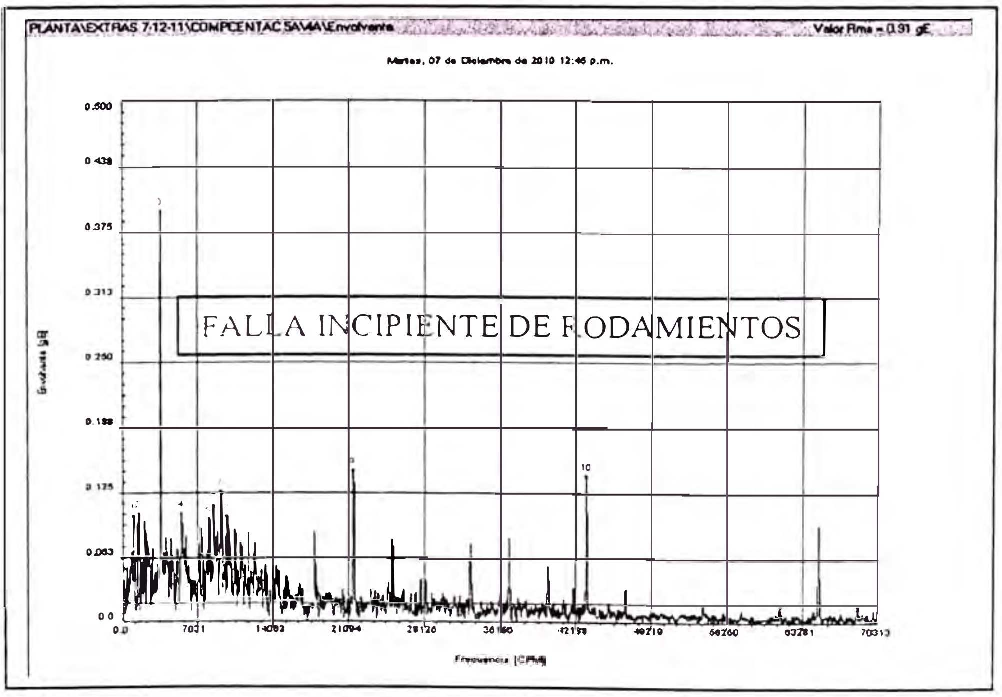
Punto 2V Valor RMS 0.39 gE.

Pico	CPM	Ordenes	gE
1	527.3	0.3X	0.026
2	3076.2	1.8X	0.024
3	3603.5	2.1X	0.041
4	4086.9	2.3X	0.038
5	7207.0	4.1X	0.093
6	10810.5	6.2X	0.041
7	14458.0	8.3X	0.069
8	18544.9	10.6X	0.023
9	21621.1	12.4X	0.289
10	43199.2	24.7X	0.065



Punto 4A Valor RMS 0.91 gE.

Pico	CPM	Ordenes	gE
1	1054.7	0.6X	0.102
2	1494.1	0.9X	0.105
3	3603.5	2.1X	0.396
4	5581.1	3.2X	0.104
5	8085.9	4.6X	0.099
6	8569.3	4.9X	0.111
7	9228.5	5.3X	0.126
8	9755.9	5.6X	0.102
9	21577.1	12.3X	0.145
10	43198.2	24.7X	0.141



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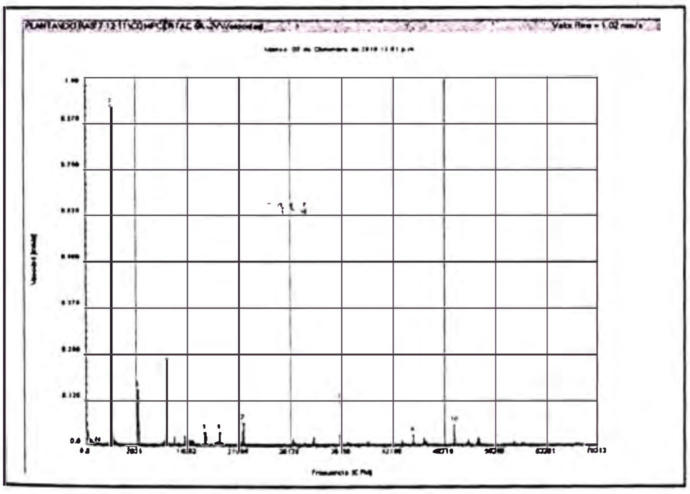
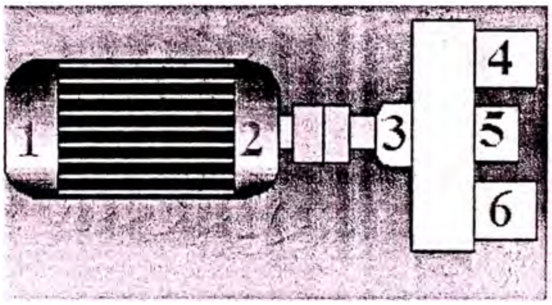
REPORTE DE ANALISIS VIBRACIONAL

Nº ESI-10812-10

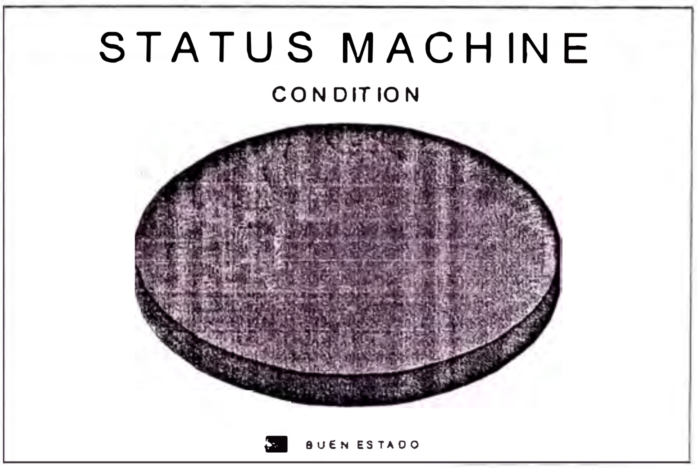
EMPRESA	OWENS ILLINOIS	**NORMAS ISO 10816-3**	**NIVEL TOTAL**	**ESTADO**
AREA	PLANTA LURIN			
MAQUINA	COMPRESORA CENTAC N°6	**VIBRACION EN UNIDADES DE VELOCIDAD**	**1.02 mm/s.**	**ACEPTABLE**
VELOCIDAD	RPM — **POTENCIA** HP			**TOLERABLE**
REALIZADO POR	ING. TEC. JONATHAN GAMIO	**REVISADO POR** ING. VICTOR ENCINAS BELTRAN	**FECHA** 07/12/2010	**NO PERMISIBLE**

Punto 2V en Velocidad





Pico	CPM	Ordenes	mm/s
1	263.7	0.2X	0.040
2	3603.5	2.1X	0.922
3	7207.0	4.1X	0.150
4	11206.1	6.4X	0.216
5	16435.5	9.4X	0.036
6	18369.1	10.5X	0.037
7	21621.1	12.4X	0.061
8	34980.5	20.0X	0.116
9	44956.1	25.7X	0.029
10	50537.1	28.9X	0.055



DIAGNOSTICO

- *Motor* : *Buen estado, vibración inducida de compresor.*
- *Compresor* : *Buen estado.*

RECOMENDACIONES

- *Motor* : *Monitoreo vibracional cada 30 días.*
- *Compresor* : *Monitoreo vibracional cada 30 días.*

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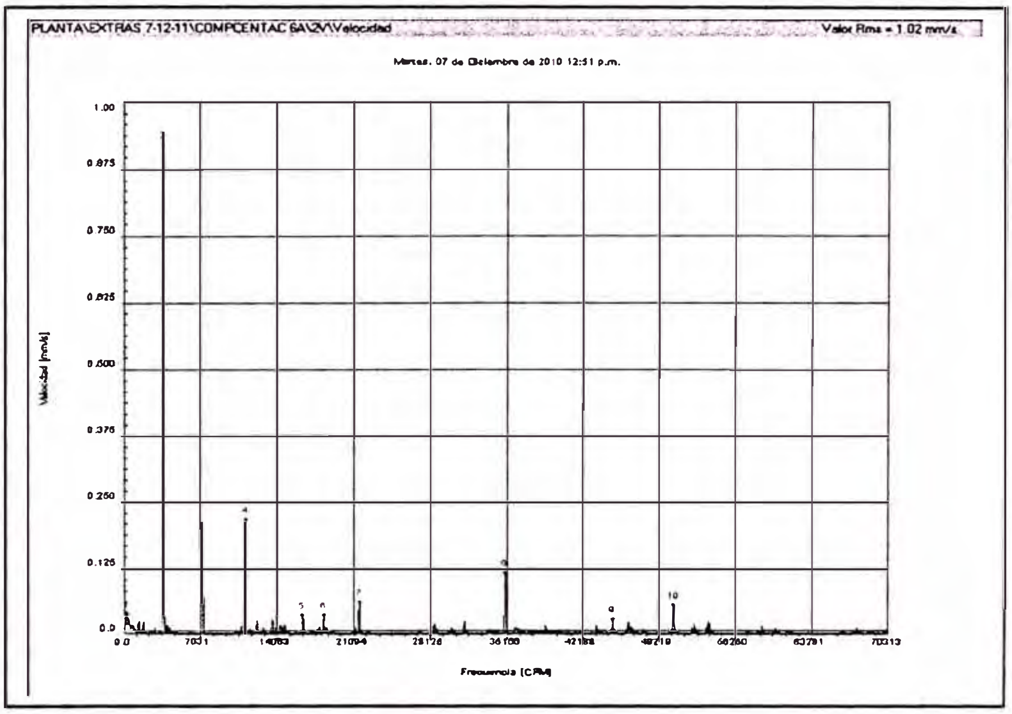
Espectros Vibracionales

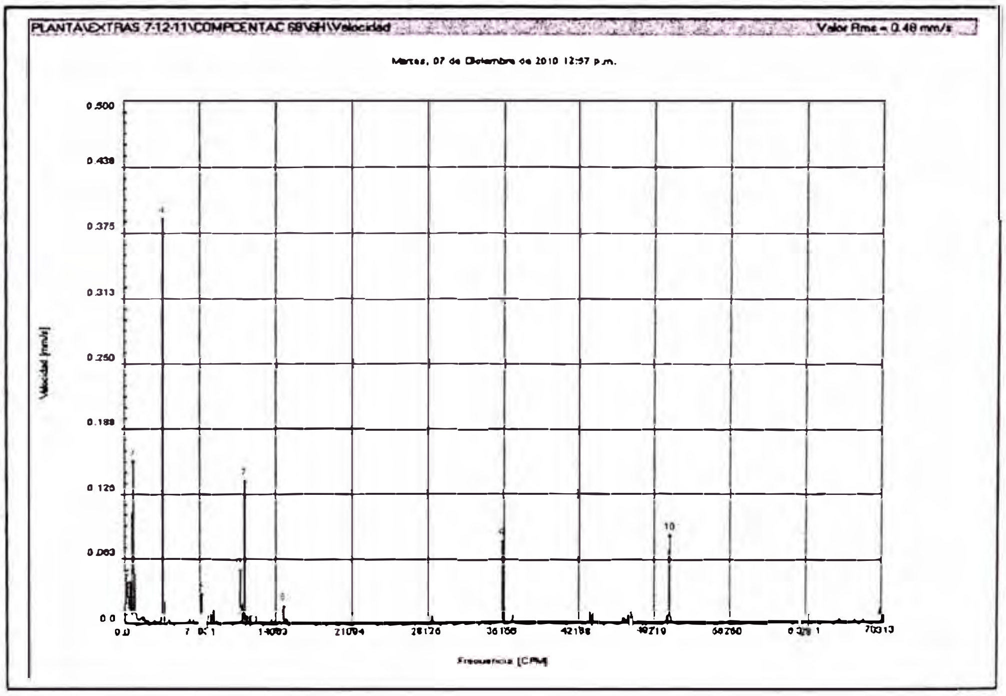
Punto 2V Valor RMS 1.02 mm/s

Pico	CPM	Ordenes	mm/s
1	263.7	0.2X	0.040
2	3603.5	2.1X	0.922
3	7207.0	4.1X	0.150
4	11206.1	6.4X	0.216
5	16435.5	9.4X	0.036
6	18369.1	10.5X	0.037
7	21621.1	12.4X	0.061
8	34980.5	20.0X	0.116
9	44956.1	25.7X	0.029
10	50537.1	28.9X	0.055



Punto 6H Valor RMS 0.48 mm/s

Pico	CPM	Ordenes	mm/s
1	219.7	0.1X	0.047
2	527.3	0.3X	0.040
3	835.0	0.5X	0.156
4	3603.5	2.1X	0.388
5	7207.0	4.1X	0.029
6	10810.5	6.2X	0.052
7	11206.1	6.4X	0.136
8	14809.6	8.5X	0.018
9	35068.4	20.0X	0.079
10	[illegible]	[illegible]	[illegible]



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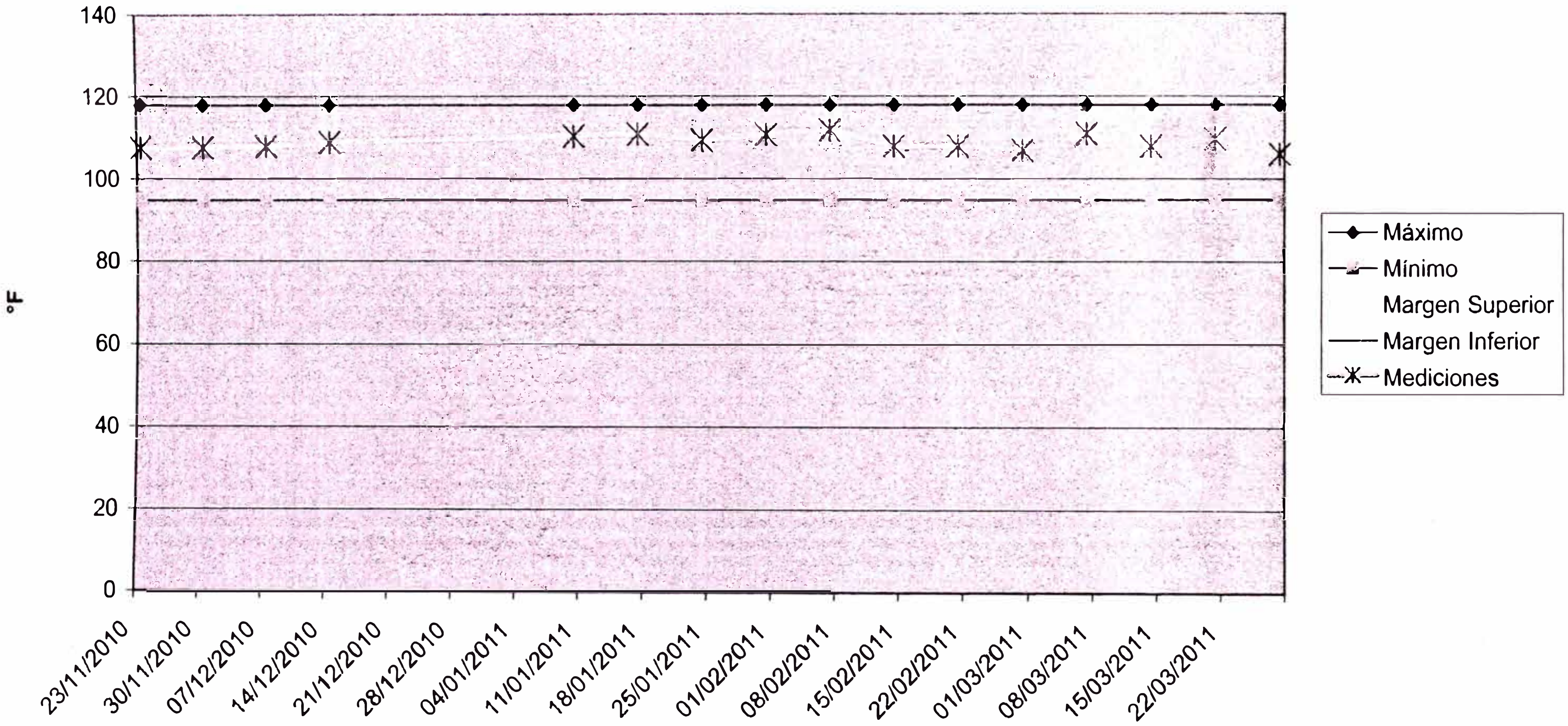
E-mail: esi@esi-peru.net / esi@infonegocio.net.pe / www.esi-peru.net

D: Gráficos de Mediciones Rutinarias

Gráfica de mediciones

Equipo: COMPRESOR CENTAC 4 INGERSOLL RAND C95040M3MP C13054

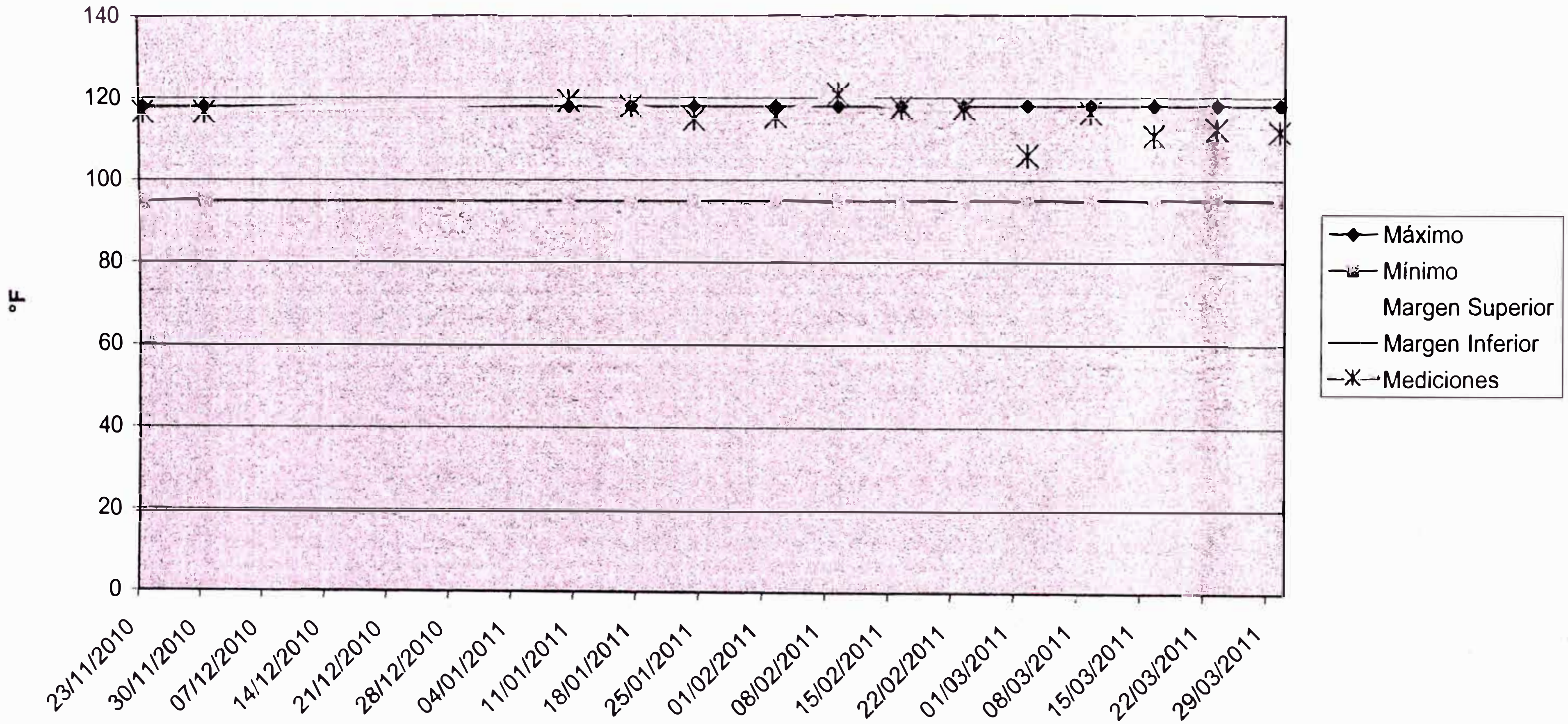
Parte/Actividad: \ 05 SISTEMA DE ENFRIAMIENTO\ SISTEMA DE ENFRIAMIENTO DEL ACEITE \ Medicion de temperatura de aceite



Gráfica de mediciones

Equipo: COMPRESOR CENTAC 5 INGERSOLL RAND C95040M3MP C13053

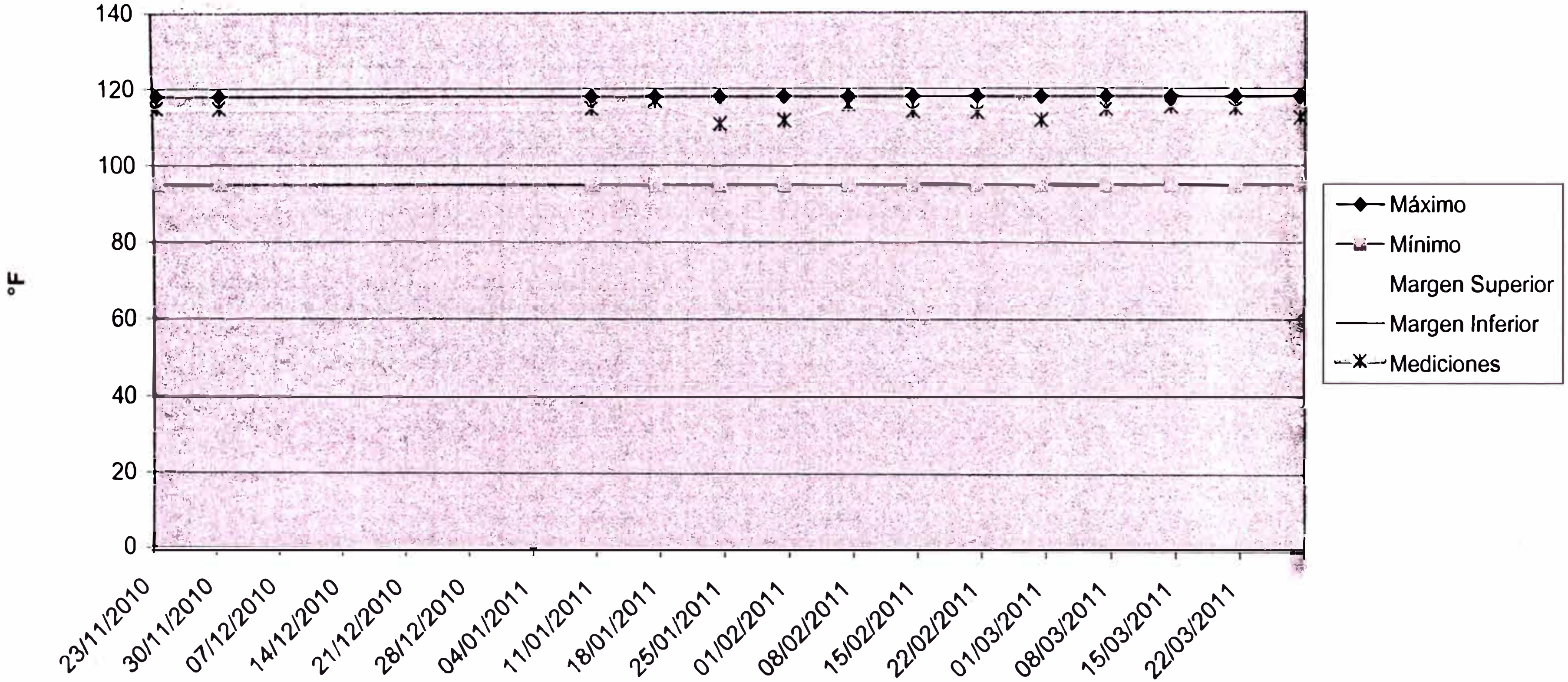
Parte/Actividad: \ 05 SISTEMA DE ENFRIAMIENTO\ SISTEMA DE ENFRIAMIENTO DEL ACEITE \ Medicion de temperatura de aceite



Gráfica de mediciones

Equipo: COMPRESOR CENTAC 6 INGERSOLL RAND C70027M3 C13052

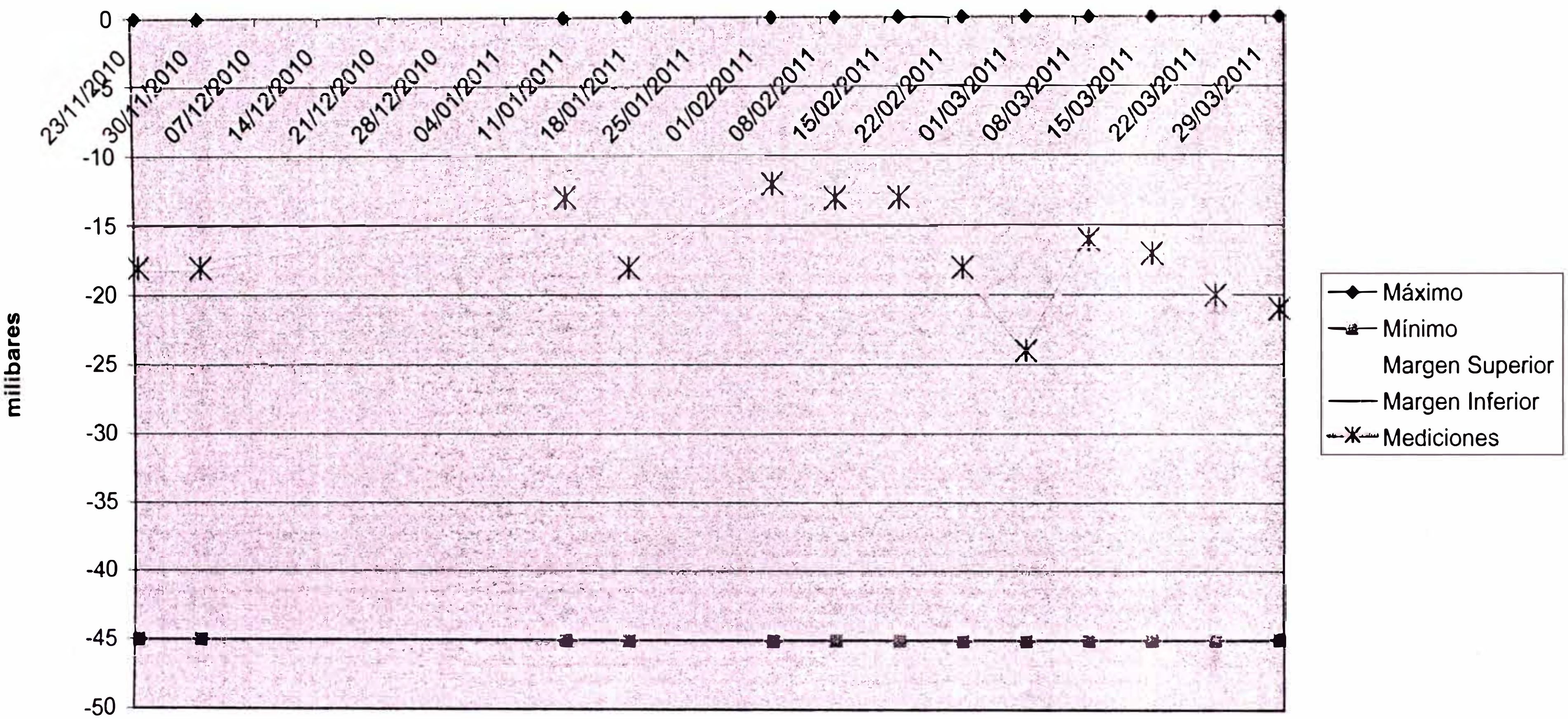
Parte/Actividad: \ 05 SISTEMA DE ENFRIAMIENTO\ SISTEMA DE ENFRIAMIENTO DEL ACEITE \ Medicion de temperatura de aceite



Gráfica de mediciones

Equipo: COMPRESOR CENTAC 5 INGERSOLL RAND C95040M3MP C13053

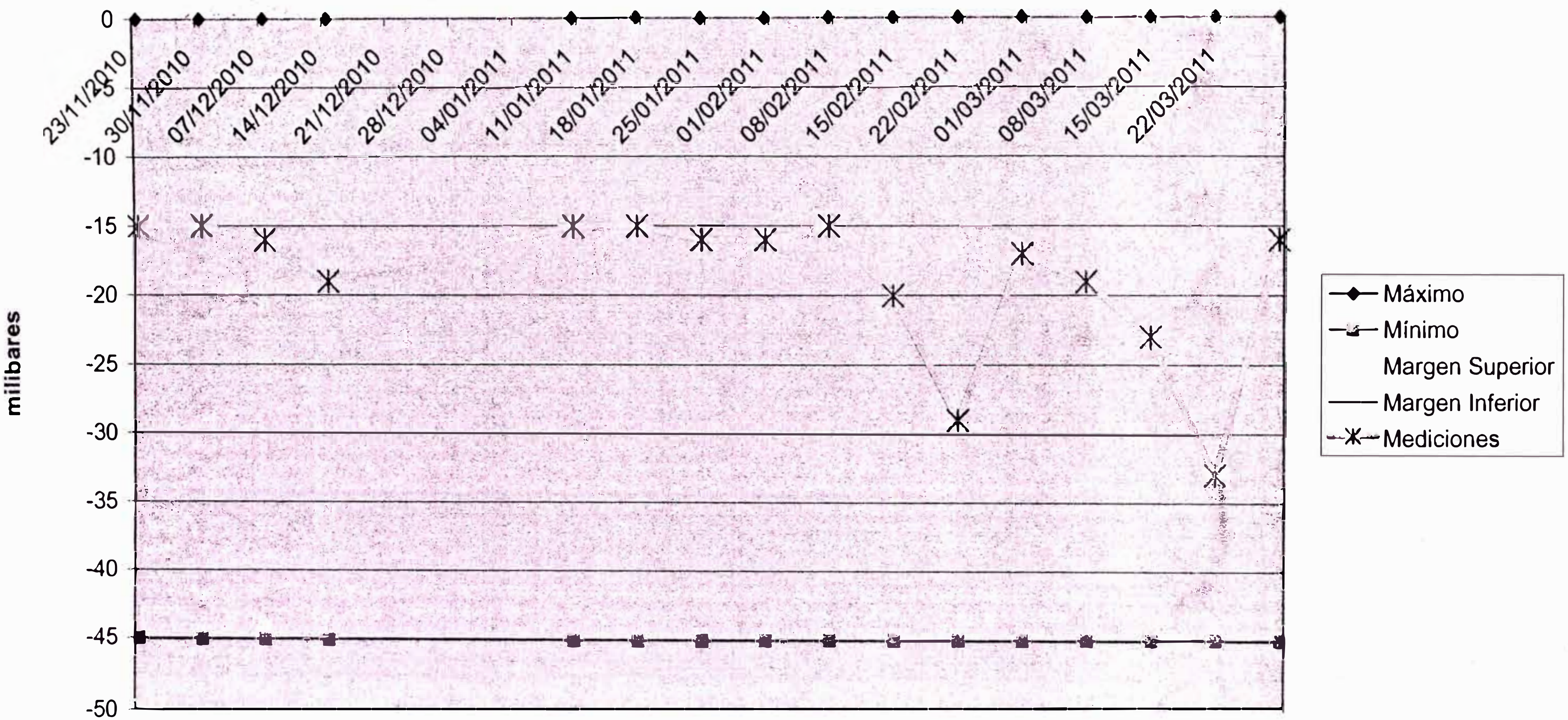
Parte/Actividad: \ 04 SISTEMA DE ADMISION\ FILTRO DE AIRE PRIMARIO \ Inspeccion del filtro primario



Gráfica de mediciones

Equipo: COMPRESOR CENTAC 4 INGERSOLL RAND C95040M3MP C13054

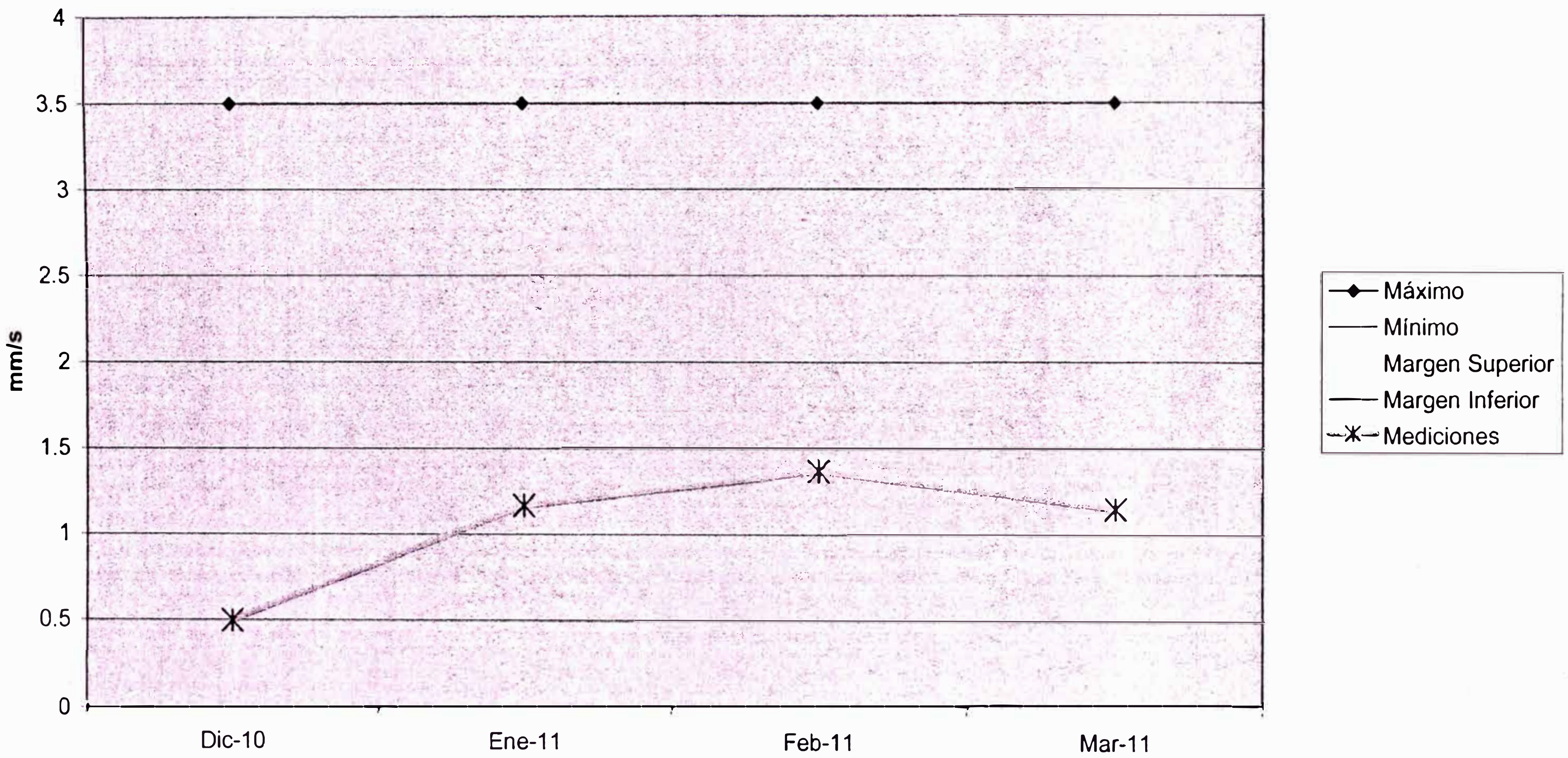
Parte/Actividad: \ 04 SISTEMA DE ADMISION\ FILTRO DE AIRE PRIMARIO \ Inspeccion del filtro primario



Gráfica de mediciones

Equipo: COMPRESOR CENTAC 2 INGERSOLL RAND C95040M3MP C12695

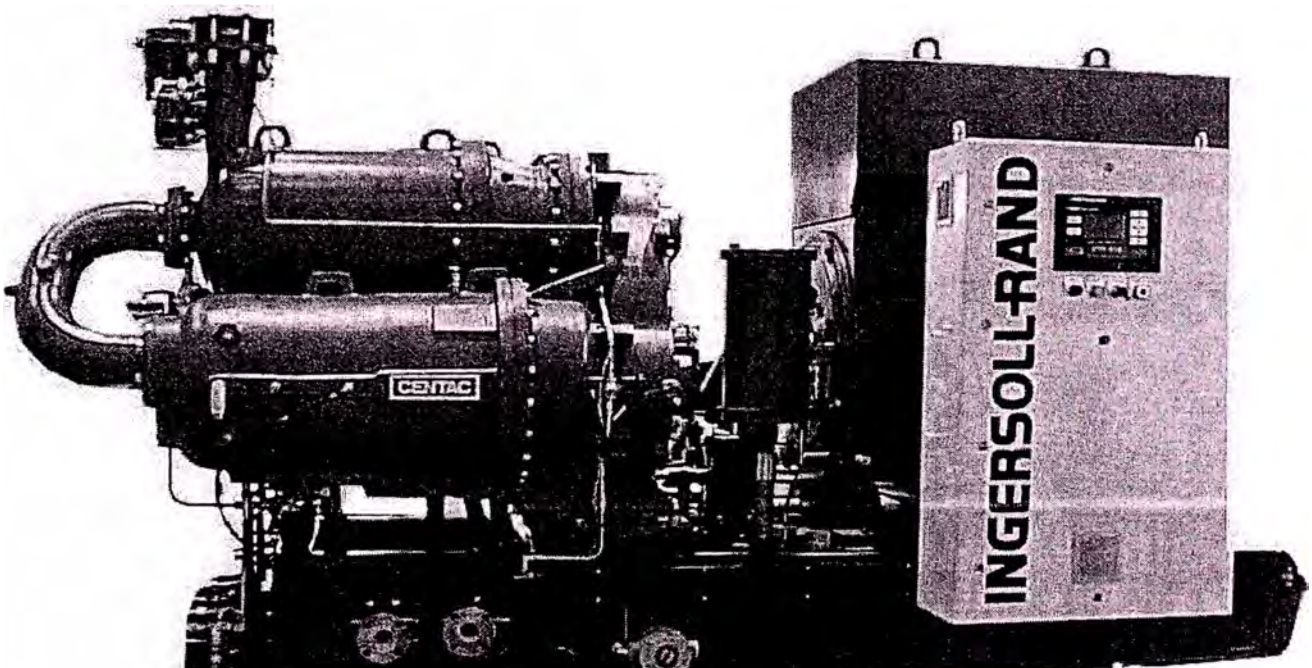
Parte/Actividad: \ 01 MOTOR \ Medicion de Vibracion



E: Catálogo de compresores centrífugos CENTAC

CENTAC®

C950 Planning & Installation Manual



Ingersoll-Rand

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Date of Revision: 15 August, 2000

NOTICE

On receiving the Centac compressor, be sure to inspect the unit for evidence of damage during shipment. Immediately notify the carrier and the nearest Ingersoll-Rand representative if any damage is noted.

The compressor should be stored on a level floor or supports, in a dry protected area. Based on these conditions, the Centac compressor has been prepared for 180 days of storage. If the unit is to be stored for periods longer then 180 days, it will require additional protection.

Please contact the nearest Ingersoll-Rand representative prior to shipment for instruction on extended storage and advise them of the proposed period of storage.

WARNING

⚠ **Not to be used for breathing air application**. Ingersoll-Rand Company air compressors are not designed, intended or approved for breathing air applications. Ingersoll-Rand does not approve specialized equipment for breathing air applications and assumes no responsibility or liability for compressors used for breathing air service.

Date of Revision: 15 August, 2000

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TP0029 Rev.5

Date of Revision: 15 August, 2000

Date of Revision: 15 August, 2000

Introduction

The purpose of this manual is to provide a planning tool for new owners of Centac compressors to use before their compressor is delivered. This manual contains valuable information on installation procedures and checkout of equipment before start-up. In addition to this manual, you should have the following:

- General Arrangement Drawing
- Electrical Schematic
- Process and Instrumentation Diagram
- Motor Outline and Data Sheet

A properly installed Centac C950 air compressor, operated in accordance with the manufacturer's instructions will reward its owner with many years of dependable compressed air service.

NOTE
Where found in this manual, the word **must** means that the specification must be met to validate the warranty. The word **should** means that it is a desirable condition, but not mandatory for the operation of the compressor and failure to meet this specification does not necessarily affect the warranty. Deviation from these recommendations may severely limit efficient operation or interfere with the service technician's ability to perform maintenance on the machine.

Safety

This manual contains instructions for planning of the installation, operation and maintenance of your Ingersoll-Rand centrifugal air compressor. Your compressor has been designed to provide safe and reliable service. However, it is both a pressure system and a rotating machine, therefore, the operator(s) must exercise good judgment and proper safety practices to prevent personal injury and avoid damage to the equipment and surroundings. The instructions in this manual are intended for personnel with a general training in operation and maintenance of centrifugal air compressors.

Safety Program

It is assumed that your safety department has established a safety program based on a thorough analysis of industrial hazards. Before installing, operating or performing maintenance on the compressor and associated components described in this manual, review the safety program to ensure that it covers the hazards that come with high speed rotating machinery.

It is also important to consider the hazards associated with electrical power, hot oil, high pressure and temperature liquids, toxic liquids and gases, and flammable liquids and gases. Proper installation and care of protective guards, shutdown devices, and over pressure protection equipment are also essential parts of any safety program.

Date of Revision: 15 August, 2000

Special precautionary measures include:

- Eliminate the possibility of power going to the equipment at any time when maintenance work is in progress.
- Prevent rotation due to reverse flow.
- Ensure that the block valve is closed and tagged during maintenance.

In general, all personnel should be guided by the basic rules of safety associated with the equipment and the process.

Safety Procedures

Throughout this manual, you will encounter boxes with the words WARNING, CAUTION, and NOTE. These are intended to emphasize certain areas where caution is needed. This is in the interest of personal safety and satisfactory compressor operation and maintenance. The definitions of these words are as follows:

WARNING
⚠ An operating procedure, practice, etc. that, if not correctly followed, could result in severe personal injury, or loss of life.

CAUTION
⚠ An operating procedure, practice, etc. that, if not strictly observed, could result in damage to, or destruction of equipment.

NOTE
An operating procedure, condition, etc. that is essential to highlight.

The information in this manual does not relieve operating and maintenance personnel of the responsibility of exercising normal good judgment in operation and care of the compressor and its components. We suggest that all personnel follow the safety precautions associated with this type of equipment.

In addition to the many obvious safety rules, follow the safety procedures listed below when personnel are operating or maintaining Centac compressors:

1. DO NOT USE THE DISCHARGE AIR FOR BREATHING. IT COULD CAUSE SEVERE INJURY OR DEATH. Consult a filtration specialist for additional filtration and treatment equipment to meet health and safety standards.
2. Pull the main disconnect switch and disconnect any separate power lines before attempting to work or perform maintenance on the unit.
3. Do not attempt to remove any compressor parts without first relieving the entire system of pressure.
4. Do not attempt to service any part while the machine is operating.
5. Do not operate the compressor at pressures in excess of its rating as indicated on the compressor nameplate.
6. Do not operate the compressor at speeds in excess of its rating (or less than its rating) as indicated on the driver nameplate.
7. Do not remove any guards, shields, or screens while the compressor is operating.
8. Periodically check all safety devices for proper operation.
9. Be cautious when using compressed air. Pressurized air can cause serious injury to personnel.
10. Be sure no tools, rags, or loose parts are left on the compressor or drive parts.
11. Do not use flammable solvents for cleaning parts.
12. Exercise cleanliness during maintenance and when making repairs. Keep dirt away from parts by covering parts and exposed openings with clean cloth or kraft paper.
13. Do not operate the compressor without guards, shields, and screens in place.
14. Do not operate compressor in areas where there is a possibility of ingesting flammable or toxic fumes.
15. Shut down the compressor before removing any caps or plugs. Oil or air under pressure can cause severe personal injury, or death.

NOTE

The owner, lease holder, or operator of the compressor is hereby notified and forewarned that any failure to observe common safety precautions, whether stated herein, or not, may result in damage or injury.

Ingersoll-Rand Company expressly disclaims responsibility or liability for any injury or damage caused by failure to observe those specified, or other common precautions or by failure to exercise that ordinary caution, common sense, and due care required in operating or handling the compressor even though not expressly specified above.

Date of Revision: 15 August, 2000

Receiving/Handling/Storage

Receiving

Centac compressors are shipped in first class condition. They have been inspected prior to leaving the factory. Loading of the compressor has been supervised by Ingersoll-Rand personnel to ensure that the unit has not been damaged during loading and that all accessory equipment has been properly documented.

Inspect the compressor for shipping damage before removing the compressor from carrier's vehicle. If damage or indication of rough handling is evident, file a claim with the carrier at once, and notify your Ingersoll-Rand representative.

Remove only the shipping notice. Do not remove tags pertaining to lubrication, operation, and storage. Read all tags and instructions.

Document receipt of all items included with the compressor, but packed separately. Make a list of any items that were not received and notify your Ingersoll-Rand representative. Store all items either with the compressor or in an appropriate secured area.

Handling/Lifting

An experienced rigger should move and install the compressor. Adequate rigging and lifting equipment must be provided to safely handle the unit. Use spreader bars to prevent damage to piping, tubing, gauges, and other accessory equipment. Provisions for lifting the unit are located at the corners of the baseplate (*see Figure 1)*.

Installation of a Centac compressor can best be done by the use of an overhead crane. Lifting points have been provided in the baseplate for the purpose of lifting the complete unit. To facilitate lifting and avoid possible damage, spreader bars are recommended. Figure 1 illustrates the lift points for a standard unit. An overhead rail with a chain hoist will also simplify the removal of the largest component parts when maintenance is required.

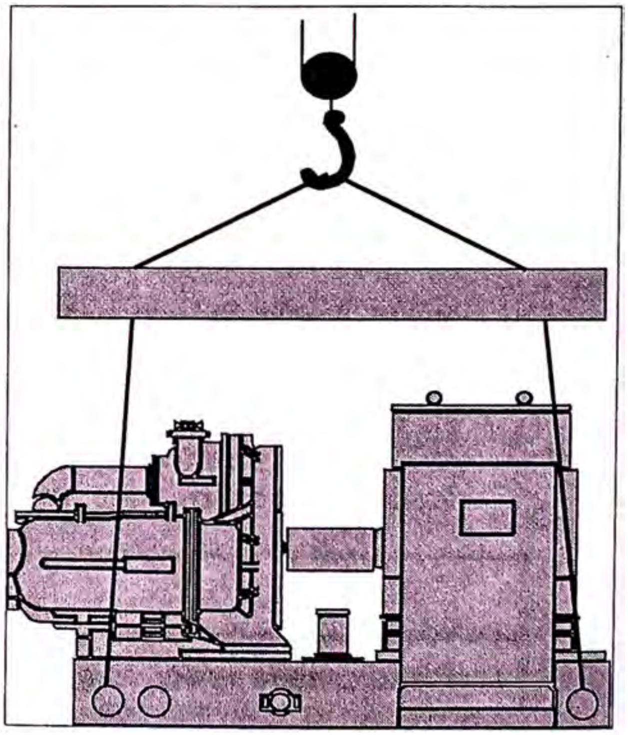

Figure 1 Lifting Diagram for Standard Unit

WARNING

⚠ Do not lift the unit by the lifting eyes on the compressor or driver. These eyes are for lifting the individual component parts only. Damage to equipment and injury to personnel could result from misuse of the lifting eyes.

Storage

The Centac compressor, as it is shipped from the factory (flanges banked and desiccant bags placed at inlet and discharge), can be stored on a level surface in a climate-controlled area for up to 180 days after the ship date tagged on the compressor unit without requiring long-term storage preparation. The unit must be started within the first 180 days following shipment from Ingersoll-Rand to assure the full 12-month operational warranty after start-up. Store all loose parts in a controlled environment for adequate protection prior to use.

If the motor is supplied with sleeve bearings, fill the motor bearing reservoir to the level recommended by the manufacturer. Use a good grade of rust inhibiting oil. The shaft should be rotated a minimum of 10 revolutions every month to keep the bearings lubricated. At the end of the storage time, the motor should be "meggered" to ground before connecting to the power line. Specific motor start-up instructions provided by the motor supplier must be followed

If the unit is to be stored for periods longer than 180 days or in an uncontrolled climate, the unit will require additional protection. Consult your local Ingersoll-Rand representative for long term storage requirements and extended warranty coverage.

Consider a unit in storage when:

- It has been delivered to the job site and is awaiting installation.
- It has been installed but operation is delayed pending completion of plant construction.
- There are long periods (30 days or more) between operating cycles.
- The plant (or department) is shut down.

Installation Planning

General

Proper installation is a critical component of satisfactory operation of all rotating machinery. Proper support of the machinery is required to give maximum reliability at minimum operating cost. In addition, a well-designed installation will result in lower installation and operating costs. See the General Arrangement drawing for compressor/customer connection details and lift points. Contact your local Ingersoll-Rand representative for further information.

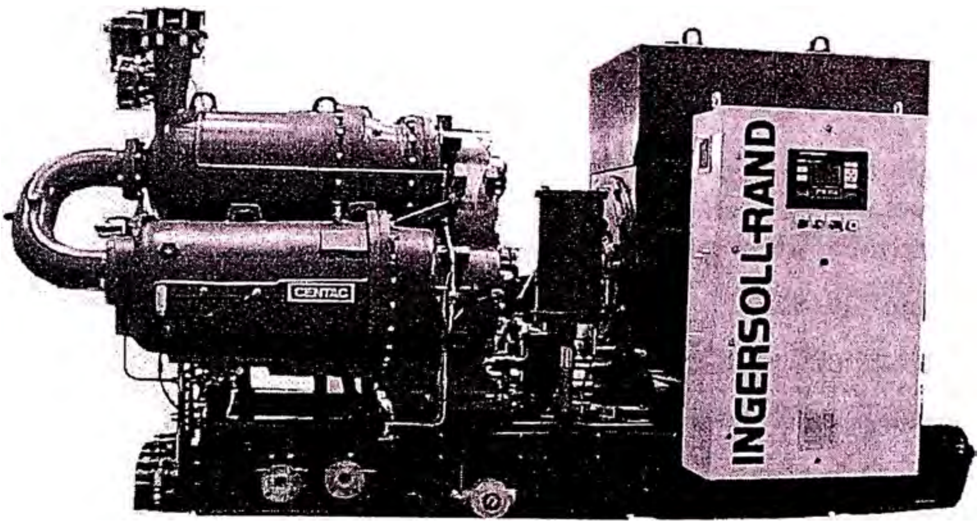

Figure 2

Typical C950 Compressor

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Plant Layout

The location of a packaged centrifugal compressor within a plant facility is very important. The compressor should be located in an area that is accessible to operators and maintenance personnel.

Machinery should be installed where it is easily accessible for observation and maintenance. Operation and maintenance personnel will generally give better attention to a compressor located in a well planned, accessible area. Compressors installed in elevated locations or in pits should have stairways, catwalks, etc. for easy access to the machinery.

During installation, machinery can best be handled with overhead crane facilities. Adequate space should be provided to permit easy handling of the unit during installation (see the General Arrangement drawing for compressor maintenance space). Provide floor space in the vicinity of machinery where parts may be placed during periodic inspection of the rotating elements and internal parts. Make provisions for clearance requirements specified on the General Arrangement drawing.

Indoor/Outdoor Installation

The unit may be installed indoors or outdoors. For an outdoor installation, protective measures are necessary for the motor, control panel, and other items. It is important when the compressor package is purchased that Ingersoll-Rand is made aware of plans and makes any necessary recommendations for outdoor installation.

If the unit is an indoor installation, a heated building is preferred. Provide adequate space for ease of handling during installation.

Ventilation

Ventilation around the unit is important. The unit should not be installed in a damp or dusty atmosphere or where corrosive vapors may enter the compressor or driver.

On motor driven units the heat radiated to air in the room will be approximately 6% of the total horsepower: 1HP=42.4 BTU/MIN
1KW=56.9 BTU/MIN

Noise

In areas where noise could be a problem, it is important to treat hard reflective surfaces in the area. Avoid installing the unit in an area with low hard ceilings and walls.

Foundation

The compressor foundation does not need to be massive but should be sufficient to provide support for the unit.

Since there are no out-of-balance forces, such as reciprocating or shock loads, all loads on the foundation may be considered as static loads. If the unit is to be located in an area with other machinery, it is essential that vibrations are not transmitted to the compressor. Isolation pads are recommended in these instances.

For the Centac compressor package, a simple continuous concrete pad or steel support structure is recommended for each compressor. Precautions should be taken to ensure a reasonably uniform base around the pad. Uneven settling or thermal expansion could cause machinery misalignment. Appropriate bolting must be used to keep the compressor in place. Refer to the General Arrangement drawing for location and size of anchor boltholes.

NOTE
The design of the foundation is the responsibility of the customer. These comments are offered as an aid to assure a successful installation, but Ingersoll-Rand Company cannot assume the responsibility for the design. We recommend that the customer consult a specialist skilled in the design of machinery foundations.

Leveling

The Centac compressor should be leveled at the time of installation. To level the unit, place it over the anchor bolts with the feet resting on steel wedges or shims, if necessary (see *Figure 3*).

The unit may be leveled using a machinist level or transit level. When a machinist level is used, start at one end of the unit and work side to side toward the opposite end, placing the level on the machined baseplate compressor pads. The compressor should be level from 0 to 0.1 inch/foot (0 to 8 mm/M).

After the unit is level with snug (not tightened) anchor bolts, the coupling should be aligned. Some baseplate distortion may be noted but this is unimportant as long as the machine pads remain level. Precise driver alignment is not required until the time of start-up, but should be within 1/16 inch (1.5 mm). Follow the procedures found in the Operation Manual once the compressor arrives on site. The General Arrangement drawing lists the values for the coupling alignment. Record the values obtained, but do not dowel the driver or install the coupling spacer.

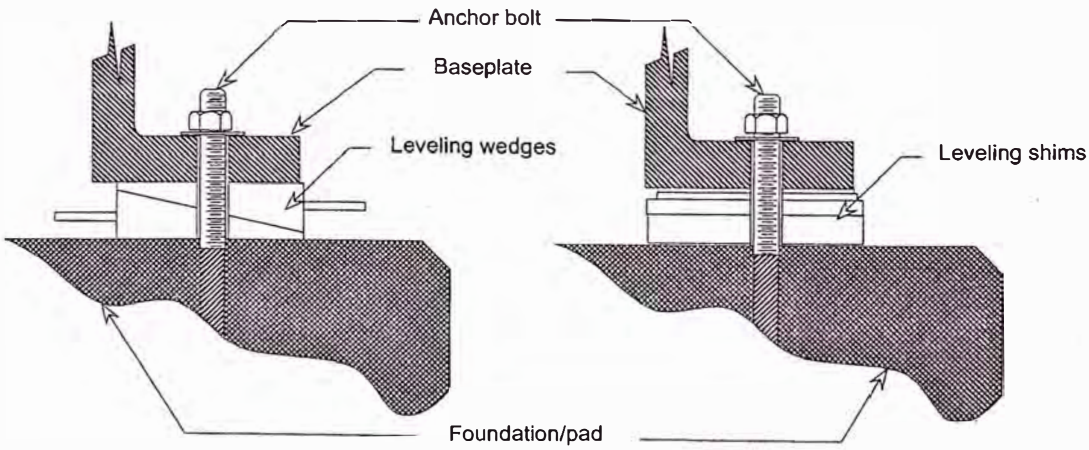


Figure 3.
Wedge and shim placement

After the coupling has been brought into rough alignment and the alignment values have been recorded, the Centac compressor is ready for grouting.

Grouting

Grouting is the most common method for permanent installation of rotating machinery. Fill the area between baseplate and foundation with a minimum of 1" of grout to create a uniform bearing surface. Common grouting materials are non-shrinking concrete and epoxy type grouts.

Grout is installed in the space below the baseplate beams after preparation of the foundation surface by chipping. After the grout has set, any wedges or shims used to level the unit must be removed and the remaining spaces filled with grout.

Air Piping

A well-designed air piping configuration requires proper planning and execution. This section covers the following topics:

- Inlet air piping and filters
- Bypass air piping
- Expansion joints
- Discharge air piping
- Discharge air piping for multi-compressor installation
- Receivers
- Control air piping / filtration
- Instrument air piping

Centac products have no design provision for accepting the full weight of external piping connections. The discharge, inlet, bypass, water, and other piping connected to the machine must be self-supporting. Adequate piping supports are necessary to prevent excessive dead loads on the flanges of rotating machinery.

Piping alignment to the compressor mating flanges is essential. The piping must be installed and supported to avoid strains on the casing. Misalignment, which is a frequent cause of vibration, can often be traced directly to piping strains. Three sources of piping strains are:

- Dead weight of the piping itself
- Expansion or contraction of the piping as it undergoes temperature change
- Pressure within the piping

In the practical sense, if any pipe needs to be levered or pried into position to match up the flange face with the compressor, there will be excessive pipe strain. A properly matched up pipe flange will have just enough space to slip in a gasket, will allow all flange fasteners (bolts, studs, etc.) to pass through the flange bolt bores without adjustment of the mating flanges, and does not twist in any plane when the fasteners are tightened.

All piping connected to the Centac compressor should have provisions for compressor maintenance. This usually means that there are flanged sections or unions in the connecting pipe. A sufficient number of removable sections of pipe should be provided to allow ease of maintenance and repair. Failure to make provisions for repair will result in difficulty during disassembly.

Summarizing, a satisfactory piping arrangement can normally be obtained by giving proper attention to:

1. Providing adequate support for all parts of the piping system.
2. Allowing for expansion in a manner that will avoid piping strains on the compressor.
3. Installing a sufficient number of anchors in the piping system so that direction and magnitude of expansion are controlled.
4. Designing the inlet and discharge piping so as to provide smooth flow with minimum pressure drop and uniform velocity over the entire area of piping.

NOTE

The design of the piping system is the responsibility of the customer. Data and comments are offered as an aid to ensure a successful installation, but Ingersoll-Rand cannot assume responsibility for its design or installation. We recommend that the customer consult a specialist skilled in the design of piping systems to supplement and interpret the piping information and to ensure a successful installation.

The inlet pipe and filter must be inspected before startup by an Ingersoll-Rand factory certified service representative.

NOTE

All air and water piping to and from the inlet and discharge port connections must take into account vibration, pulsations, temperature, maximum pressure applied, corrosion, and chemical resistance. Where compatibility questions may exist, contact your Ingersoll-Rand representative.

Inlet Air Piping

Inlet air is the lifeline of any compressor. It is imperative that the compressor receives clean filtered air to function correctly with low maintenance. A well thought out piping design will save many hours and dollars in maintenance.

Whether the inlet air piping is supplied with the compressor or by others it must be inspected for cleanliness by an Ingersoll-Rand factory certified service technician prior to start-up.

Maintenance

It is advisable that you install spool pieces that allow the casing sections to be removed and the piping to be out of the way of personnel for maintenance. The inlet pipe will be removed for inspection at start-up.

The importance of always operating the compressor with clean air inlet piping must be stressed. No compressor will accept the injection of foreign material into the operating components without possible damage or loss of performance.

Inlet Air Filter

An inlet air filter should be mounted by the customer at a suitable location. At minimum, it should be a high efficiency two-stage unit designed to remove 99.97% of all particles larger than 2 microns and 90% of all particles larger than 0.4 microns. For adverse environmental conditions, a more efficient inlet air filter is recommended.

The inlet filter is normally oversized to increase the time between element changes and reduce the velocity through the filter to give a lower noise level.

Routine inspection of the filter is recommended and the addition of instrumentation to indicate pressure drop across the filter elements is also suggested. When this drop increases substantially, the elements should be cleaned or replaced.

Remote Inlet Air Filter (Panel Type)

When the filter is mounted at a remote location with the inlet air piping supplied by others, the following recommendations should be observed.

The remote inlet air filter should be, at minimum, a high efficiency unit designed to remove 99.97% of all particles at 2 microns or larger. For adverse environmental conditions it is recommended that you use a special filter, such as:

- A 0.3 micron inlet air filter
- An inertial spin filter
- A chemical type filter

Check with your Ingersoll-Rand representative for specific filter information.

The air filter should be located as close to the unit as possible to minimize pressure drop. If the filter is located outside the compressor building, the inlet housing should be at least 8 to 10 feet above the ground or roof and 6 feet away from the side of a wall. *(See Figure 4)*

Access to the filter should be provided with ample room around the filter for maintenance. A permanent platform should always be built around elevated filters to provide safety for personnel assigned to changing filter elements.

For best performance the inlet air piping should conform to the following recommendations:

- The inlet piping, from the inlet filter to the compressor, must be clean and made from a non-rusting material such as stainless steel, aluminum, or PVC, and suitably flanged so that it may be inspected in sections.
- Inlet piping should be short and direct, with the combined filter and piping pressure drop less than 0.3 psi (2.1 kPa[a]).
- Always use long radius elbows.
- Transitions in pipe diameters should be gradual.
- Any horizontal run of pipe should be installed so that condensation in the piping will run away from the compressor.
- Drain valves should be installed in the inlet piping at low points to allow the removal of condensation.

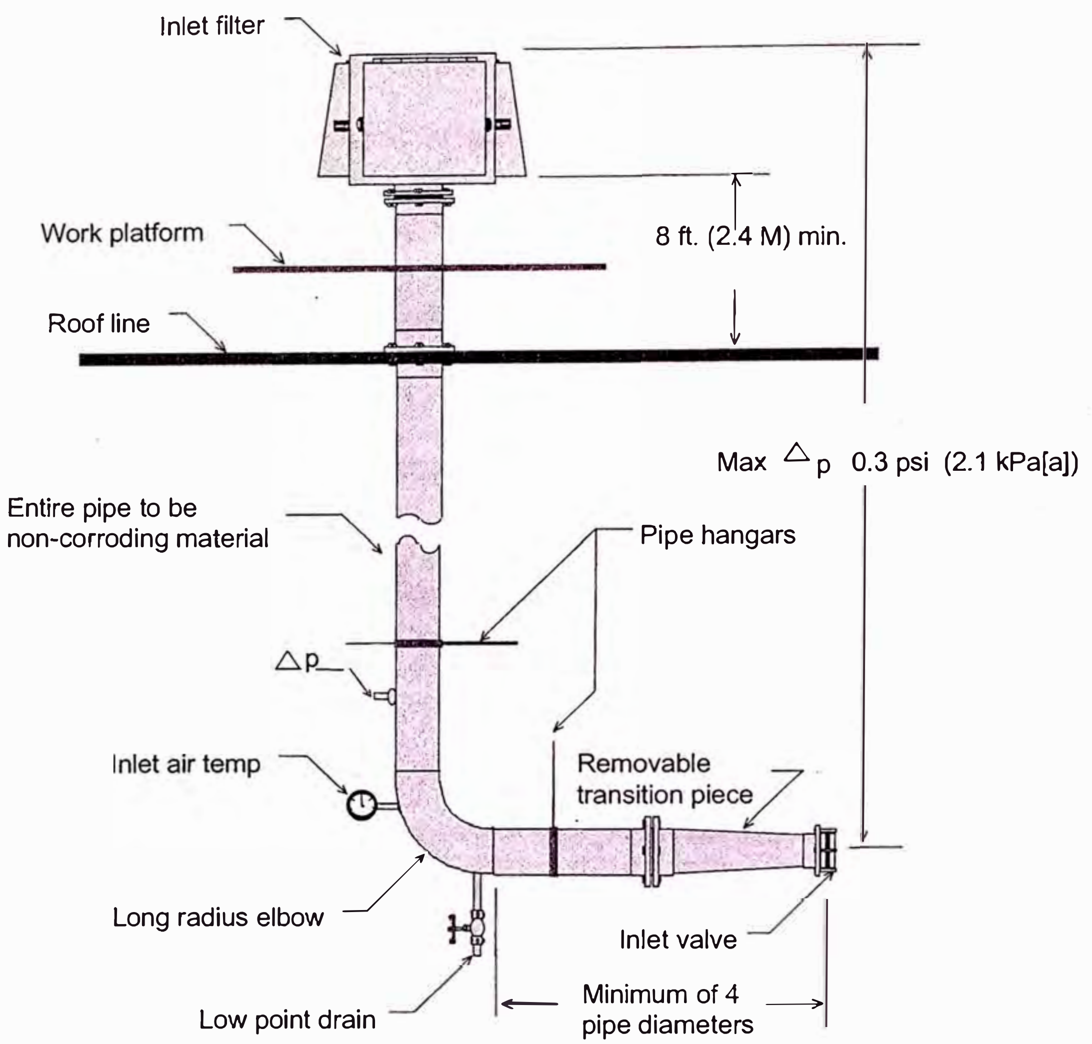


Figure 4
Inlet Air Piping – Air Filter

Bypass Air Piping

Atmospheric bypass piping vents the compressed air when the compressor is running unloaded or at partial load. Bypass piping should be well supported to minimize loading on the compressor flange. Care should be taken in the piping design so that all alignments can be made in the piping.

A bypass silencer should be installed in the atmospheric bypass line to reduce noise. A suitable silencer is offered as an option with the compressor package and is customer mounted. The silencer has acoustic absorption material at a controlled density. The silencer is usually installed close to the compressor and the vent piped outside. Alternately, the silencer may be installed outside the building. Consult the certified drawings for complete details of the silencer.

For sound attenuation in piping, a straight run of pipe from the compressor flange, at least 8 pipe diameters long, is suggested before entering a long radius elbow (see *Figure 5*). The silencer should be kept as close to the compressor as possible and the total length of pipe kept short. In noise critical areas, the discharge piping from the silencer may be lagged to further reduce sound.

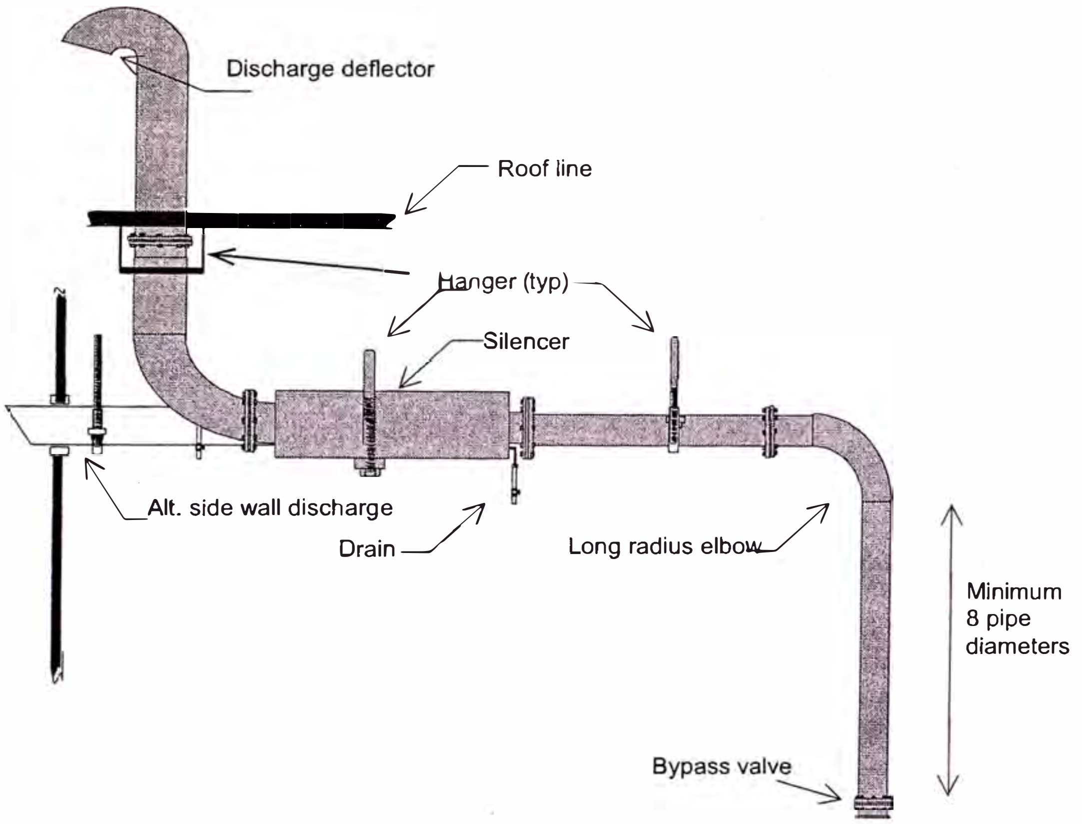


Figure 5
Model Bypass Pipe

Discharge piping from the silencer should be sized so that the maximum backpressure on the silencer is 5 psi or 35 kPa (a). Standard silencers are equipped with ANSI 150# standard flanges. Bypass piping to the silencer should be of the same diameter or larger than the bypass valve. Piping from the bypass silencer should be of the same size or larger than the silencer discharge. Refer to the certified drawing for complete details of silencer.

The bypass piping should be suitably flanged so that a minimum amount of pipe needs to be removed during major maintenance. This will reduce maintenance time.

The end of the pipe should be turned down or have a short horizontal run of pipe to prevent rain and snow from entering the bypass piping. Expanded metal should be installed on the end of the pipe to prevent large objects and animals from entering the pipe when the compressor is stopped. To remove condensation from the piping, install a drain in the lowest part.

Expansion Joints

With proper piping layout and installation, expansion joints may not be required on all compressors. However, expansion joints are required on:

- All hot air discharge compressors (no internal aftercooler)
- All steam turbine drivers – on the inlet and discharge.

Expansion joint installers must consult the manufacturer's instructions to ensure correct installation.

WARNING

⚠ Improperly applied and/or installed expansion joints can result in severe injury, death, or property damage due to over stressing and fatiguing of the bellows material.

NOTE

While Ingersoll-Rand may recommend or even supply an expansion joint, proper installation is the customer's responsibility.

Discharge Air Piping

For the best performance, a straight run of pipe which is at least 3 pipe diameters long should be interposed between the discharge check valve and a long radius elbow to allow for smooth operation of the check valve. The piping should be the full size of the compressor discharge connection. Where pipe diameter conversion is necessary, the transition should be gradual. The use of long radius elbows is recommended and piping may be sized by normal methods.

On all compressors it is necessary to install a spool piece that will allow parts of the compressor to be removed and piping to be out of the way of maintenance personnel. The customer should install a block valve in the discharge line to isolate the unit for maintenance. A safety relief valve should be installed between the block valve and the compressor (see *Figure 6*).

NOTE

Drain valves should be installed in piping low points to remove condensation, which might form during periods of shutdown. Piping should be designed so that the condensation will not drain back to the compressor.

WARNING

⚠ The use of plastic piping, soldered copper fittings, or rubber hose, as part of the discharge piping is not recommended. In addition, flexible joints and/or flex lines can only be considered for such purposes if their specifications fit the operating parameters of the system. Failure to adhere to these recommendations can result in mechanical failure, property damage, and serious injury or death.

It is the responsibility of the installer and owner to provide the appropriate service piping to and from the machine.

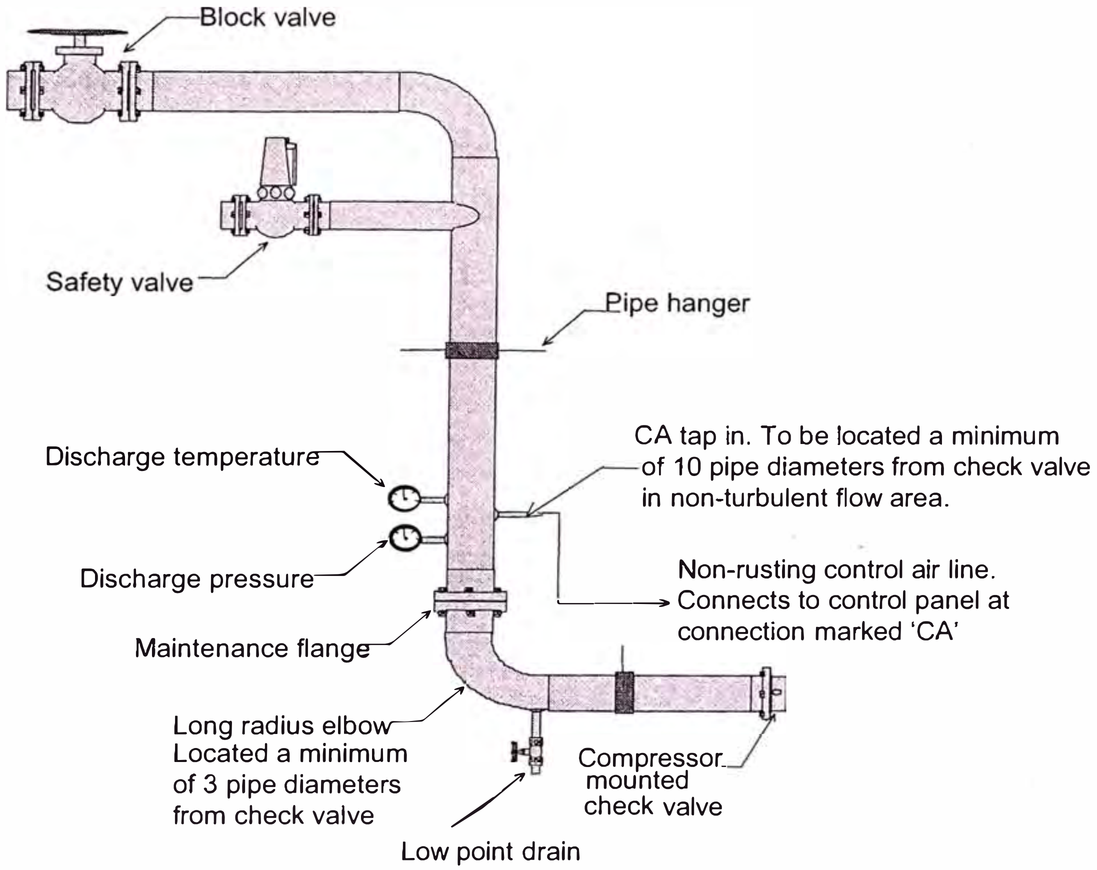


Figure 6

Model Discharge Pipe

Adequate piping support is needed to prevent excessive dead loads on the compressor flange. Provisions should be made in the discharge piping so that all alignments are made in the piping and not the compressor.

Discharge Air Piping for Multi-Compressor Installation

Parallel Operation with Positive Displacement Compressors

The steep performance curve of the Centac compressor allows for operation in parallel with piston or rotary screw compressors (*see Figure 7)*. However, piping layout design should isolate the Centac compressor from the pulsations in the discharge produced by these compressors. Piping the Centac compressor into the discharge header downstream of the pulsation bottle or receiver effectively eliminates pulsation problems.

Fast valve operation allows the lagging compressors to supply huge quantities of air at system pressure. Proper consideration to the entry of this added capacity into the system will eliminate control or surging problems commonly associated with this type of installation.

Discharge piping from the compressor should enter the system header by way of long radius elbows or at an angle in the direction of flow. By staggering entry into the header the added capacity will have no detrimental effect on the other units already on line.

Centac compressor connections and sizes are located on the certified customer prints. Refer to the General Arrangement Drawing and the Process and Instrumentation Diagram for further detail.

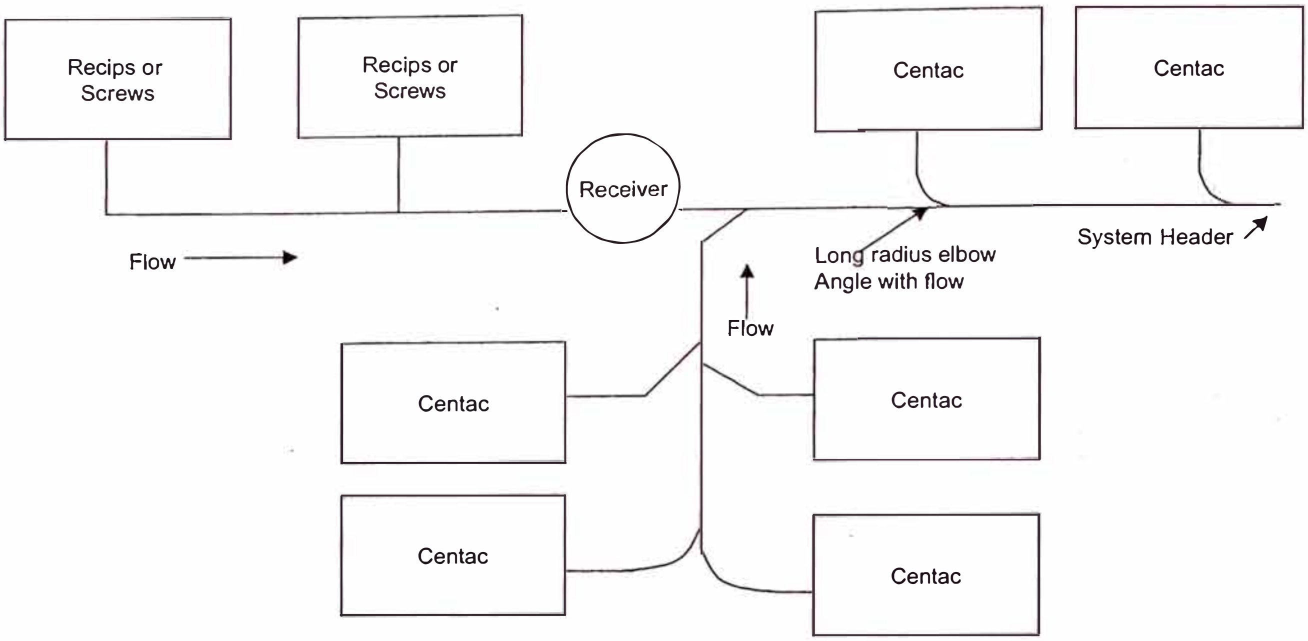


Figure 7

Centrifugal and Positive Displacement Piping Arrangement

Receivers

Receivers store compressed air for systems in which air demand fluctuates over a short period of time. A properly sized receiver will decrease the number of times the compressor loads and unloads. This will increase the compressor's efficiency and decrease wear on valve components. Receivers can be installed as "Wet" (before the dryer) or "Dry" (after the dryer) receivers or in both locations. Contact your local Ingersoll-Rand representative for assistance in properly sizing and locating this equipment.

A receiver may also be used to isolate centrifugal compressors (or other equipment) from pulsations created by positive displacement air compressors. A pulsation bottle may be needed to eliminate pulsations more effectively.

Control Air Piping

The control air pipe penetration is made at a minimum of 10 pipe diameters downstream of the discharge check valve in the discharge pipe (*see Figure 6*). The control air line connects to the control panel bulkhead fitting marked 'CA' *(see Figure 8)*, which is a 1/2 inch NPT connection. The control air line should be a minimum of 1/2 inch diameter, made of a non-rusting material such as stainless steel, aluminum, or copper. If the line is to be installed in a horizontal run of pipe, it should be located at the top of the discharge pipe to minimize condensate or debris buildup in the line. The control air line should be routed to the control panel in such a manner that the line will not have to be disconnected in order to perform major maintenance. A drip leg with a drain valve, which can be used to remove condensate, is recommended as part of the customer's control air line.

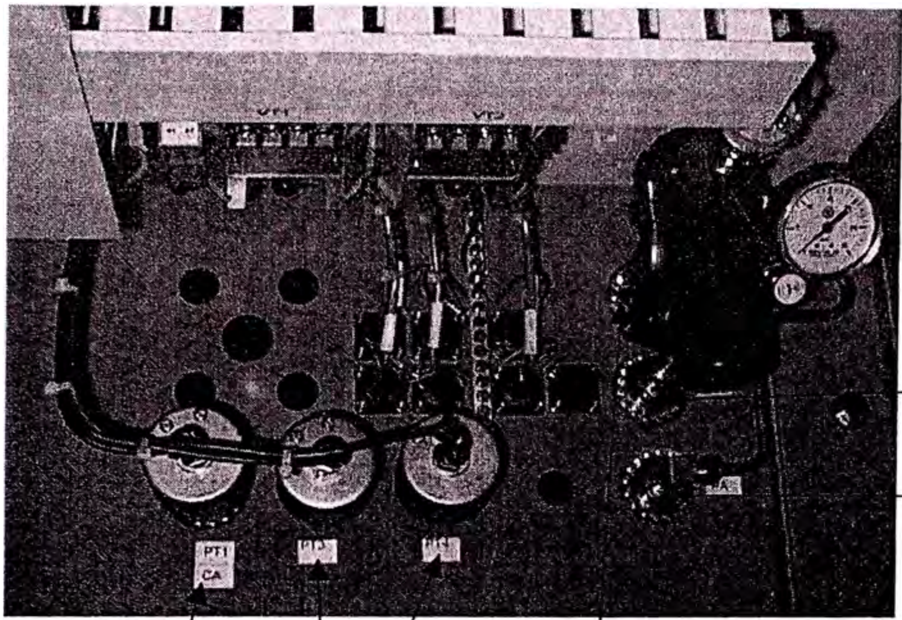


Figure 8
Control Panel Connections

Instrument Air Piping

Instrument air must be provided for the operation of the pneumatic control valves and for the seal buffer air. The air used must be clean dry instrument quality air. For best results, piping should be connected to a refrigerated air dryer and filter prior to connection on the unit. The Centac compressor normally requires 10 SCFM (0.33 m^3/m) of air at 60-120 PSIG (414-827 kPa).

The final filtering medium should be rated at a theoretical efficiency of 99.9999%, particle size of 0.01 micron, and a minimum or 25 SCFM (0.82 m^3/m). This filter should be located close to the control panel. An isolation valve may be located ahead of the filter.

Piping from the instrument air source should be constructed of 1/2 inch minimum non-corroding material to limit the possibility of corrosion products entering the system. Instrument air piping connects to the control panel at the 1/2 inch NPT bulkhead fitting marked “IA”.

Water System Piping

The water piping section consists of the following topics:

- Cooling water piping – provides cooling water to the air and oil coolers of the compressor
- Cooling water specifications – gives recommendations for clean water
- Air cooler vent and drain – connects air vents and cooler drains
- Condensate drain piping – provides a means of removing condensate from the moisture removal sections

Cooling Water Piping

Unless otherwise stated, water flows are based on the design conditions of the compressor for rated discharge pressure with 80°F cooling water temperature.

Sizing of water pipe may be done by conventional methods based on the GPM flows given. The size of pipe may be determined so as to hold flow velocities in the range of 6 to 7 ft/sec. The pipe design must allow for a minimum water pressure of 35 PSIG and the maximum water pressure of 75 PSIG (*see General Arrangement Drawing for connection locations.).*

A throttle valve is recommended on the discharge line to aid in temperature control. Placing the throttle valve on the discharge line helps ensure that the coolers operate full of water. In addition, gate valves should be fitted at the inlet of the water system to allow isolation of the compressor when necessary.

In dirty or silt laden water systems, a piping arrangement that will allow for backflushing the coolers must be used. The backflush valve arrangement is one where water flow may be reversed in the coolers and foreign matter flushed out (*see Appendix A for diagram of Cooling Water System Backflush).*

Regardless of the cooling system used, a strainer should be installed in the water supply line.

Cooling Water Specification

Water used for cooling should be clean and free of corrosive elements. It is best that the water used is filtered and treated to fall within the following specification:

- Total hardness expressed as $CaCO_3$ should be less than 100 PPM.
- Acidity should be within the 6.0 to 8.5 pH range.
- Suspended solids should not exceed 50 PPM.
- The langelier saturation index should be between +0.5 and +1.0.

The Langelier's index is a technique of predicting whether water will tend to dissolve or precipitate calcium carbonate. If water precipitates calcium carbonate, scale formation may result and this water will have a corrosive tendency. Other factors that contribute to corrosion include:

- Temperature differences within a system.
- Changing operating conditions.
- Presence of chemical treatment in the water.
- Presence of dissolved oxygen in the water

Air Cooler Vent Lines

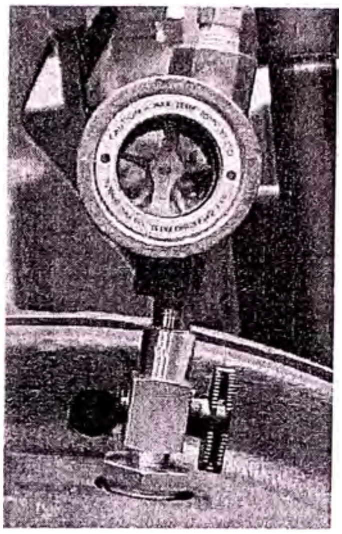


Figure 9
Visual indicator of water flow through vent lines

Air cooler vents with valves are provided at the highest point on the air cooler casings. They are supplied to ensure that the coolers are full of water when the compressor is operating and no air pockets form in the coolers. If part of the cooler is starved for water, overheating may occur resulting in damage.

The vents should remain open at all times. The connections must be piped, by the customer, to a drain or suitably connected to the compressor water discharge with a sight flow indicator for each air cooler (*see Figure 9).*

Do not connect the vent lines together. When a closed cooling water system is utilized, casing vents should be piped to the lower pressure discharge water line to ensure flow through the vent piping.

Condensate Drain Piping

Air entering the first stage of the unit carries with it a certain amount of moisture. The amount of moisture depends on the temperature and relative humidity. The maximum moisture content occurs on days of high temperature and high relative humidity.

Moisture is removed from the air as it passes through each stage of compression. As the air passes through the coolers, water vapor in the air is condensed and collected in the moisture separator. This condensation is removed by condensate traps to prevent water carryover into the next stage of compression. Excessive water carryover may create problems.

Condensate traps with bypass valves for each stage are factory installed (when ordered). Each condensate trap must be provided with a separate drain. In addition, each trap discharge should be piped to a drain that will allow a visual check of the individual trap function *(see Figure 10).*

The location and size of the trap discharge connection is listed on the General Arrangement Drawing. The piping arrangement is shown on the Process and Instrumentation Diagram.

If the unit is unattended or in a location where maintenance is minimal, a high-level condensate and shut down alarm should be used. If the traps become clogged, water carry-over in the unit will result.

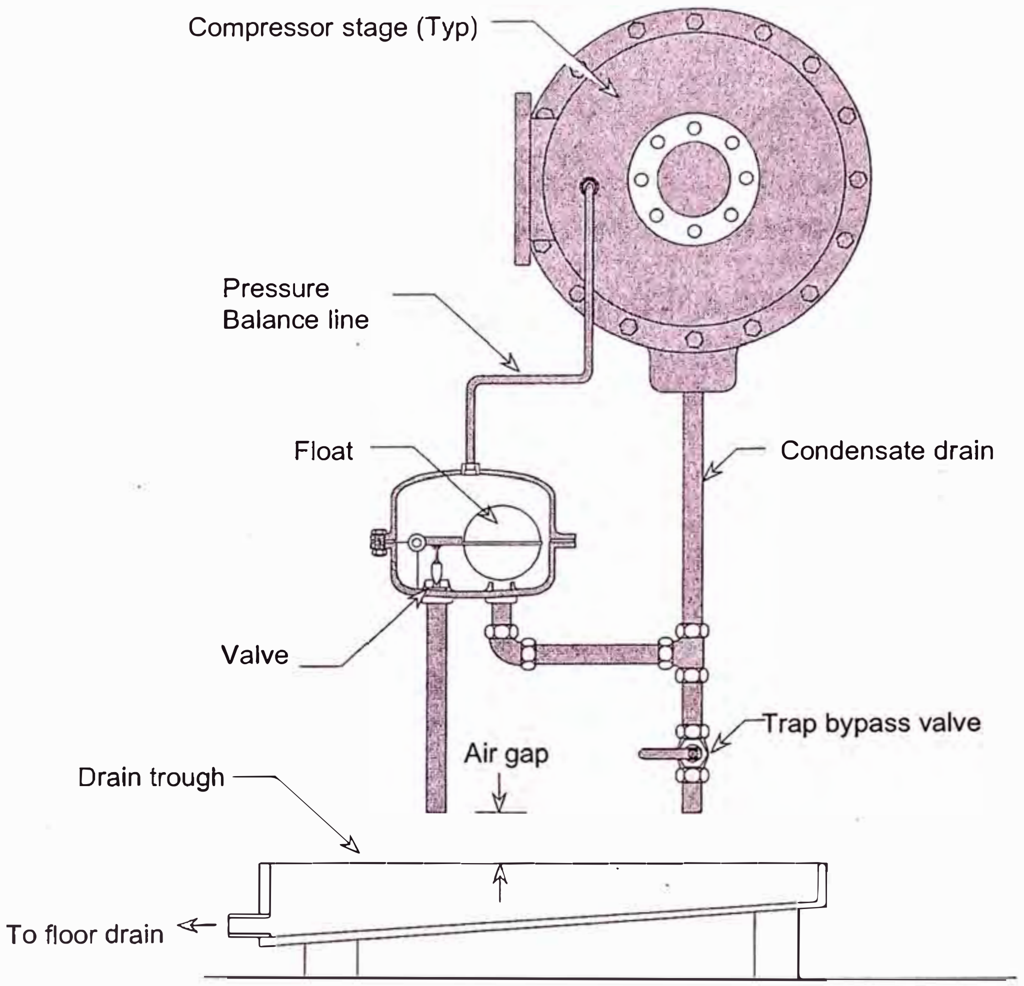


Figure 10
Standard Condensate Trap and Drain Arrangement

External Compressor Piping Notice

CAUTION

⚠ All air and water pipes, to and from the inlet and discharge port connections, must take into account: vibration, pulsations, temperature, maximum pressure applied, corrosion and chemical resistance. In addition, it should also be noted that lubricated compressors discharge some oil into the air stream, therefore, compatibility between discharge piping, system accessories, and software must be assured. Where compatibility questions exist, contact your nearest Ingersoll-Rand office.

It is the responsibility of the installer and owner to provide the appropriate service piping to and from the machine.

Electrical Connections

Introduction

The following electrical connections are required to the extent referenced in the supplied General Arrangement and Electrical Schematic drawings:

- Control panel power
- Starter interface
- Main driver connections
- Heater contactor
- Prelube pump starter
- Current transformer
- Optional switches

WARNING
⚠ Electrical-trade personnel must do electric installation on the Centac compressor. Electricity can cause serious injury or even death if proper handling and installation procedures are not observed. Contact a qualified electrical installation contractor for help installing and/or maintaining any electrical services to this compressor.

NOTE
Design and installation of disconnect, overvoltage, short circuit, and overload protection is the responsibility of the customer.

Control Panel Power

The standard Centac compressor control circuitry is designed for a 120 VAC source. If the customers source is greater than 120 VAC, a control transformer must be used. Check the Electrical Schematic to determine whether the control transformer has been factory installed.

To properly make electrical connections to the control panel, refer to the Electrical Schematic to identify the proper terminals for wire connection, and refer to the panel outline drawing for conduit entry size. Incoming power should be connected to the appropriate terminal blocks in the control panel as shown by the Electrical Schematic.

Starter Interface

Remote starters require two interface points:

1. A feedback circuit, which indicates a running condition, is connected to the control circuits inside of the compressor's control panel. This is done by the customer.
2. The starter's on/off circuit is connected with the panel's start control relay. Local start pushbuttons on the starter should not be used. The starter's 120 VAC control circuit should be connected to the control panel start circuit. Do not exceed 720 VAC. The circuit must be wired in series with the starter. The starter must not be powered by any other source other that Ingersoll-Rand's control panel.

Motor Connections

Three-phase power must be connected to the starter and the three-phase wiring must also be connected from the starter to the main motor. The motor will be furnished with leads terminating in a junction box on the side of the motor to which the three-phase wiring from the starter is to be terminated. Refer to the main motor nameplate and manufacturer's data sheet to properly size the three-phase wiring that connects the starter to the motor. The customer should ensure that the incoming voltage matches the voltage on the main motors nameplate. Before wiring and applying power to the main motor, it must be meggered to ensure the integrity of the insulation.

Heater Contactor

This device is required for operation of the oil reservoir heater. It must be sized according to the electrical information found on the oil reservoir heater nameplate. Ingersoll-Rand supplied oil reservoir heaters have thermostats mounted within the housing for "pilot" type operation of the contactor. Ingersoll-Rand supplied contactors are mounted inside the control panel enclosure.

Prelube Pump Starter

This device is required for operation of the prelube pump driver. It must be sized according to electrical information found on the prelube pump motor nameplate. Ingersoll-Rand supplied prelube pump starters are mounted inside the control panel enclosure.

WARNING

⚠ Do not disconnect secondary wiring during operation. Anytime secondary side of the current transformer is disconnected from its load, a jumper must be placed across secondary terminals to prevent injury or death of personnel and/or damage to equipment.

Current Transformer

This device may be required to provide a 0-5 ampere signal to one or more devices located in the control panel. When supplied by Ingersoll-Rand, the current transformer is often shipped loose for installation by the customer.

WARNING
⚠ An appropriate grounding strap should be attached to the motor and a suitable ground. DO NOT CONNECT TO A PLANT GROUND CIRCUIT.

Optional Switches

Optional switches such as pressure, temperature, flow, etc. supplied by Ingersoll-Rand but mounted by the customer must be connected to the control panel. Information on how to wire these devices to the control panel is shown on the Electrical Schematic.

Lubrication

NOTE
The initial fill of lubricant for the Centac compressor should be installed under the supervision of an authorized Ingersoll-Rand Technical representative.

Cleanliness of the lubrication system is of vital importance to the Centac air compressor. The system is flushed and fully tested at the factory. The sump access cover should be wire sealed as shipped from the factory. If the wire seals have been violated, then the following procedure must be followed under the supervision of an authorized Ingersoll-Rand Technical representative.

Piping Flush

1. Remove the sump access cover. Thoroughly clean the sump of any shipping oil and dry with lint free rags.
2. Fill with recommended oil to the proper level and replace sump access cover.
3. Disconnect the oil piping at the entrance to the gear casing and use a flexible oil line to route the oil to the sump in the baseplate.
4. Circulate the oil for a minimum of one hour using the prelube pump. Optimum flushing temperature is 100°F.
5. Tap any welded piping with a plastic or lead hammer during oil circulation to dislodge any foreign material lodged at the welded joints.
6. Change position of the transfer valve at 15 minute intervals on systems having dual oil filters and/or coolers.
7. Shut off the prelube pump.

WARNING

⚠ Hot oil can cause serious injury to personnel. Precaution must be taken to prevent contact with hot oil.

8. Drain the oil filter and inspect the element(s). Continue with one of the following:
   - If foreign material is found in the filter housing or element, replace the oil filter and repeat step 4 through 8 until filter housing and element are clean upon inspection.
   - If no foreign material is found, go to step 9.
9. Replace the oil filter element(s) and inspect the housing for cleanliness. Continue with Casing Flush.

Casing Flush

1. Reconnect lube piping to the gear casing.
2. Apply instrument quality air to the seals (6 PSIG [41 kPa] minimum).
3. Restart prelube pump and circulate oil for one hour.
4. Tap any welded piping with a plastic or lead hammer during oil circulation to dislodge any foreign material lodged at welded joints.
5. Change position of the transfer valve at 15 minute intervals on systems having dual oil filters and/or coolers.
6. Shut off the prelube pump.
7. Drain oil filter and inspect the element(s). Continue with one of the following:
   - If foreign material is found in the filter housing or element, replace the oil filter and repeat step 3 through 7 until filter housing and element are clean upon inspection.
   - If no foreign material is found, go to step 8.
8. Replace the oil filter element(s) and inspect the housing for cleanliness.
9. Fill sump to the proper level with recommended oil.
10. Replace sump access cover and secure.

Recommended Lubricant

Lubrication for the compressor system should be a synthetic lubricant. The lubricant must have unusual oxidation stability and contain defoaming inhibitors and be free of inorganic acids or alkali. There must be no tendency toward permanent emulsification and a minimum tendency to oxidize or form sludge when agitated at operating temperatures when mixed with air and water. Ingersoll-Rand offers Techtrol Gold III, a synthetic lubricant specifically formulated for Centac compressors.

CAUTION

⚠ Some lubrication mixtures are incompatible with each other and result in the formation of varnishes, shellacs or lacquers which may be insoluble. Such deposits may cause serious trouble, including clogging of the oil filter. Avoid mixing lubricants of the same type, but of different brands. A brand change is best made at the time of a complete lubrication change.

CAUTION

⚠ Lubricant obtained by the user for operation of this equipment must comply with the following specification and perform satisfactorily in the compressor. The Ingersoll-Rand Company assumes no responsibility for damages caused by non-compliance to this specification within the period of its standard equipment guarantee or thereafter. On subsequent purchases of lubricant for use with this equipment, the user is cautioned to be on the alert for any changes in the lubricant that may deviate from this specification thereby causing equipment damage.

Physical and Chemical Requirements for Techtrol Gold III Coolant:

Property	ASTM Test Method	Limits
PHYSICAL:		
ISO Viscosity Grade	D2422	32
Viscosity Index	D2270	139
Viscosity, cSt (SUS)		
@ 0°F/-17.8°C	D445	895 (4195)
@100°F/37.8°C	D445	30 (142)
@104°F/40°C	D445	28 (133)
@210°F/98.9°C	D445	5.6 (45)
@212°F/100°C	D445	5.5(44)
Pour point, °F (°C)	D97-87	-40 (-40)
Flash Point, COC °F (°C)	D92	450 (232)
Flash Point, PMCC °F (°C)	D93-85	390 (199)
CHEMICAL: (a)		
Total acid number, mg KOH/g, max.	D664	0.1
pH	D664	8
Density (Grams per cc @25 °C	D941	0.988
Specific Gravity	D941	0.99
Copper Strip Corrosion, 3 hrs. @ 212°F/100°C	D130	1
Ferrous Metal Corrosion (Rust Test)	D665A	Pass
Foam Tendency (Sequence I,II,III)	D892	0 (Nil)

NOTE
The initial lubricant supply required for the compressor installation is not normally supplied with the compressor.

NOTE
Failure to meet this specification may result in damage to internal compressor components.

NOTE
The Pour point specification **must** be met unless there is a means available for heating the oil when used in low temperature areas.

NOTE
Oil specifications are constantly being reviewed. Verify that correct oil is used by consulting appropriate serial number manual. Ingersoll-Rand does not endorse any other trade name product or any individual oil company.

Reservoir Capacities

Model Number	Sump Capacity (Gallons)	Sump Capacity (Liters)	Total Oil System Capacity (gal/lit)
C950	105	397	110 gal/ 416 liter

Actual capacities will vary with specific sumps. The above listed values are for standard Centac models. Total oil system capacities account for reservoir oil capacity plus oil piping.

Review of the Specification section of the compressor Operation Manual is recommended for exact capacity of a specific unit.

The above values do not apply to API style sumps.

Standard Oil Cooler and Filter Data

Lube Oil Cooler

Water side design pressure	150 PSIG	1034 kPa
Shell side design pressure	150 PSIG	1034 kPa

Lube Oil Filter

Dual Element	10 Micron

Recommended Oil Temperatures

Minimum Oil Temperature for:

Starting	95°F	35°C
Operating Bearing Inlet Oil Temp.	100°F to 115°F	37.5°C to 46°C

Weights and Dimensions

Specific machine weights and dimensions will vary according to motor selected and any additional special options purchased. The weights and dimensions provided are to be used for estimating purposes only. Refer to the specific General Arrangement drawing for actual dimensions.

Length (in/mm):	Width (in/mm):	Height (in/mm):	Weight (lb./Kg):
148/3759	89/2261	74/1880	17,000/7,711

Compressor Connections:

Inlet Air Connection:	10 in. 125# ANSI FF Flange
Discharge Air Connection:	6 in. 125# ANSI FF Flange
Bypass Air Connection:	4 in. 125# ANSI FF Flange
Air Cooler Connections:	2 in. 125# ANSI FF Flange
Oil Cooler Water Connections:	2 in. NPT

Recommended Tools

The following list of standard mechanic's tools is provided as a guide for maintenance and installation of a Centac compressor.

- Lifting Device (1/2 ton, or 500 kilos minimum)
- Allen wrenches
- Feeler gauges
- Drive sockets with extensions
- Open end and box wrenches
- Adjustable wrenches
- Pipe wrenches
- Torque wrench (to 200 ft-lb or 300 Nm)
- Vise grips
- Channel locks
- Rubber or Lead hammer
- Dial indicator with magnetic base
- Digital Multimeter
- Machinist scale
- Transit Level
- Micrometer

Checklist Summary

All systems on the Centac compressor should be checked prior to initial start-up. This check should be completed under the direction of an Ingersoll-Rand customer service representative.

The operational checklist should be completed in accordance with the individual units Operation Manual. The following checklist is provided to prevent over-sights which could delay start-up of the unit and additional expense in correcting these.

Check off each section before the initial start-up.

☐ The following are inspected for corrosion and cleanliness prior to start-up:

- Oil Reservoir
- Inlet Air Filter
- Inlet Air Piping
- Discharge Piping
- Bypass Piping
- Water Piping

☐ Check inlet air filter location and installation.

☐ Check the following on the inlet air piping:

- Material
- Minimum size
- Distance to first elbow (minimum of 4 pipe diameters)
- Facilities for moisture removal on any horizontal run of pipe
- Piping supports
- Manometer or differential pressure gages on inlet air filter

☐ Check the following on the discharge piping:

- Minimum size
- Distance to first elbow (minimum of 3 pipe diameters)
- Piping supports
- Facilities for moisture removal on any horizontal run of pipe
- Safety valve (located between block valve and compressor)
- Block valve

☐ Check the following on the bypass piping:

- Minimum size
- Distance to first elbow (minimum of 8 pipe diameters from bypass valve)
- Piping supports
- Location of silencer
- Facilities for moisture removal on any horizontal run of pipe

☐ Check the following on the controlled air piping:

- Material
- Minimum size
- Attached to control panel at bulkhead fitting "CA"
- Attached to discharge air piping a minimum of 10 pipe diameters from check valve

☐ Check the following on the instrument air piping:

- Material
- Minimum size
- Attached to control panel at bulkhead fitting "IA"
- Attached to dry, clean air source, 60-120 PSIG (414-827 kPa) at 10 SCFM (0.33 m^3m) minimum
- Absolute air filter (0.01 micron)
- Shut-off valve

☐ Check the following on the water piping:

- Minimum size
- Attachment to compressor
- Attachment to oil cooler
- Maximum of 75 PSIG (517 kPa) water pressure
- Minimum of 35 PSIG (241 kPa) water pressure
- Differential pressure between inlet and outlet flanges on air coolers is normally 12 PSIG (15 PSIG maximum) [83 kPa - 103 kPa maximum]
- Check for water leaks (leave condensate trap bypass valves open)
- Throttle valves at outlets
- Block valve on inlet
- Casing vents open

- [ ] Check piping on condensate traps (piped to open drain).
- [ ] Check compressor lubricant, motor lubricant, & coupling grease for conformance to specifications.
- [ ] Fill oil reservoir to "Normal" level.
- [ ] Check anchor bolts and grouting.
- [ ] Check unit level.
- [ ] Check electrical power supply to unit.
- [ ] Check all control panel connections per applicable schematics.
- [ ] Manually rotate compressor and driver shafts, checking for free, uncoupled, rotation with prelube pump running and seal air 'on'.
- [ ] Check driver per manufacturer's instructions found in the individual unit's Operation Manual.
- [ ] Check driver electrical connections.
- [ ] Check direction of rotation and magnetic center of main drive on motor driven units prior to coupling to compressor.
- [ ] Align driver to compressor.
- [ ] Install coupling spacer and lubricate coupling per manufacturer's instructions.
- [ ] Check rotation of prelube pump (three phase only).
- [ ] Check clearances on thrust bearings. Disregard if the access covers are wire sealed.
- [ ] Check lubrication system for oil leaks.
- [ ] Check operation and calibration of the inlet and bypass valves per the Operation Manual.

Assistance

Ingersoll-Rand is committed to serving you. If you require information, service or parts, we are strategically located to serve your needs. When you need support for your Centac compressor, contact your local Ingersoll-Rand representative or call the factory direct.

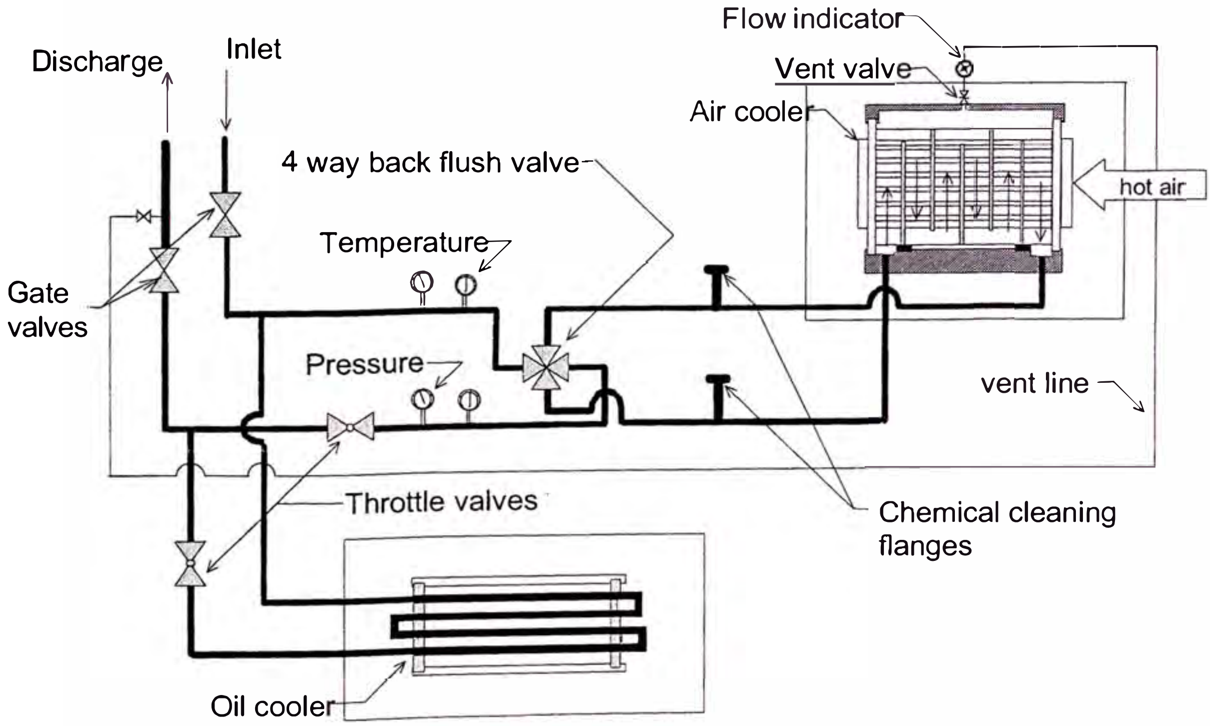
Centac Aftermarket can be reached 24 hours a day

Phone: 800-247-8640 or 502-247-8640

Fax: 502-251-1273

Appendix A

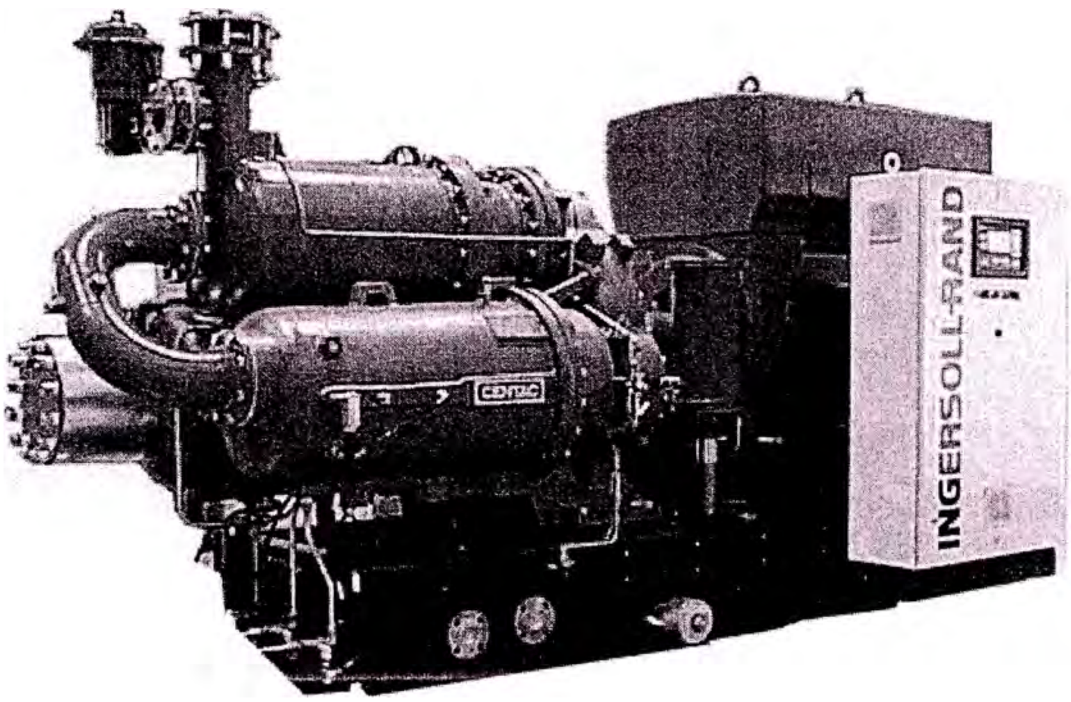
OPTIONAL COOLING WATER SYSTEM BACKFLUSH



* Valves and gauges normally supplied by customer

CENTAC®

C950 Operation Manual



INGERSOLL RAND®
AIR COMPRESSORS

Proprietary Notices and Disclaimer

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Ingersoll-Rand Company
Centrifugal Compressor Division
Highway 45 South
Mayfield, Kentucky 42066

Warranty and Limitation of Liability

Warranty

The Seller warrants that the Equipment manufactured by it and delivered hereunder will be free of defects in material and workmanship for a period of twelve months from the date of placing the Equipment in operation or eighteen months from the date of shipment, whichever shall first occur. The Buyer shall be obligated to promptly report any failure to conform to this warranty, in writing to the Seller within said period, whereupon the Seller shall, at its option, correct such nonconformity, by suitable repair to such Equipment or, furnish a replacement part F.O.B. Jobsite, provided the Buyer has stored, installed, maintained and operated such Equipment in accordance with good industry practices and has complied with specific recommendations of the Seller. The Seller reserves the right to take possession of or direct Buyer to return any replaced parts, which shall become Seller's property. Accessories or equipment furnished by the Seller, but manufactured by others, shall carry whatever warranty the manufacturers have conveyed to the Seller and which can be passed on to the Buyer. This warranty shall not apply to any component which Buyer directs Seller to use in or add to the Equipment, and which would not otherwise be used or added by the Seller. The Seller shall not be liable for any repairs, replacements, or adjustments to the Equipment or any costs of labor performed by the Buyer or others without the Seller's prior written approval.

The effects of corrosion, erosion and normal wear and tear are specifically excluded. Performance warranties are limited to those specifically stated within the Seller's proposal. Unless responsibility for meeting such performance warranties are limited to specified tests, the Seller's obligation shall be to correct in the manner and for the period of time provided above.

THE SELLER MAKES NO OTHER WARRANTY OR REPRESENTATION OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE HEREBY DISCLAIMED.

Correction by the Seller of nonconformities whether patent or latent, in the manner and for the period of time provided above, shall constitute fulfillment of all liabilities of the Seller for such nonconformities, whether based on contract, warranty, negligence, indemnity, strict liability or otherwise with respect to or arising out of such Equipment.

The Buyer shall not operate Equipment which is considered to be defective, without first notifying the Seller in writing of its intention to do so. Any such use of Equipment will be at the Buyer's sole risk and liability.

Limitation of Liability

THE REMEDIES OF THE BUYER SET FORTH HEREIN ARE EXCLUSIVE, AND THE TOTAL LIABILITY OF THE SELLER WITH RESPECT TO THIS CONTRACT, WHETHER BASED ON CONTRACT, WARRANTY, NEGLIGENCE, INDEMNITY, STRICT LIABILITY OR OTHERWISE, SHALL NOT EXCEED THE PURCHASE PRICE OF THE UNIT OF EQUIPMENT UPON WHICH SUCH LIABILITY IS BASED.

THE SELLER AND ITS SUPPLIERS SHALL IN NO EVENT BE LIABLE TO THE BUYER, ANY SUCCESSORS IN INTEREST OR ANY BENEFICIARY OR ASSIGNEE OF THIS CONTRACT FOR ANY CONSEQUENTIAL, INCIDENTAL, INDIRECT, SPECIAL OR PUNITIVE DAMAGES ARISING OUT OF THIS CONTRACT OR ANY BREACH THEREOF, OR ANY DEFECT IN, OR FAILURE OF, OR MALFUNCTION OF THE EQUIPMENT HEREUNDER, WHETHER BASED UPON LOSS OF USE, LOST PROFITS OR REVENUE, INTEREST, LOST GOODWILL, WORK STOPPAGE, IMPAIRMENT OF OTHER GOODS, LOSS BY REASON OF SHUTDOWN OR NON-OPERATION, INCREASED EXPENSES OF OPERATION, COST OF PURCHASE OF REPLACEMENT POWER OR CLAIMS OF BUYER OR CUSTOMERS OF BUYER FOR SERVICE INTERRUPTION WHETHER OR NOT SUCH LOSS OR DAMAGE IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, INDEMNITY, STRICT LIABILITY OR OTHERWISE.

DK 2/17/99 Dom/Int'l

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NOTICE

On receiving the Centac compressor, be sure to inspect the unit for evidence of damage during shipment. Immediately notify the carrier and the nearest Ingersoll-Rand representative if any damage is noted.

The compressor should be stored on a level floor or supports, in a dry protected area. Based on these conditions, the Centac compressor has been prepared for 180 days of storage. If the unit is to be stored for periods longer then 180 days, it will require additional protection.

Please contact the nearest Ingersoll-Rand representative prior to shipment for instruction on extended storage and advise them of the proposed period of storage.

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Ingersoll Rand
Industrial Technologies

CENTAC® Compressor Specifications

This data has been tabulated for serial number

C13053 & C13054

MODEL C95040M3MP	Value	Units
Nominal Discharge Capacity	4661	ACFM
Barometric Pressure	14.6	psia
Inlet Pressure	14.3	psia
Discharge Pressure	65	Psig
Inlet Temperature	86	°F
Relative Humidity	100	%
Rated Speed	3575	RPM
Coolant Temperature	86	°F
Coolant Temperature Rise	20	°F
Stage 1 Coolant Flow	85	gpm
Stage 2 Coolant Flow	69	gpm
Stage 3 Coolant Flow	64	
Oil Cooler Coolant Flow	47	gpm
Total Coolant Flow	265	gpm
Stage 1 C.T.D.	9	°F
Stage 2 C.T.D.	12	°F
Stage 3 C.T.D.	11	°F

Section 2 – Description

Introduction

The Centac compressor is a reliable and efficient centrifugal compressor that is designed to provide oil-free compressed air or nitrogen. Each compressor is fully packaged on a common fabricated steel baseplate and is equipped with a self-contained lube oil system and a state-of-the art control panel. Some of the outstanding features and benefits are:

Features	Benefits
Small rigid baseplate	No special foundation required
Mounted control valves	Machine mounted
Mounted intercoolers and aftercooler	Compact efficient design
Baseplate mounted control panel	Prewired and factory tested
Fewest electrical hookups	Minimal installation time and cost

How a compressor works

The Centac compressor is a dynamic centrifugal type compressor. As we can see in Figure 1, air enters the compressor through the machine mounted inlet control valve and flows to the first stage where the impeller (1) imparts velocity to the air. The air proceeds through the stationary diffuser section (2) that converts velocity to pressure. The built-in intercooler (3) removes the heat of compression, which improves efficiency. Air then passes through a stainless steel moisture separator (4) in a low velocity zone to remove condensate. Entrained moisture in the air is reduced when the air is forced through stainless steel moisture separators. This sequence repeats in each succeeding stage until the compressor achieves the desired operating pressure.

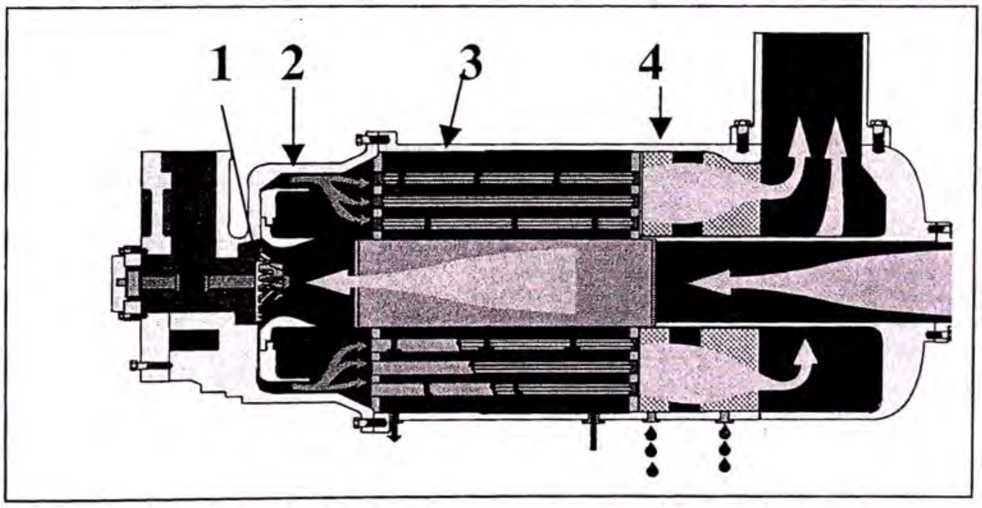

Figure 1
How a compressor works

Machine Description

The Centac compressor is a centrifugal air compressor driven by an electric motor, a steam turbine, gas engine, or diesel engine. The compressor and driver are direct coupled and the entire unit is mounted on a common baseplate with its own lube system, control system, and auxiliaries.

The compressor package contains:

- A main driver that directly drives a bullgear that is common to all stages.
- Compression stages consisting of an impeller mounted on its own shaft, enclosed within a common cast iron casing.
- Rotors consisting of an integral pinion gear driven at its optimum speed by a common bullgear.
- An intercooler that is mounted within each stage.
- A moisture separator and a moisture removal system are supplied after each cooler to remove condensate.
- In some compressor configurations an integral aftercooler is also supplied as part of the package.

Low-pressure designs will typically have fewer stages than the standard compressor. High-pressure designs are also available.

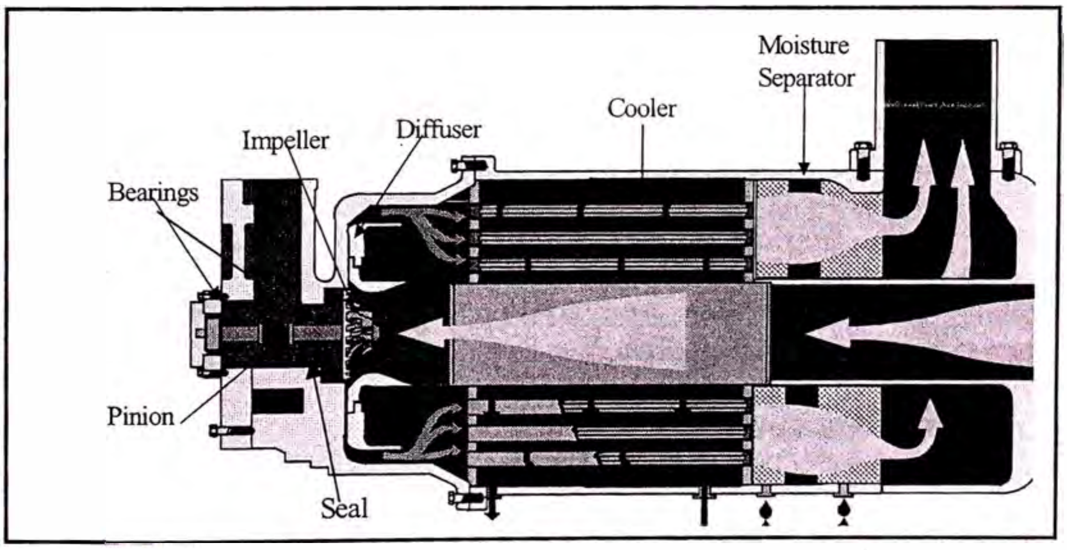

Figure 2
Centac compressor stage

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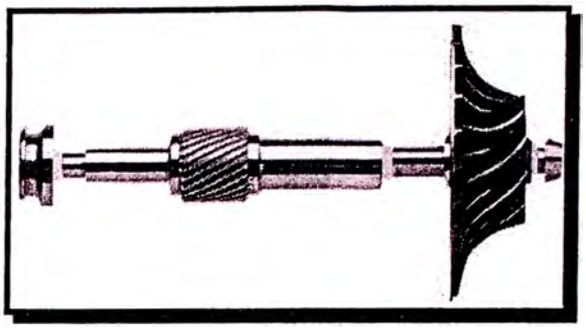
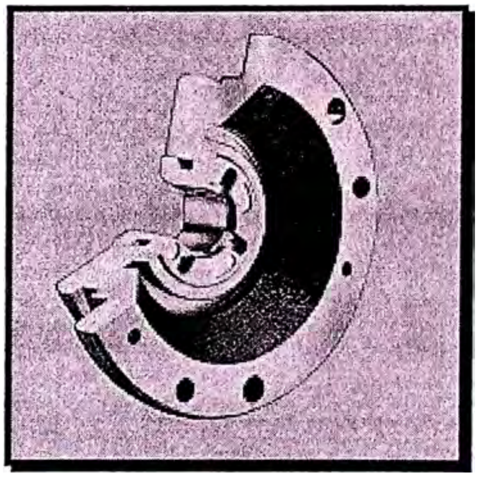
Rotor Assemblies

Each rotor assembly consists of an efficient and high quality stainless steel impeller and a removable thrust collar mounted on a helical geared pinion shaft. The impeller and thrust collar are each secured to the shaft by a polygon spline, which eliminates the need for keyways. All rotating parts are dynamically balanced as a complete assembly.



Bearings



Thrust Bearing

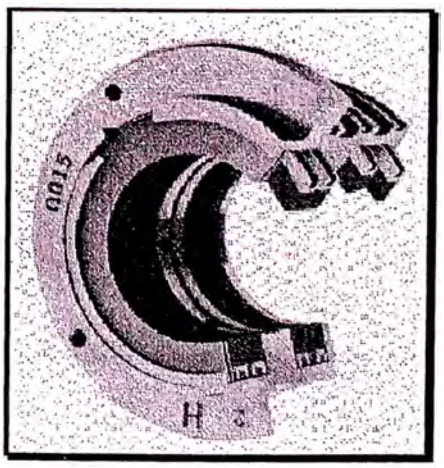
Thrust loads are absorbed at each pinion by a hydrodynamic thrust bearing. The thrust bearings are designed to maximize load carrying capacities and to minimize power loss.

Bullgear bearings for some Centac compressor models are of the rolling element type and some incorporate hydrodynamic designs.

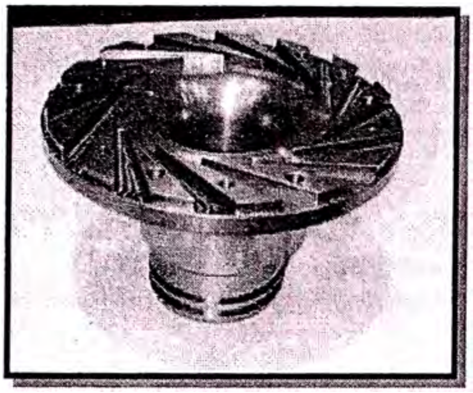
The plain journal bearings, used to support the shaft radial load, are babbitt lined, fixed tilted pad design for maximum stability and load capacity with minimum power loss.

Seals

A single cartridge seal is mounted in the plain bearing housing behind each impeller. Each cartridge consists of three, one piece, fully floating non-contact carbon rings. One ring is used as an air seal and the remaining two as oil seals. Buffer air supplies air to the oil seals assuring that lube oil is not drawn past the seals, thus ensuring oil free air.



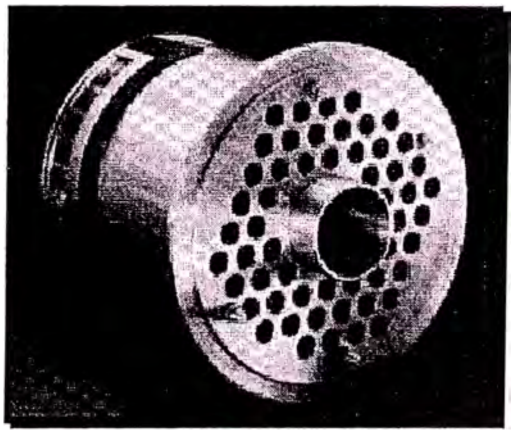
Diffusers



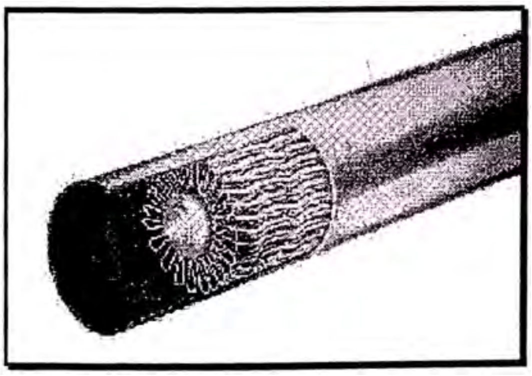
A diffuser, located between each impeller and cooler, converts velocity energy to pressure energy. The diffusers are designed for maximum efficiency while limiting physical size, thereby keeping the compressor as compact as possible.

Intercoolers

The Centac cartridge cooler is internal to the compressor casing. The coolers are donut type, with the water over the tubes. The tubes are internally finned. Air passes through the tubes while the water makes a number of counter passes to the air flow. This arrangement results in a highly efficient of heat transfer.



The internal fin design, along with the straight through tube design, produces the best heat transfer and lowest pressure drop.



Cooler Design Features:

- Lead-free cooler design and construction
- Straight tube design
- Rolled tube to header bond
- Large diameter tubes equally spaced for accessibility during cleaning.
- TEMA constructed leak free brass headers

Externally mounted coolers with internal separators are also available. The optional external coolers have water through the tubes and air side fin construction.

Moisture Separators

The moisture separator is a stainless steel mesh screen type construction. The thickness of the separator is designed to separate the maximum amount of moisture at a minimal pressure drop. The separators are located at points in the compressor where air velocities are relatively low permitting effective moisture separation.

Vibration Probes

A non-contacting vibration probe is mounted on each stage next to the plain bearing. The vibration probe measures the radial vibration of each rotor assembly. Each probe is connected to a vibration transmitter. Stage vibration protection is provided as standard on all compressors.

Casing

The gear case consists of a casing and casing cover. The joint between the casing and cover is vertical. This bolted assembly is only opened for servicing the bullgear or its bearings. The cooler assemblies, which are mounted onto the casing, can be easily removed for inspection or for dismantling the rotor assemblies, diffusers, bearings, or seals.

Compressor Driver

The Centac compressor may be furnished with an electric motor, steam or gas turbine driver, gas engine, or diesel engine. Main drivers are available with optional accessories and features.

Safe and efficient operation of the main driver is of prime importance to the overall performance of the compressor package. Because of the importance of the main driver, manufacturer's literature is supplied as part of the compressor package. The customer should refer to the driver instructions for a detailed description of the driver supplied.

Operating the Compressor in Cold Ambient Temperatures

To facilitate start up and shutdown in cold climates, power to the lube oil heater should be kept on at all times. If power failure is anticipated, it may be desirable to insulate and/or heat trace the lube oil piping from the oil reservoir to the casing. This will speed up the start after extended shutdowns in cold climates.

When the temperature drops down below -20°F (-28.9°C) and/or there is wind driven snow, follow the guidelines listed below:

- Dry nitrogen – when dry nitrogen is used for instrument air no additional protection is required.
- Cooling water – when cooling water is used for drain and vent lines, rather than a water/glycol mixture, heat trace or insulate the following items to prevent possible freezing in the lines that are remote to the compressor.

– Air cooler vent lines

Air cooler drain lines

– Water Manifold drain lines

Oil cooler drain lines

Heat tracing or insulating this line will allow for proper drainage of water from the system in the case of a shutdown.

- Cooling water – as above. If cooling water (rather than a water/glycol mix) is used and it is possible for the Centac compressor to shut down without draining, the following items may be insulated and/or heat traced to prevent possible freezing of the undrained water.

  Main casing (air coolers and condensate system)

  Oil cooler

  Cooling water manifold

Lubrication System

The lubrication system for the compressor is completely self-contained and mounted on the baseplate. This system is designed to provide clean oil to the compressor bearings and gears for operation. See the Process & Instrumentation Diagram for the oil flow schematic.

Oil is drawn from the oil reservoir located in the baseplate and passes through the oil pump. Two oil pumps: a prelube pump and a main oil pump are provided.

Prelube pump:

- Serves to prime the main oil pump, lubricate the compressor bearings and gears, and fill the oil lines before the compressor starts.
- Is driven by an electric motor or turbine.
- Starts when the control panel is energized and runs until the compressor is up to speed and the main oil pump increases oil pressure. It is not intended to function as an auxiliary oil pump to backup the main oil pump.
- Shuts down automatically by a pressure transmitter that stops the pump after the main oil pump is supplying the required system pressure. When the unit trips on the shutdown cycle, the prelube pump will start immediately and will continue to run until the panel is de-energized.
- Cools down the compressor. After the compressor shuts down, the prelube pump should be allowed to run 20 to 30 minutes to cool down the compressor bearings.
- A seal air pressure transmitter interlock prevents the prelube pump from operating if seal air pressure is not established.

Main oil pump:

- An oversized gerotor type pump driven by the main shaft.
- The discharge pressure is controlled by a relief valve downstream of the oil cooler and filter.
- In the event of a main driver or power failure, the main oil pump will continue to supply oil to the bearings and gears during coast down.

The oil pumps are equipped with an inlet strainer for protection against foreign particles. Check valves in the discharge line of the prelube pump and on the inlet of the main pump are provided to prevent reverse flow through the pumps.

The oil follows the following path:

1. Oil passes through the oil pump to the oil cooler, where the oil is cooled to between 105° and 115°F.
2. Oil from the cooler is mixed with hot oil in the thermostatic control valve.
3. Oil then flows to the oil filter. The oil filter supplied is a 10 micron treated paper element type filter.
4. Oil passes from the oil filter to the compressor bullgear and pinion bearings.
5. A portion of the oil is bypassed through a relief valve to the reservoir. This valve allows the input pressure to the compressor to be raised or lowered by adjusting the valve setting.
6. The remainder of the oil passes through the compressor and drains into the reservoir.

All the necessary instruments and safety devices are included in the oil system to protect the compressor. The compressor protection devices in the lubrication system include:

- A pressure-sensing device trips the unit to indicate low oil pressure.
- A temperature-sensing device that senses abnormal oil temperature is provided. This device is set to trip the unit and indicate abnormal temperature. The same device acts as an interlock to prevent the unit from being started if oil temperature is below the minimum.
- A wet element type lube oil reservoir heater is supplied for most units to insure adequate oil temperature for compressor start-up.
- The lube oil reservoir has provisions for a lube oil drain with plug. The customer may install a valve on the connection to facilitate changing lubricant.
- An oil temperature control device is supplied that automatically regulates proper oil temperature to the bearings by mixing hot and cold lubricant.

Some common optional equipment which may be furnished as part of the Centac compressor lubrication system include:

A dual element oil filter complete with built-in transfer valve.

- An additional oil cooler, in parallel, complete with transfer valve for single or simultaneous operation.

Refer to certified drawings for optional devices and proper settings.

The coupling **must be** lubricated **before** operation. Hand packing of grease in **each** half of the coupling is recommended.

Coat the hub and sleeve gear with grease. Slide the sleeve over the hub gear. Insert the gasket. Bolt the sleeves to coupling spacer and tighten uniformly. Remove two plug fittings in the coupling sleeve 180° apart. Rotate the coupling to place the bottom hole 45° off horizontal. Pump grease into the top hole until it appears at the bottom hole. Sufficient lubricant has now been added. Do not attempt to fill the coupling without venting the interior; an air lock can result in incomplete filling or in damage to the 'O' ring seal.

After lubrication excess grease must be removed to prevent hydraulic lock. After removal of excess grease, install and tighten the lube plugs to a torque value of 50 lb. ft. See Table 1.

NOTE

Spacer; limited end float; floating shaft couplings, and some other styles, require each end to be separately lubricated. Do not fill the interior of spacer coupling arrangements. Lubricant capacities for each size and coupling style are given. One-half this amount should be placed in each coupling half.

Gear Coupling Recommendations

Table 1

	* GREASE CAPACITY	TIGHTENING TORQUE - LB.-IN.	
SIZE	WEIGHT LB. – OZ.	SHROUDED BOLTS	EXPOSED BOLTS
H-2	0 - 5	23	50
H-2-1/2	0 - 8	55	100
H-3	0 - 15	55	100
H-3-1/2	1 - 7	110	175
H-4	2 - 0	110	175
H-4-1/2	3 - 3	110	175
H-5	5 - 0	195	165

* Lubricant capacities for each size and coupling style. This is the total lubricant required for both coupling halves

Cenlube GL Grease

Ingersoll-Rand provides synthetic grease for lubricated couplings. This grease is a non-hazardous anti-friction bearing and coupling grease designed for all speeds of machine between - 40°F and 500°F.

Recommended Lubricants - Gear Coupling

Lubricating greases should equal or exceed these specifications:

Grade:	NLGI #1
Base oil Viscosity Min.:	3000 SSU at 100°F 160 SSU at 210°F
Dropping Point, Min.:	190°F
Four Ball Wear, ASTM D-2266:	.500mm Maximum
Base oil content:	87% Minimum
K36 Factor, ASTM D-4425:	KSG: K36 = 8/24 = .33
Required:	Rust and Oxidation Inhibitors E. P. Additives

The most reliable test of a suitable lubricant is often the result of user experience and satisfaction. If a lubricant has been known to sludge, separate into heavy components or dry out consider the use of other lubricants meeting the minimum specifications.

Checking Vibration

On motor and turbine units, periodically monitor shaft vibration on both sides of the coupling with a vibration analyzer. In normal operation do not run the unit when vibration levels, as measured on the shaft, exceed two (2) mils on three thousand to thirty-six hundred (3000-3600) RPM drivers and two and one half (2-1/2) mils on fifteen to eighteen hundred (1500-1800) RPM drivers. If vibration is measured using a non-contacting probe, add one half (1/2) mil to the above levels. If vibration levels exceed the above values shut the unit down and determine the cause of vibration.

Main Driver Preparation (Refer to driver Instruction Manual)

The preparation of the **main driver** shall include but not be limited to:

1. Check the bolted joints for signs of looseness.
2. Make sure the bearings have been properly lubricated and the bearing reservoirs filled.
3. Rotate the shaft by hand to insure there is freedom of movement.
4. Check the control device connections to make sure they agree with the wiring diagrams.
5. After final alignment checks are made, dowel the driver feet to maintain the alignment.

Control System Adjustment

Centac compressor control systems may be ordered with a wide variety of monitoring, control, and protection features. Many options are available to meet specific needs of customer.

Pre-start adjustment may vary considerably depending on features ordered. Therefore, see the control panel instructions and electrical prints for necessary adjustments.

Current To Pressure (I/P) Transducer Adjustment

1. Turn off power to the panel and disconnect the current to pressure (I/P) transducer wires.
2. Connect to the I/P a DC power supply with a $4M_A$ to $20M_A$ output capability. Observe for correct polarity.

   Alternatively, the microcontroller may be used to supply the $4M_A$ and $20M_A$ signals to the I/P transducers. The microcontroller will send a $4M_A$ signal to the transducers when the control panel is energized. The microcontroller will send a $20M_A$ signal to the transducers after the start pushbutton is depressed and the start cycle times out. (Note: mode selector switch should be in the "modulate" position.)
3. Apply 80 PSIG instrument air to the I/P supply connections.
4. Apply a $4M_A$ signal to the transducers:
   a. Adjust zero screw on inlet valve I/P to obtain 3 PSIG output.
   b. Adjust zero screw on bypass valve I/P to obtain 3 PSIG output.
5. Apply a $20M_A$ signal to the transducers:
   a. Adjust the span screw on inlet valve I/P to obtain 15 PSIG output.
   b. Adjust the span screw on bypass valve I/P to obtain 15 PSIG output.
6. Repeat steps 4 and 5 until correct outputs are obtained at signal inputs of $4M_A$ and $20M_A$.

Before Starting the Compressor

Lube System Adjustment

Cleanliness of the lubricating system is of paramount importance to the Centac compressor. Although the system is flushed and fully tested at the factory, the following steps should be taken prior to initial startup.

Flushing

1. Remove the sump access cover. Thoroughly clean the sump of any shipping oil and dry with lint free rags. (This is not required for units with sealed covers.)
2. Fill with a quantity of recommended oil to cover the suction screens.
3. Disconnect the oil piping at the entrance to the gear casing and use flexible oil line to route the oil to the sump in the baseplate.
4. Circulate the oil for a minimum of one (1) hour using the prelube pump. Optimum flushing temperature is 100°F.
5. Tap any welded pipe with a plastic or lead hammer during oil circulation to dislodge any foreign material lodged at the welded joints.
6. Change position of transfer valve at fifteen (15) minute intervals on lube oil systems having dual oil filters and/or oil coolers.
7. Shut off the prelube pump.

WARNING

⚠ Hot oil can cause serious injury to personnel. Precaution must be taken to prevent contact with hot oil.

8. Drain oil filter and inspect the element(s). If foreign material is found in the filter housing or element, repeat step four (4). Repeat until filter housing and element are clean upon inspection.
9. Install clean filter element(s).
10. Reconnect lube piping to the gear casing.
11. Ensure Instrument Air is on and check pressure regulator for seal air to be sure it is set between 6 and 10 PSIG.
12. Restart prelube pump and circulate oil for one (1) hour.
13. Repeat steps 5 and 6. Proceed to step 11.
14. Fill sump to the proper level with recommended oil.
15. Replace sump access cover and secure.

Pressure Setting

The Centac compressor lube system is designed to operate between 20 and 30 PSIG. When setting the system oil pressure, attention must be given to both the prelube pump internal relief valve and the pressure sensing valve (PSV) mounted in the lube system piping.

To adjust the prelube pump internal relief valve or the system PSV:

1. Hold adjusting screw while turning the lock nut CCW to loosen.
2. Turn adjusting screw CW to increase pressure and CCW to decrease pressure.
3. After pressure adjustment, hold adjusting screw while turning the lock nut CW to tighten.

The following procedure should be followed to set lube system pressure:

1. Start the prelube pump with instrument air applied to the seals, and the reservoir filled to proper level with recommended oil.
2. Observe the oil pressure indicator on the CMC panel. If oil pressure exceeds 50 PSIG, shut off the prelube pump and turn the system PSV adjusting screw (CCW) to reduce pressure.
3. Adjust the prelube pump internal relief valve to obtain maximum oil pressure to the casing; but do not exceed 26 PSIG. It may be necessary to turn the system PSV adjustment screw CW to obtain maximum pressure from prelube pump.
4. Turn the system PSV adjusting screw (CCW) until a decrease in pressure is observed on the lube oil pressure indicator on CMC.
5. Turn the prelube pump internal relief valve adjusting screw (CCW) until system pressure drops to 20 PSIG to the casing. Lock down the adjusting screw. The lube system is now properly adjusted for starting the compressor.
6. Start the compressor.
7. Adjust system PSV to obtain 26 - 28 PSIG (nom) at 110°- 115°F.
8. Lock down adjusting screw.

As oil temperature increases, adjustments may be necessary to compensate for the change in oil viscosity.

WARNING

⚠ Operation of the unit without proper lubrication can result in overheating of the bearings, bearing failures, pump seizures and equipment failure exposing operating personnel to personal injury.

Date of Issue: 4 October, 1999

Impeller to diffuser clearance

Impeller to diffuser clearances are factory set, but the clearance should be checked prior to initial start-up (unless the unit has a wired cover) or any start-up after a rotor assembly or bearing has been removed from the unit. This procedure should be done under the supervision of an Ingersoll-Rand service supervisor.

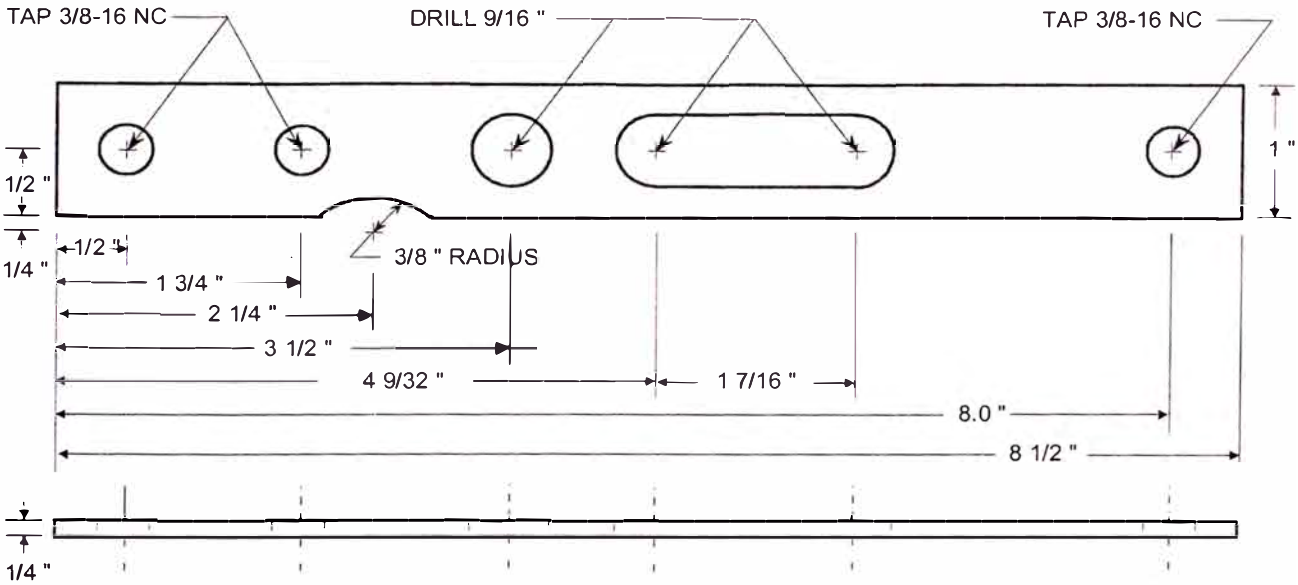
Procedure for **setting impeller clearance for units which require shims**.

1. Remove the bearing cover and bearing locking bolts.
2. Tighten the jacking screws until the bearing is free to move, then loosen the jacking screws.
3. Push the bearing in until it seats against the gear case.
4. Push the rotor assembly in by the thrust collar until resistance is felt.

Never attempt to set the clearances without an impeller clearance setting tool. See the Centac Clearance Setting Tool diagram on the previous page.

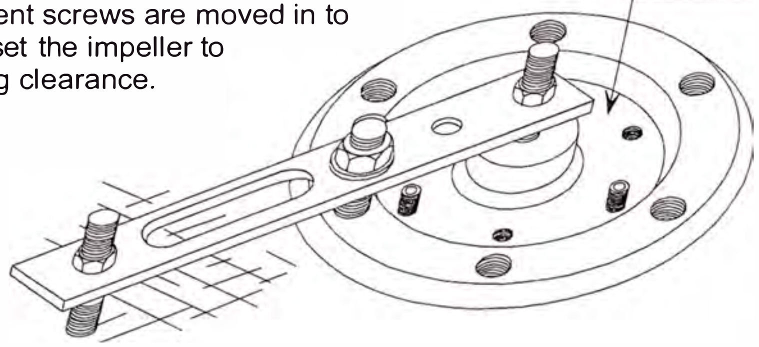
5. Install the clearance setting tool against the thrust bolt using one of the bearing cover bolt holes to support the other end.
6. Install (2) dial indicators on a post installed in one of the other thrust cover bolt holes.
7. Set (1) dial indicator to contact the top of the clearance-setting tool above the thrust bolt. The purpose of this is to show the movement of the rotor.
8. Set (1) dial indicator to contact the thrust bearing flange. The purpose of this indicator is to indicate the movement of the bearing.
9. Zero both indicators.
10. Begin tightening the jacking bolts in sequence. Each turn of the jacking bolt should cause no more than .001 inch (0.03mm) of bearing movement. Gently tap bearing flange near jacking bolt using soft hammer.
11. Note that the bearing moves before the rotor assembly begins to move.
12. Continue to tighten the jacking bolts until the specified "Y" clearance is indicated on the rotor assembly dial indicator.
13. The reading on the bearing flange dial indicator is the thickness required for the thrust bearing shims.
14. Use specified shims and grind to the correct size -- should be less than .100 inch (.393mm).
15. Install the shims under the 3 locking bolts, back off the jacking bolt (1) full turn and tighten locking bolts.
16. Install the bearing cover.

CENTAC UNIVERSAL CLEARANCE SETTING TOOL



Material: Common 1/4" bar stock

Use any combination of threaded and unthreaded holes in the clearance setting bracket to apply bracket spring pressure on the thrust collar. This action keeps the thrust collar in positive contact with the thrust bearing as the thrust adjustment screws are moved in to establish and set the impeller to diffuser running clearance.



UNIVERSAL CLEARANCE SETTING TOOL METHOD OF USE

Pre-Start Checklist

CAUTION

⚠ The importance of starting and operating the compressor with clean inlet piping cannot be over-emphasized. Loss of performance or physical damage could result from the ingestion of foreign material.

1. Check anchor bolts and grouting.
2. Check levelness of unit.
3. On units that do not have sealed covers, inspect the following for corrosion and cleanliness just prior to start-up:
   a. Oil Reservoir
   b. Inlet Air Filter
   c. Inlet Air Piping
   d. Discharge Piping
   e. Bypass Piping
   f. Water Piping
4. Check inlet air filter location and installation.
5. Check the following on the inlet air piping:
   a. Material (stainless steel of non-ferrous)
   b. Minimum size
   c. Distance to first elbow (minimum of 4 pipe diameters)
   d. Facilities for moisture removal on any horizontal run of pipe
   e. Piping supports/strain
   f. Manometer or differential pressure gages on inlet air filter
6. Check the following on the discharge piping:
   a. Minimum size
   b. Distance to first elbow (minimum of 3 pipe diameters)
   c. Piping supports
   d. Facilities for moisture removal on any horizontal run of pipe
   e. Safety valve (located between block valve and compressor)
   f. Block valve
7. Check the following on the bypass piping:
   a. Minimum size
   b. Distance to first elbow (minimum of 8 pipe diameters from bypass valve)
   c. Piping supports
   d. Location of silencer
   e. Facilities for moisture removal on any horizontal run of pipe.

8. Check the following on the controlled air piping:
    a. Material
    b. Minimum size
    c. Water and dirt line filter (5 micron)
    d. Attached to control panel at bulkhead fitting "CA"
    e. Attached to discharge air piping a minimum of 10 pipe diameters from check valve
9. Check the following on the instrument air piping:
    a. Material
    b. Minimum size
    c. Attached to control panel at bulkhead fitting "IA"
    d. Attached to dry, clean air source, 60-120 PSIG 10 SCFM per stage minimum
    e. Absolute air filter 0.01 micron
    f. Shutoff valve
10. Check the following on the water piping:
    a. Minimum size
    b. Attachment to compressor
    c. Attachment to oil cooler
    d. Water pressure minimum 35 PSIG and maximum 75 PSIG
    e. Differential pressure between inlet and outlet flanges on air coolers is normally 12 PSIG (15 PSIG maximum)
    f. Check for water leaks (leave condensate trap bypass valves open)
    g. Hand or thermostatic control valves in discharge piping
    h. Casing vents open
11. Check piping on condensate traps (piped to open drain).
12. Check compressor lubricant for conformance to specifications.
13. Drain and clean oil sump if the unit has a sealed cover.
14. Change oil filter elements after flushing (See page 9).
15. Fill oil reservoir.
16. Check anchor bolts and grouting.
17. Check levelness of unit.
18. Check electrical power supply to unit.
19. Check all control panel connections per applicable schematics.
20. Check rotation of prelube pump (three phase only).
21. Manually rotate compressor and driver shafts, checking for free, uncoupled rotation with prelube pump running (ensure seal air is on the compressor).
29. Check lubrication system for oil leaks.
30. Set impeller clearances on all stages.
22. Check driver per manufacturer's instructions found in the driver instructions.
23. Check driver electrical connections.
24. Check to see that driver bearings are properly lubricated.

25. Check direction of rotation and magnetic center of main drive on motor driven units prior to coupling to compressor.
26. Align driver to compressor.
27. Install coupling spacer and lubricate.
28. Check vibration monitor per control section.
31. Check operation and calibration of the inlet and bypass valves.
32. Dowel driver in place.
33. Calibrate all temperature and pressure switches.
34. Functionally test control system.
35. Check operation of main driver trip device.
36. Start and run compressor.
37. Correct any oil, water or air leaks.

Routine Start/Stop

WARNING

⚠ The unit must not be operated unless coupling guard is in place. Failure to observe this warning could result in personal injury to operating personnel.

CAUTION

⚠ Never attempt a restart until the compressor has completely come to rest.

Prior to starting, the operator should become familiar with the operation of the main driver. Refer to the driver manufacturer's instructions. The operator should also be familiar with all the accessory equipment and optional equipment contained on the unit.

Personnel unfamiliar with the compressor package should not start, operate or tamper with the equipment. Only fully trained personnel should be allowed to start and operate this compressor. The following procedure is a guideline for the fully trained operator.

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Starting

1. Turn on the cooling fluid to the oil cooler(s), air cooler(s), and any other optional heat exchanger. Ensure that the air coolers are continuously vented.
2. Open the valve in the instrument air line to the control panel.
3. Check the seal air pressure gauge. The seal air pressure must be between 7-8 PSIG. Adjust the seal air regulator if necessary.
4. Check the main driver and compressor oil level.
5. Turn on the electrical power to the control panel. The prelube pump should start.
6. Check the oil pressure to the compressor casing. This should be 20 PSIG (nominal).
7. Check the oil temperature. This should be 95°F (nominal).
8. Check to see that the inlet valve is closed and the bypass valve is open.
9. Open the isolation block valve in the discharge air line.
10. Drain residual condensate from the compressor casing by opening each condensate trap bypass valve.
11. Drain any condensate from the air inlet piping drip leg.
12. Check the discharge pressure set point. Adjust if necessary.
13. Press the start button on the control panel.
    a. Oil pressure should increase to 26 - 30 PSIG at 110 - 115°F.
    b. The prelube pump should automatically shut off.
    c. If the compressor was started in "unload" mode, it will continue to operate in this mode until another control mode is selected.
    d. If the compressor was started in an operating mode other than "unload", the discharge pressure will increase to the discharge pressure setpoint after the starting time has expired.
14. Observe the oil pressure to the unit. If pressure is not within the recommended operating range, adjust the oil pressure-sensing valve at the sump return.
15. Observe vibration levels. If excessive vibration levels exist, the unit will automatically shut down.
16. Observe the supply oil temperature to the compressor casing. The oil temperature should be between 105 - 115°F with a water supply temperature of 95°F and less.
17. Observe the air cooler water flow rates. Generally water flow should maintain a 25°F water temperature rise across the cooler. At this setting, the air temperature leaving the cooler, with a full load, should be no more than 20°F of the inlet water temperature.

The Centac compressor is automatic in operation and contains the following minimum protective devices:

- Low oil pressure shutdown.
- Oil temperature (high and low) shutdown.
- High air temperature shutdown.
- High pinion shaft vibration shutdown.
- Surge alarm.

Refer to the electrical and pneumatic schematics, and Control section of Operation Manual for any additional protective devices.

Stopping

Refer to the main driver manufacturer's instruction for any special instructions for stopping the main driver.

Simply pushing the “Compressor Stop” pushbutton will stop any Centac compressor. Refer to the electrical schematic and the Control section for stopping units with special options.

When possible, unload the compressor before stopping. This is the recommended method to allow the operating temperature to stabilize.

The prelube oil pump will start immediately when the compressor shuts down. The prelube pump should be permitted to operate 20 to 30 minutes after the compressor has stopped. Then the power to the control panel may be turned off, stopping the prelube pump. Some units may have optional equipment that automatically stops the prelube pump. Refer to the electrical schematic and the Control section for details on the operation of the optional equipment.

Post shut down lubrication is required to allow internal heat to be carried away by the circulating oil.

Cooling fluid should also be permitted to flow about 20 to 30 minutes after the compressor has stopped. Some units may have optional equipment, which automatically stops the flow. This procedure is recommended to allow for controlled cool down of the compressor.

Turbine Units – use precaution against overspeed. A sudden reduction in load on a turbine could, under certain conditions, cause a quick increase in speed to which the governor may not respond promptly. Governor "hang-up" can be caused by long periods of running at a fixed speed, which may allow contaminants in the steam to form deposits and buildup around normally movable parts, causing them to stick or bind.

To insure that the governor is fully operative, prior to unloading the Centac compressor, it is advisable to vary the pressure controller setting while observing the motion of the governor linkage and steam valve stem. Free movement of these items is an indication of normal governor performance.

Section 4 – Maintenance

The Centac compressor does not require constant attendance. However, a few items should be checked periodically.

Scheduled preventive maintenance and inspection is essential for continued optimum performance and long service life of the compressor. The following are general requirements and schedules for inspection and preventive maintenance. Since unusual service conditions and environment affect equipment reliability, these items and schedules should be adjusted in time and content as necessary to suit your specific requirements.

Maintenance Schedule Daily and Each Start-Up

1. Check and record instrument air pressure.
2. Check the compressor reservoir oil level.
3. Check and record the oil temperature to the compressor.
4. Check and record the compressor oil supply pressure.
5. Check the main driver oil level. (Does not apply to a driver with anti-friction bearings.) Refer to driver manufacturer's instructions contained in the Operation Manual.
6. Check the vibration level on each stage of the compressor
7. Check and record all interstage pressures (if available).
8. Check and record all interstage temperatures.
9. Check and record the inlet air temperature.
10. Inspect for tubing/fitting leakage.
11. Check and record the air cooler water temperature, both to and from the coolers.
12. Check and blow down the condensate traps.
13. Check and record the inlet air filter differential pressure.
14. Check to make sure the air coolers are continuously venting. Vent valves are located on top of the casing.
15. Drain the condensate from the inlet air line drip leg. Do not open the valve with the compressor operating.
16. Drain the condensate from the discharge header drip leg.
17. Drain the condensate from the bypass air line drip leg.
18. Drain the drip legs on any other horizontal run of air piping.
19. Check for oil leaks. Correct as necessary.
20. Inspect for gasket/O-ring leakage.
21. Check for water leaks. Correct as necessary.
22. Open the control air line drip leg valve to remove any moisture that may have collected.
23. Check the instrument air line filter. Drain any moisture, which may have collected.
24. Check and record the oil filter differential pressure. Replace the filter element as necessary.

Quarterly Maintenance

1. Inspect instrument air filter.
   - Drain and clean the filter.
   - Replace the element.
2. Drain control air drip leg.
3. Inspect condensate traps.
   - Remove and clean. Replace parts as necessary.
   - Replace trap if necessary.
4. Grease motor bearings.
   - Use correct type and amount of grease.
   - Use hand-pump grease gun only.
   - Bearings should be greased with the motor stopped.
5. Visually inspect the inlet air filter.
   - Clean element.
   - Replace element as necessary.
   - Inspect seams of the filter for cracks for potential bypassing. Seal seams as needed.
6. Change oil mist arrestor element.
   - Add oil to U-tube.
   - Clean element housing.
   - Inspect old element for over-crushing. Add restricting nuts to prevent over-crushing.
   - Eliminate lock washer under wing nut, if installed.
   - Replace seal washer under wing nut.
   - Check to insure the element cover is making good contact with the element. The cover should fit squarely on the housing.
7. Inspect the Mist Eliminator element and replace as needed. Mist Eliminator elements are a long life item and should not require routine replacement.
8. Inspect control panel.

- Watch for: loose wiring, wrong line filter, damaged line filter, and adequate arc suppressors.
- Clean panel fan filters and panel.
- Disconnect and tie back all unused wires from terminal strips.
- Check the vibration transmitter wires to make sure they run directly to the microcontroller terminal strips.

Semiannual Maintenance

1. Lubricate the main driver coupling. Dry-type coupling components must be inspected.
2. Change oil filter.
3. Hydrotest the air coolers.
4. Follow the quarterly schedule.
5. Change the driver bearing lubrication on sleeve bearing units without force feed.
6. Obtain an oil sample and have it analyzed.
7. Check the control system per the procedure found in the Control section of the Operation Manual.
8. Check the inlet and bypass valve calibration.

Annual Maintenance

1. Inspect the main driver per the manufacturer's instructions found in the Operation Manual.
2. Visually inspect the coupling. Align and lubricate as required. Replace any components that have excessive wear.
3. Manually rotate bullgear to feel for roughness on models with bullgear anti-friction bearings.
4. Inspect and clean the oil reservoir suction screens.
5. Visually inspect the oil cooler tubes. Clean the water side of the oil cooler if necessary.
6. Visually inspect the zinc anodes (pencils) in the oil cooler. Replace if necessary.
7. Visually inspect the inlet throttle valve.
8. Visually inspect the bypass valve.
9. Visually inspect the discharge check valve.
10. Change the oil once a year or after 8,000 hours of use, unless Techtrol Gold is used. When using Techtrol Gold, the lubricant must be changed every three years of after every 24,000 hours of use.

CAUTION

⚠ Servicing of the internal parts is not recommended without the presence of an Ingersoll-Rand service supervisor. For technical assistance, please call your local Ingersoll-Rand representative.

WARNING

⚠ Develop and use a "Red Tag" procedure or similar system whereby maintenance personnel can lock off the power switch during maintenance.

Replacement coolers, rotor assemblies, bearings, and seals are available in a variety of options:

- Exchange for factory trade-ins.
- Return the part for refurbishing.
- Return damaged parts for scrap and obtain credit toward new parts.
- Factory warranty program on all exchange parts.
- Rapid cooler cleaning and hydrotesting.

Maintenance Procedures

The following procedures are added to supplement the information presented earlier in this manual in Section 5, Operation, under the heading Initial Start Preparation.

Main Driver

Depending upon the customer's requirements, different drivers are used with the Centac compressor. Consult the driver manufacturer's literature provided in this manual to insure proper lubrication and maintenance procedures.

Control Panel

The control panel checkout procedure is designed to verify that a control panel is functioning properly. The checkout can be used for initial testing or in conjunction with routine maintenance schedules.

Refer to the control drawings and checkout procedure included with the Control Panel Instructions in this manual to insure proper adjustments and calibrations.

Intake Filter

All filtration systems have a maximum recommended pressure drop at which the filter element should be cleaned or replaced. Because of the many types of atmospheric conditions that exist it is difficult to accurately determine the life of a given filter element. It is therefore advisable and highly recommended that a weekly pressure drop measurement be recorded for both the primary and final stage filter elements to determine the useful element life.

Filter maintenance is a necessary and important part of the entire air system. A properly maintained inlet air filter will result in optimum air compressor operation. An increase in filter differential pressure is an indication that the inlet air filter is performing as intended.

The following maximum pressure differential levels should be followed:

- Primary Stage Element(s). Clean or replace at 4" W.C. differential pressure.
- Final Stage Element(s). Replace at 4" W.C. differential pressure.
- Total differential pressure across filter of 8" W.C.: Clean or replace primary stage element(s) and replace final stage element(s).

When indicated by the above differential pressure data, the filter elements should be removed for either cleaning or replacement. It is recommended that the filter be serviced when the compressor is **not** in operation.

"Panel" Type Element And Cleaning Guidelines

Primary Stage Panel:

1. Unlatch the weatherhood and swing it up.
2. Grasp the removal strap located on the face of the panel filter and pull straight forward.
3. Install cleaned or new prefilter, making sure the removal strap is facing you and is in a horizontal position.
4. Swing the weatherhood down and secure the latches into the slots on the side of the filter housing.
5. Clean first by using compressed air. Blow off dust by directing the compressed air from back to front. Next, water wash by agitating the panel filter in hot water (approx. 150°F) and mild cleaning agent solution.
6. Rinse with clean water and air dry for at least 12 hours. The panel filter should be completely dry before reinstallation to prevent premature dirt loading.

NOTE

Inspect both front and rear gaskets, making sure they are not damaged. Do not touch the panel filter media portion of the panel element. Handle only by grasping the metal frame.

The panel filter corner angles indicate the bottom, and pull rings indicate the front.

7. Slide the panel filter into housing and latch all latches to the panel filter sides. All latches must be fastened to properly seal the final stage panel filter to the housing.

Final Stage Panel:

1. Remove the primary panel filter as noted above.
2. Unlatch the latches on the side of the filter housing.
3. Grasp the pull devices located on the front sides of the panel filter and pull straight forward.
4. Install a new final stage panel filter.

Final stage panels are **not** cleanable and must be replaced when dirty. Replace at a 4" W.C. differential pressure.

"Cartridge" Type Element Removal And Cleaning Guidelines

Primary and Secondary Stage Cartridge:

1. Remove filter housing cover.
2. Remove top seal plate. Primary stage cartridge(s) can be removed for cleaning or replacement. Handles are provided on the inside of the cartridge for removal.
3. Remove internal seal plate. Final stage cartridge(s) can be removed for replacement. Handles are provided on the inside of the cartridge for removal.
4. Clean first by using compressed air. Blow off dust by directing the compressed air from inside to outside. Next, water wash by agitating the cartridge in hot water (approx. 150°F) and mild cleaning agent solution.
5. Rinse with clean water and air dry for at least 12 hours. The cartridge should be completely dry before reinstallation to prevent premature dirt loading.

Final stage cartridges are **not** cleanable and must be replaced when dirty. Replace at a 4" W.C. differential pressure.

"Inertial Spin" Type Element Removal And Cleaning Guidelines

WARNING

⚠ Before servicing this type filter, open the disconnect to the blower motor.

Primary Stage Element:

The primary stage is the inertial spin filter and is designed to be self cleaning while operating at a constant pressure drop. Periodically the upstream surface of the inertial spin filter should be inspected for the accumulation of any debris such as leaves, trash, etc. Foreign debris should be removed as necessary. Should filter replacement become necessary the bleed duct and holddown device may be removed to give access to the element. The inertial spin filters are sealed with a silicone caulking adhesive compound. When installing a new inertial spin filter, observe upstream/downstream orientation. Re-caulk with RTV silicon Adhesive Sealant.

Secondary Stage Element:

The second stage is a radial-finned element. The element is non-washable, however, dirty side may be cleaned using a vacuum of approximately 40" W.C.

The recommended pressure drop for cleaning or replacing of the second stage elements is 4" W.C.

Inlet Valve

Periodically stroke the inlet valve to aid in optimum performance of the compressor. See the Manufacturer's Installation Bulletin located in the Vendor Literature Section of this manual for guidelines on stroking the inlet valve.

CAUTION

⚠ Observe for freedom of movement of the inlet valve during the stroking procedure.

Bypass Valve

Periodically stroke the bypass valve to aid in optimum performance of the compressor. See the Manufacturer's Installation Bulletin located in the Vendor Literature Section of this manual for guidelines on stroking the bypass valve. In addition to stroking, the bypass valve should be removed from the air piping system annually to inspect the seals for damage. Replace damaged seals as required and reinstall valve.

Discharge Check Valve

The discharge check valve must be removed from the piping system for inspection. When inspecting the check valve, look for:

1. Rust
2. Broken Springs
3. Damaged Seals
4. Freedom of Movement

Repair or replace as necessary and reinstall discharge check valve.

When check valve is mounted in a horizontal run of pipe, the valve should be oriented so that the stem is vertical.

Oil Suction Screens

Each time oil reservoir is drained, the suction screens should be removed and cleaned. The screens will be either an open type and located within the reservoir or an Y-type located in the suction piping upstream of the pumps. Individual suction screens are provided for the prelube pump and the main oil pump. Rinse screen in solvent to clean.

Oil Filter

A single line type oil filter is furnished as standard equipment on the Centac compressor. Some Centac compressors are furnished, as optional equipment, with a dual line type filter with a transfer valve. Both single and dual filters have throwaway replaceable cartridge elements. The following will serve as guidelines when changing filter elements.

Filter elements should be replaced when the pressure drop exceeds 8 PSIG from when the filter was new.

WARNING

⚠ Lube system pressure may reach 50 PSIG and temperatures of 160°F or more. Do not penetrate lube system while machinery is operating.

Single Filter (Single Or Dual Element)

1. Provide suitable means of collecting and disposing of used oil
2. Loosen center post to disassemble the filter.
3. Discard the element. Clean remaining parts.
4. Reassemble the housing center post, conical spring and one metal backup washer.

NOTE

Conical spring is to be installed with large end against the housing.

5. Lubricate the two rubber seals received with new element.
6. Install one seal over the center post and against the backup washer.
7. Place new element over the center post and engage the rubber seal into the recess in the element end cap.
8. Install second seal into the recess at the top end of the element.
9. Lubricate seal located on filter head.
10. Position housing assembly into place on filter head and tighten center post.

CAUTION

⚠ Keep housing from rotating while tightening center post to 20 ft. Lbs. Torque.

Dual Filter (With Transfer Valve)

1. Provide suitable means of collecting and disposing of used oil.
2. Remove pipe plug in bottom of filter element bowl to drain oil.
3. Remove four capscrews to disassemble bowl from manifold.
4. Discard old element but retain the two small and one large O'rings for re-use. Clean remaining parts.
5. Place one small o-ring in groove provided in bottom of the bowl.
6. Place one small o-ring in groove provided in hub of manifold.
7. Place large o'ring in groove located in the flange of the bowl.
8. Reassemble bowl to manifold with the four capscrews.
9. Reassemble pipe plug in bottom of filter element bowl.

Oil Cooler

Inspection:

1. Remove bonnets from oil cooler and inspect zinc anode for erosion or oxide deposits. Scrape to brighten surface and replace if more than half is corroded away.
2. Carefully examine tubes for scale and clean if necessary. After cleaning, examine for erosion or corrosion.
3. After maintenance inspection or cleaning, both shell and tube side should be carefully vented and full of liquid.

Cleaning:

The shell side of the oil cooler generally will not need to be cleaned. Flushing a high velocity stream of water through them may clean the tube side of the cooler. For more stubborn deposits, wire brushes or rods can be used.

Mist Arrestor

A reservoir mist arrestor is furnished as standard equipment on the Centac compressor. Some Centac compressors are furnished with a motor powered mist arrestor as optional equipment. Both units have replaceable elements and require periodic maintenance.

Standard Mist Arrestor

The element on this unit must be replaced, it is non-able to be cleaned. To replace element:

1. Remove wing nut on top of breather.
2. Lift off top, exposing element.
3. Remove element. Dispose of properly.
4. Replace with new element.
5. Replace top of breather and wing nut.

Condensate Trap

The condensate trap is a float type liquid drainer and requires periodic inspection and cleaning.

WARNING

⚠ Shut off compressor before performing any maintenance on the condensate system.

During normal operation the trap should have an intermittent discharge, a dribble or semi-continuous discharge, or a constant discharge flow of liquid. Any of these conditions are indications of proper trap operation.

No discharge indicates possible trouble. Open condensate bypass valve. A small amount of condensate discharged indicates a light condensate load to the trap. A large amount of condensate discharge indicates trap has failed and should be repaired.

WARNING

⚠ Condensate bypass valves should be opened slowly as condensate may be discharged at pressures exceeding 125 PSIG. Hearing protection must be worn when bypass valves are open.

Continuous air discharge from the trap indicates it has failed and should be repaired.

To clean the trap:

1. Remove the bolts holding the body together.
2. Carefully remove and clean the internal parts.
3. Inspect orifice seats for any corrosion or undesirable condition.
4. Inspect the leverage system for freedom of movement.

Similar maintenance care should be given to other optional styles of condensate removal systems.

Date of Issue: 4 October, 1999

Section 5 Troubleshooting

Symptom	Possible Cause	Corrective Action
Fail to start	Failure to clear shutdown or interlock devices.	Correct shutdown or interlock condition that is indicated by panel light.
	No primary power to starter.	Check voltage to starter. Check fuses.
	No control panel power to compressor control panel or starter.	Check voltage to panel/starter. Check control transformer.
	Loose or corroded connection or defective power cables.	Check connections. Clean, tighten and replace as necessary.
	Defective motor starter or starting circuit.	Troubleshoot starter per manufacturer's recommendation.
Ineffective Prelube Pump	Improper adjustment of prelube pump relief valve.	Adjust relief valve for correct pressure.
	Pump not running.	Troubleshoot pump starter. Check for proper voltage.
	Defective motor.	Repair or replace motor.
	Defective pump.	Repair or replace pump.
	No seal air. (Seal air interlock is optional feature.)	Establish seal air.
High Oil Temperature	Low or no water flow to oil cooler.	Establish correct water flow.
	Higher water temperature than realized.	Take necessary steps to lower the water supply temperature.
	Improper temperature device setting.	Calibrate instrument.
	Dirty or plugged oil cooler on water side.	Clean cooler tubes. Provide water strainers as necessary.
Low Oil Pressure	Improper adjustment of system pressure relief valve.	Adjust system pressure relief valve for correct oil pressure.
	Leaking or pinched oil line.	Repair or replace oil line.
	Dirty oil filter.	Replace with clean filter.
	Defective main oil pump.	Repair or replace main oil pump.

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Symptom	Possible Cause	Corrective Action
High Air Temperature	Low or no water flow to air cooler.	Establish correct water flow.
	Higher water temperature than realized.	Take necessary steps to lower the water supply temperature.
	Improper temperature device setting.	Calibrate device.
	Dirty or plugged air cooler on water side.	Clean water passages in cooler. Provide water strainers as necessary. Contact Ingersoll-Rand service representative.
Low Seal Air Pressure	Low instrument air pressure.	See "Low Instrument Air Pressure" below.
	Improper adjustment of seal air pressure regulator.	Adjust regulator to obtain correct seal air pressure.
	Excessive bleed off valve adjustment. (If supplied).	Reduce seal air bleed off.
	Worn seals.	Replace seals. Consult Ingersoll-Rand service representative.
Low Instrument or Valve Operating Air Pressure	No supply pressure, pinched or leaking air lines.	Establish instrument air supply pressure. Repair or replace air lines.
	Improper adjustment of air regulator.	Adjust regulator to obtain correct instrument air pressure.
High Vibration	Low oil temperature.	Allow warm-up period for oil.
	Driver to compressor misalignment.	Check and correct alignment (dowel motor feet after alignment).
	Worn coupling or spacer.	Lubricate. Replace coupling and/or spacer.
	Rotor assembly unbalance due to foreign matter build up.	Contact Ingersoll-Rand service representative. Cleaning and balance check required.
	Rotor assembly unbalance due to damaged aero parts.	Contact Ingersoll-Rand service representative. Repair or replacement and balance check required.
	Induced vibration from driver.	Balance motor rotor.
Fail to Load	Mode selector switch in UNLOAD position.	Turn selector switch to Modulate or Auto-Dual operating mode.
	Low set point on pressure controller.	Adjust controller to desired operating pressure.
	Bypass valve not closed or inlet valve not open.	Correct improper operation of the inlet or bypass valve.

Symptom	Possible Cause	Corrective Action
Low System Air	Compressor not loaded.	See "Fail to Load" above.
	Dirty inlet filter.	Change filter elements.
	Low surge.	See "Continual Surging" below.
	Greater demand than realized.	Repair ALL air leaks. Turn off unnecessary demands.
Continual Surge (Pumping)	Discharge block valve closed.	Open block valve.
	Improper calibration of surge sensor.	Calibrate instrument. Insure surge sensor switch is not stuck.
	Dirty inlet filter.	Change filter elements.
	Improper adjustment of throttle limit (LLR, CLL, TL).	Adjust throttle limit.
	High inter stage air temperature.	Establish correct water flow to air coolers.
	Higher water temperature than realized.	Reduce the cooling water temperature.
	Worn or fouled aerodynamics parts.	Contact Ingersoll-Rand service representative.
Excessive Power Consumption	Lower ambient temperature than realized.	Reduce compressor load. Consult Ingersoll-Rand service representative.
	Low primary voltage.	Consult power company. Check power source.
	Reduction in motor efficiency.	Consult motor manufacturer.
	Excessive load.	Reduce load.
High Drive Motor Amperage	Low primary voltage.	Restore voltage to specification.
	High load.	Reduce load.

Section 6 – Parts and Service

CAUTION

The Centac compressor is a high technology product. Service or inspections beyond the procedures given in this manual should not be attempted by operating personnel. Ingersoll-Rand service offices are listed below.

Our commitment to you is unparalleled. Twenty-four hours a day, seven days a week,

Ingersoll-Rand is ready. When you need results, Ingersoll-Rand produces.

Ingersoll-Rand is committed to serving you. If you require information, service or parts, we are strategically located to serve your needs. When you need support for you Centac compressor, contact your local Ingersoll-Rand representative or call the factory direct.

INGERSOLL-RAND

Centac Aftermarket Services:

Lubricants

Performance Enhancements

Control System Upgrades

CMC® Microprocessor Controls

CEM® Centac Energy Master

Pure Air Chemical Filters

Cooler Cleaning Inspection/Repair

Rotor Cleaning Balancing/Repair

Remanufactured Centac Compressors

Centrifugal Diagnostic Services CDS

Centac Customer Training Schools

Return Goods

No material may be returned to the Mayfield Plant without authorization from either the Aftermarket Department or Reliability Engineering. The authorization medium is a Return Material Authorization form prepared by the Aftermarket Department. An RMA number will be issued to control the returned material. This number will preclude material loss or processing delay at the factory.

After Hours Emergency Parts

INGERSOLL-RAND CENTAC DIVISION supports a 24-hour emergency parts program. For emergency parts service call the factory direct at (800) 247-8640.

6.1 PARTS IDENTIFICATION

When ordering renewal parts, the information listed below should be given.

- Type and Machine Serial Number from the compressor nameplate.
- The Quantity Required and Part Description.
- The sequence number (and/or part number) as listed on the compressor assembly drawing, process and instrumentation drawing and bill of material which is included in this section.

CENTAC®

Inlet and Bypass Valve Assembly

~~INGERSOLL RAND~~
AIR COMPRESSORS

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Introduction

The Ingersoll-Rand single acting diaphragm operated inlet and bypass control valve assembly was introduced in 1991 as the standard configuration for all Centac products. The assembly provides superior quality with enhanced reliability and performance over previously used inlet and bypass valve operating devices.

The control valve assembly consists of three separate major components. These are the **Positioner**, the **Actuator**, and the **Valve**. Each valve assembly is also fitted with an instrument air regulator and an air filter. The standard assembly is provided in different sizes for the various valve sizes. Figure 1 shows a typical arrangement with a butterfly valve attached to the actuator.

This manual will describe each of the components separately and when combined in their application in the MP3 electronic control systems.

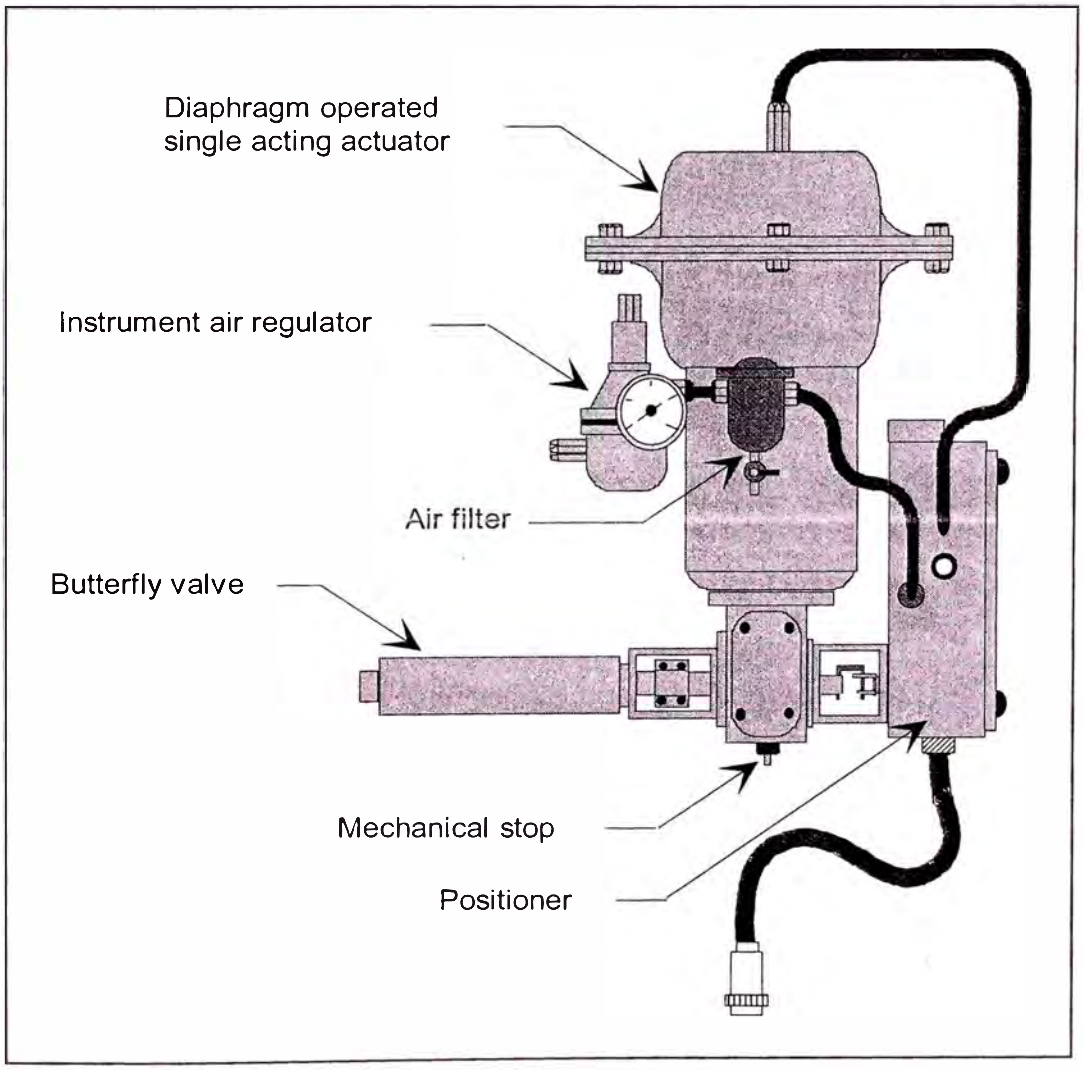

Figure 1. Standard valve assembly

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Part I: The Positioner

Valve Positioner Operating Principle

The Ingersoll-Rand valve positioner consists of a common housing that contains a 4 – 20 mA current to pressure (I/P) transducer that controls the attached pilot valve operated air to actuator assembly. Valve motion feed back-linkages that are necessary to provide the correct air pressure signal to the actuator are an integral part of the positioner. The positioner will output 0 to 65 psi (448 kPa) to the actuator as set by span and zero controls.

The actuator is supplied an air signal from the positioner. The air signal provided by the positioner is proportional to the microcontroller 4 – 20 mA output . The actuator provides the power to drive the valve open or closed in proportion to the microprocessor output control signal.

Refer to Figure 2 in following the description of the principle of operation. Operation of the positioner is based on the balanced torque principle.

Force coil (1) which is powered by the microcontroller 4 – 20 mA output signal is located in the field of the permanent magnet (2). The signal provided to the force coil creates a torque through magnetic repulsion.

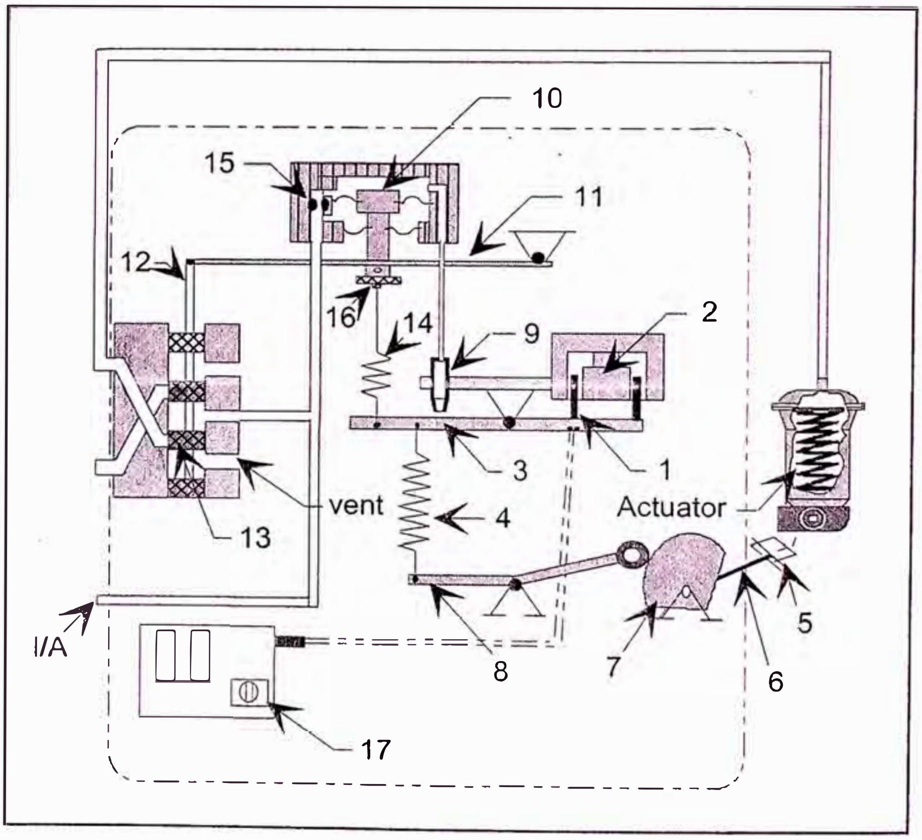

Figure 2. Positioner schematic

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A torque that is proportional to the mA signal is applied to the balance beam (3) and the balance beam moves.

The feedback spring (4) causes a counter-torque on the balance beam (3). This counter torque is proportional to the actuator, and valve position; this position is transmitted to the balance beam (3) via the actuator shaft, the coupling (5), the feed-back shaft (6), the cam (7) and the lever (8) as a relative displacement to the lower end of the feed-back spring (4).

The nozzle (9) senses the torque balance on the beam (3). When the input signal increases, the balance beam (3) approaches the nozzle (9) and the nozzle pressure increases. This causes the diaphragm piston (10), the beam (11), and the spool (12) to move downward.

The pilot valve (13) moves to channel the 65 PSIG (448 kPa) supply air to the upper side of the actuator diaphragm. The actuator piston moves until the balance beam (11) is in equilibrium. At this point, the actuator is in the exact position required by the input signal.

The spring (14) causes a negative feed-back between the first amplification stage nozzle (9) and restriction (15) and the second stage pilot valve assembly (13). The differential diaphragms effectively offset the effect of any fluctuations in the instrument air supply pressure.

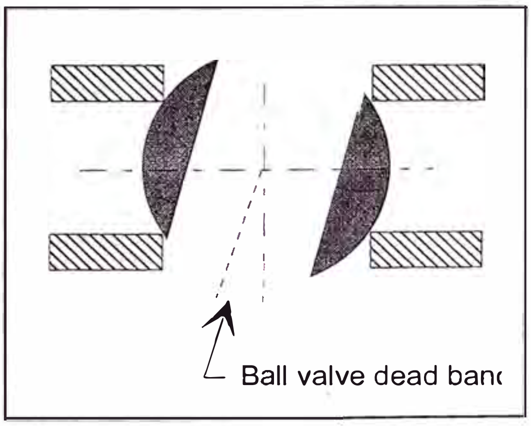

Figure 3B Dead band

By changing the lower fastening point for the spring (14) on the balance beam (3) the dynamics of the positioner can be adapted to suit the actuator size. Larger actuators are required on the larger valves.

The **zero adjustment** (16) is mechanical and the **span (range) adjustment** (17) is electrical.

Feed-back Cam

The numbers stamped on the cam are input signal ranges expressed in percentage. For example the 0 to 100 corresponds to a 4 to 20 mA range. The other ranges are not used, for your information the 0 to 50 range refers to an input signal of 4 to 12 mA, and 50 to 100% refers to 12 to 20 mA. The 0 to 100 range is used on all standard Centac Microprocessor applications. The arrow stamping refers to the direction of turn of the valve shaft. For Centac application, the **A side is for the bypass** and the **B side is for the inlet valve**.

Figures 3 and 3A show details of the A and B sides of the cam.

Figures 4 and 4A show position of the lever arm roller for correct cam positioning. No dead band is required.

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The areas on the cam between the dots are non-rising with respect to the lever arm wheel. The purpose of this area is to provide a feed-back "dead band" for the first few degrees of motion of a ball valve (see Figure 3B above). The dead band is not used on standard Centac compressors.

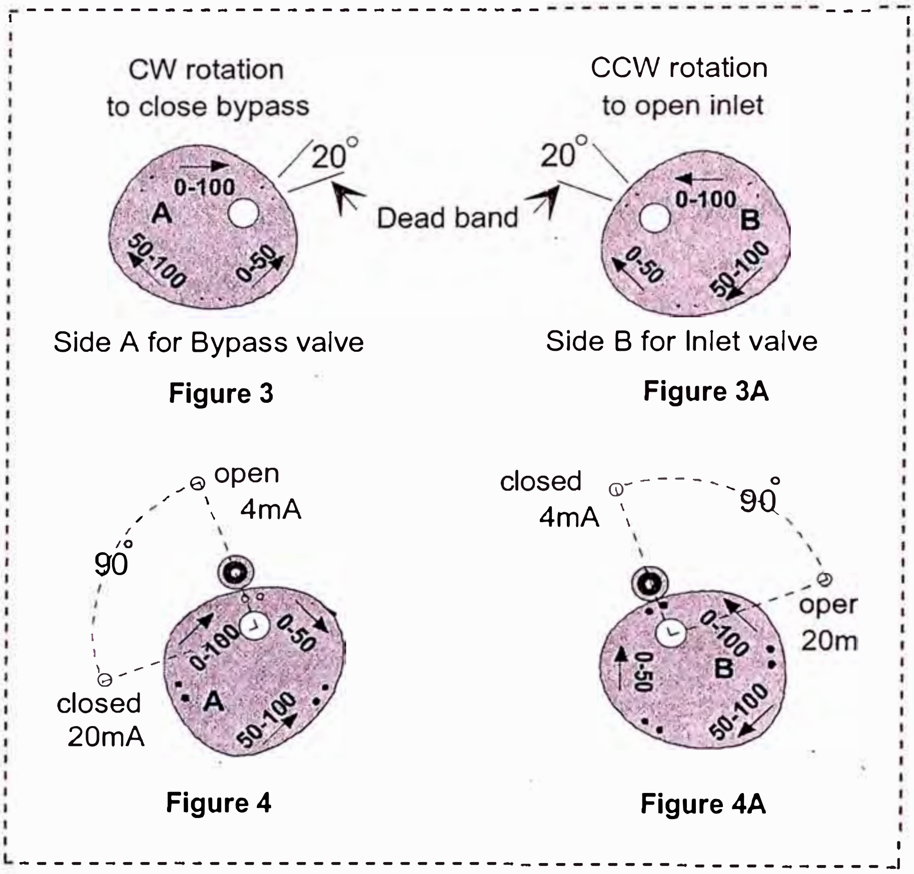

Figure 3

Figure 3A

Figure 4

Figure 4A

The center line of the roller should align with the Zero dead band dot on the cam.

If the cam is removed for any reason, insure upon its re-installation that it is correctly seated against the land on the operating shaft. The shaft may slide towards the actuator when the cam is removed. In this event there is no positive means to know that the cam is properly seated.

To properly seat the cam, loosen the set screw on the positioner to the actuator shaft. Hold the shaft towards the positioner while tightening the cam and locking wheel.
See Figure 5 below for correct configuration of the cam on its shaft.

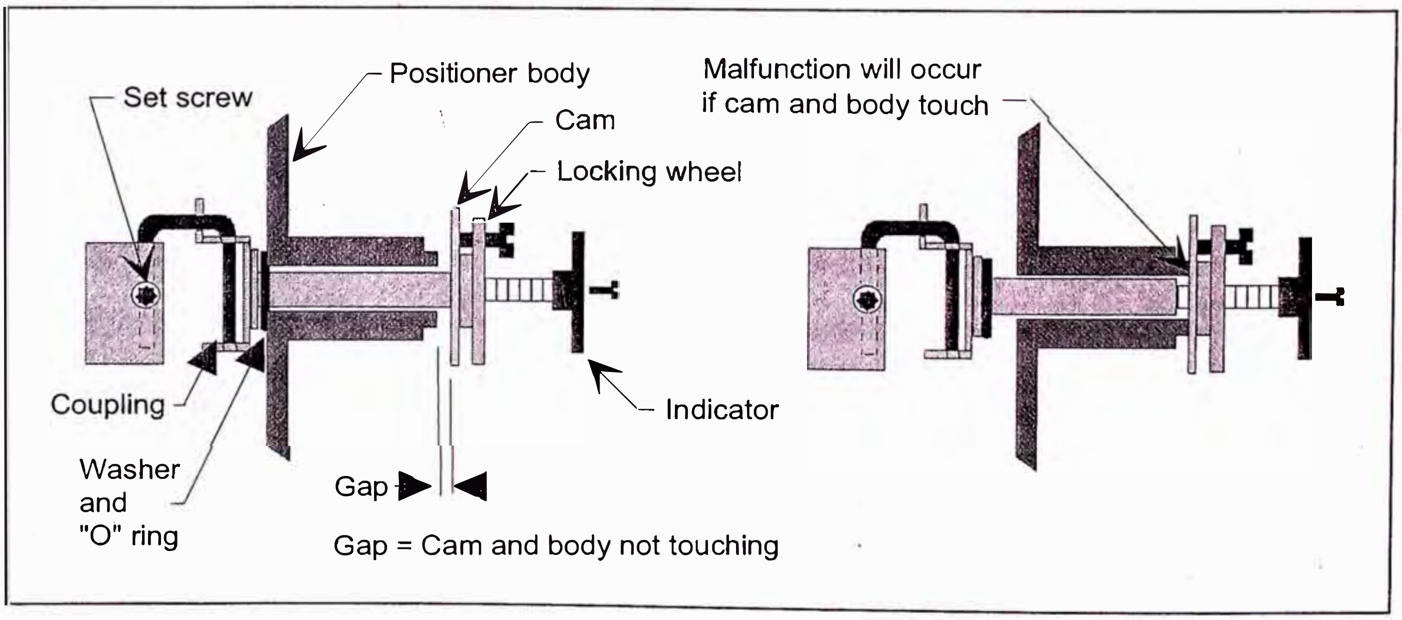

Figure 5. Correct position of cam on shaft

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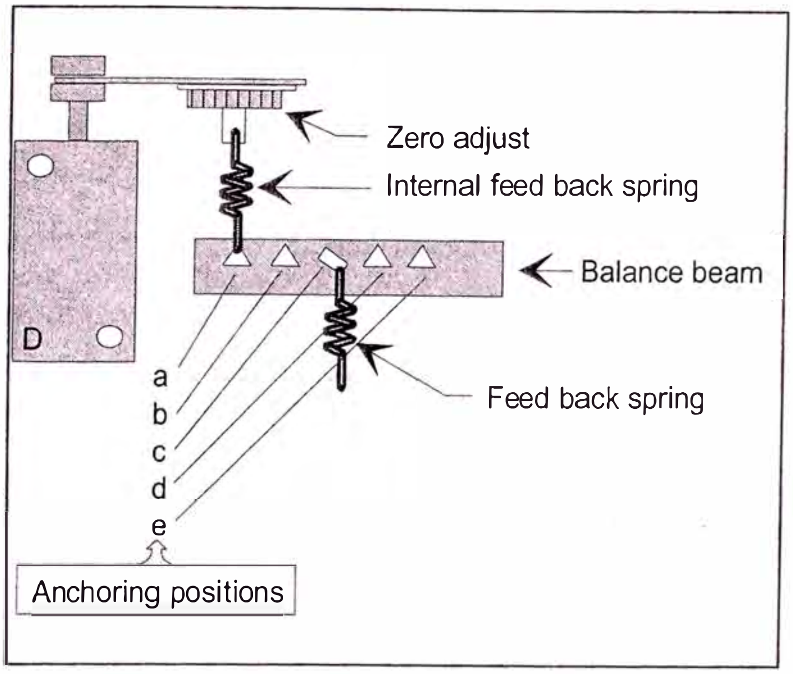

Figure 6. Feed back spring attachment

Internal Feed-back Spring

The internal feed-back spring is identified on Figure 1 as item (14). Figure 6 below is an expanded view of the attachment mechanism for this spring.

The internal feed-back spring anchoring point (a – e) is preset for the particular size of the actuator being used.

The amplification of the positioner increases as the spring anchor is moved from position a to e.

The anchoring position of the internal feed-back spring is set when the assembly is tested. This is done under ideal conditions with specific air supply pressures, etc. Conditions in the field at customer sites may be different than the set up test conditions. The spring may need to be re-adjusted. If it is found during operation that the valve overshoots or moves too slowly, the spring can be moved in the a or e direction as required. If a new (replacement) positioner is being installed on an existing installation, insure the internal feed-back spring is anchored in the same position as on the old positioner. The internal feed-back spring must be positioned before doing the zero and span adjustments to the positioner.

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Terminal Card Assembly

The terminal card assembly contains the span potentiometer, electrical filters and test points (See Figure 7 item 35). The electrical condition of the positioner can be measured without shutting down the compressor. Remove the pin jumper (upper right hand corner or terminal card). Using the exposed terminals attach a voltmeter and ammeter as shown in Diagram 1 to the pins to perform checks. See Table 1 for indications. Insure the jumper is correctly reinstalled at completion of tests.

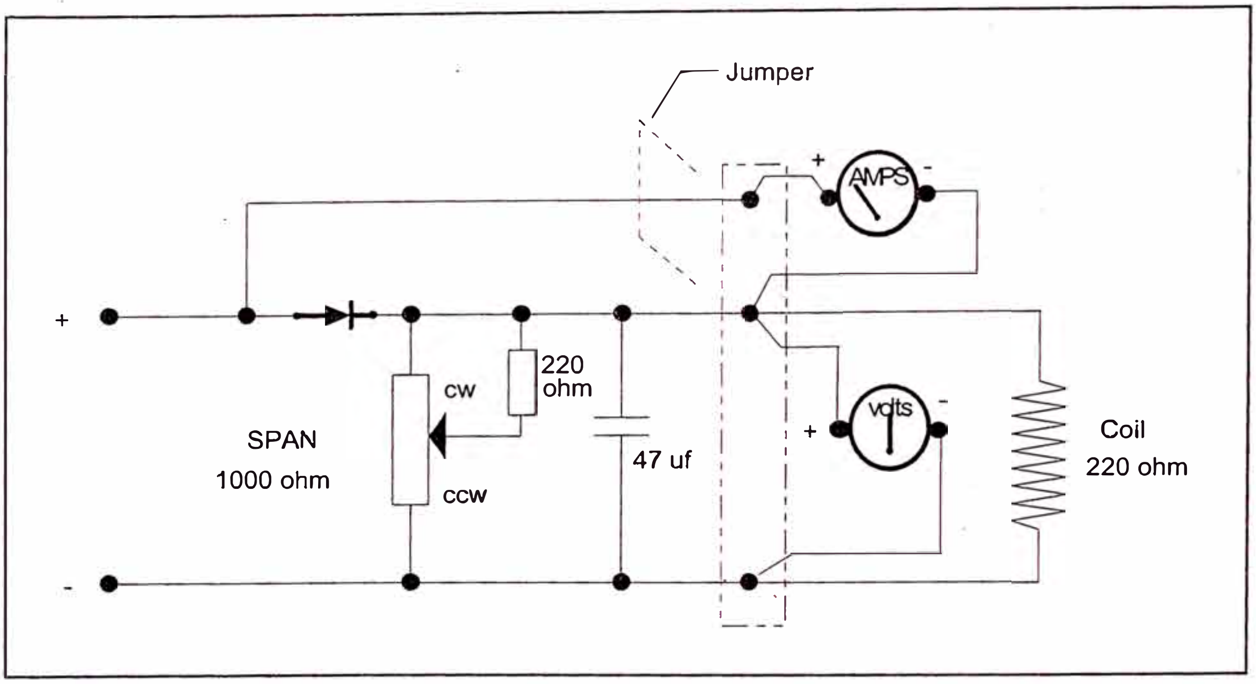

Diagram 1. Terminal card schematic

Measurement		
Volts	Amps	Possible faults
None (0)	Meter goes negative	Signal wire wrong polarity.
None (0)	None (0)	Signal wire defect Wire not connected
Greater than 4 volts	When Amps=20 mA	Coil connections or coil opened. 220 ohm shunt resistor open.
None (0)	Some amp reading	Coil or shunt resistor shorted

Table 1

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Positioner Specifications:

Input signal [direct current from microcontroller]	4 to 20 mA or 0 to 20 mA
Split range capability [Not used]	4 to 12 mA and 12 to 20 mA
Input resistance	Max. 190 ohms
Turning angle of feed-back shaft	max. 90 degrees
Relationship between turning angle and signal	Linear
Supply air pressure	60 PSIG (414 kPa) minimum 65 PSIG (448 kPa) maximum
Supply air quality [Instrument air quality]	Clean, dry and oil free
Ambient temperature	-13 to 185° F (-25 to 85° C)
Construction materials:	
Case	Anodized aluminum
Cover	Poly carbonate
Internal parts	Stainless steel
Springs	Aluminum and Stainless steel
Diaphragms and seals	Nitrile rubber.
Positioner air signal output	0 to 65 PSIG (414 kPa) maximum. Proportional to 4 – 20 mA input signal between zero and span setting

NOTE

The positioner itself is capable of accepting a maximum of 115 PSIG (793 kPa) instrument air pressure. The actuator can withstand a maximum of 65 PSIG (448 kPa). The actuator is the limiting device in the air supply pressure specification for the entire Standard Valve Assembly.

CAUTION

⚠ DO NOT EXCEED 65 PSIG (448 kPa) INSTRUMENT AIR SUPPLY TO THE POSITIONER – ACTUATOR ASSEMBLY.

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Valve positioner exploded view and parts identification list:

1	Housing assembly
2.1	Cover assembly
2.3	Name plate
2.4	Seal
2.5	Screw
3	Protective cover
4	Screw
5	Beam assembly
6	Plate
7	Screw
8	Lower diaphragm plate
9	Middle diaphragm plate
10	Upper diaphragm plate
11	O -- ring
12	O -- ring
13	Diaphragm
14	Diaphragm
15	Screw
16	Hex nut
17	Diaphragm housing assembly
18	O -- ring
19	O -- ring
20	O -- ring
21	O -- ring
22	Diaphragm cover
23	Screw
24	Restriction assembly
25	Screw
26	Shaft assy
27	Washer
28	o -- ring
29	Cam plate
30	Locking wheel
31	Screw
32	Pointer
33	Lever arm
34	Ring
35	Terminal card assembly
36	Screw
37	Force coil nozzle
38	Screw
39	o -- ring
40	Internal feed-back spring
41	Feed-back spring
42	Spring
43	O -- ring
44	Pilot valve assembly
45	Gasket
46	Change over piece
47	O -- ring
48	Protective plate
49	Hex nut
50	Filter
51	Plug
52	Coupling
55	Gasket
57	Grub screw
58	Upper support plate
59	Gasket
61	Zero adjustment nut

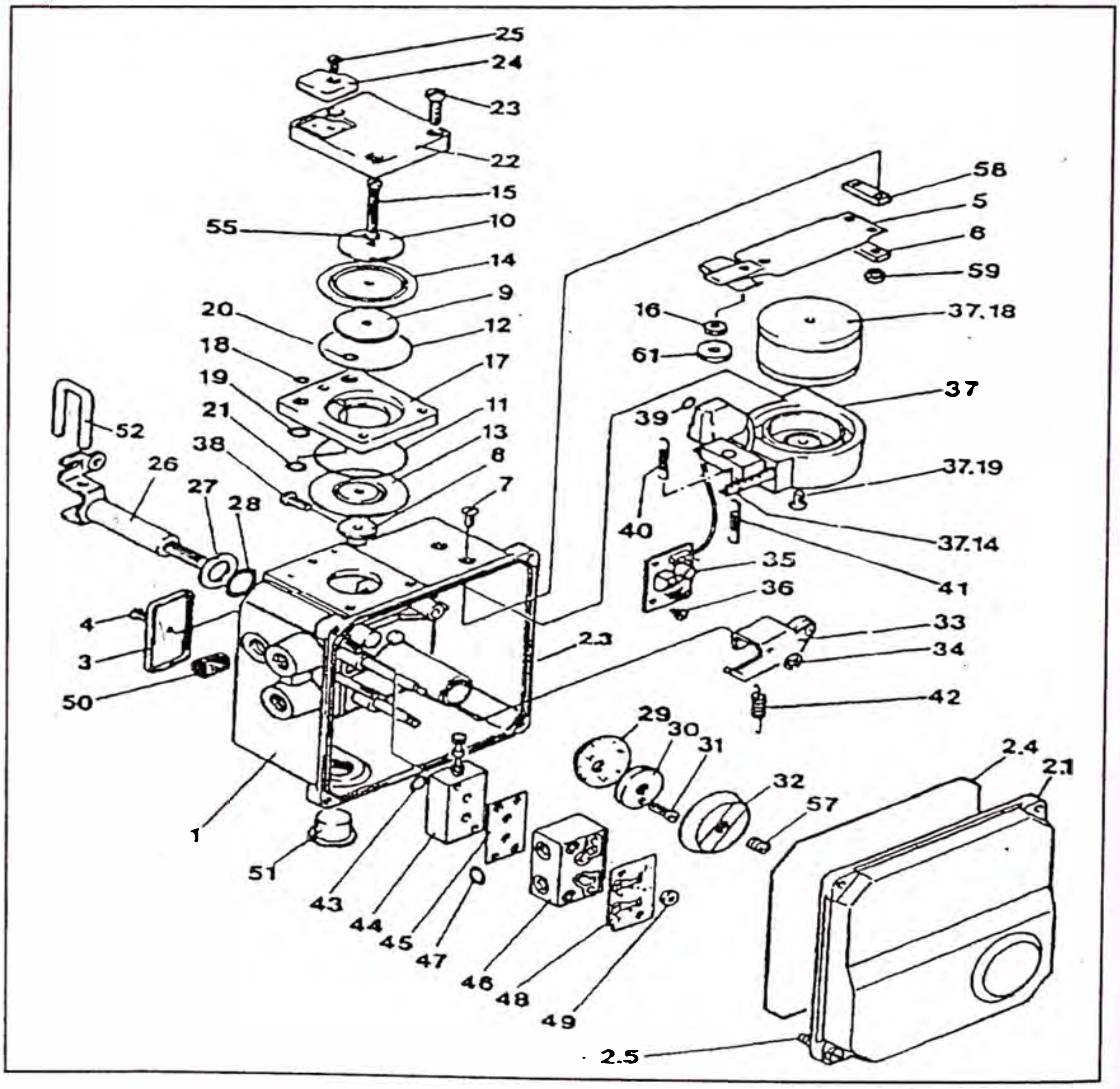

Figure 7

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Part II: The Actuator

Actuator Operating Principle

The Ingersoll-Rand actuator is designed for proportional control of 90° rotary valves. It has a totally enclosed drive train that makes the actuator safe to use and protects the drive train against damage or accidental changes in setting. The actuator mounts rigidly on the valve with the valve driver lined up directly with the valve stem.

The actuator is a single acting (control air pressure on one side only) diaphragm operated spring return device. This feature makes the actuator fail safe. On loss of control air signal, the valve returns by way of the spring pressure to its shut down condition. The inlet valve closes and the bypass valve opens on loss of signal.

Refer to Figure 8 in following the principle of operation description. The positioner sends a power air signal to the supply and vent port (1) of the actuator. The PSIG of the power air is proportional to the 4 to 20 mA microcontroller output signal being fed to the positioner.

The air pressure on the diaphragm (2) forces the spring (3) to be compressed to the point where the spring pressure exactly equals the force being applied by the air signal on the diaphragm. As the spring (3) compresses, the actuator rod (4) moves (downward).

The vertical motion of the actuator rod is transformed into an angular motion of the valve by the connector plate (5) and driver arm (6).

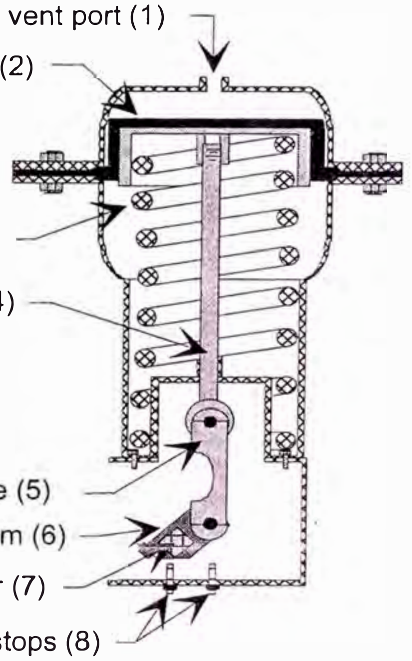

Figure 8. Actuator cross section

The valve driver (7) is supported on either end by bushings in the actuator housing. The valve driver (7) is rotated through 0° to 90° over the stroke of the actuator rod (4). When the air signal is reduced the excess air is vented through the port (1) back to the positioner and subsequently to the atmosphere. The reduced pressure on the diaphragm allows the spring to expand which in turn provides a reverse motion to the actuator rod.

Valve Open and Closed travel stops (8) for either end of the stroke are provided. These are used to prevent valve jambs on opening and closure by setting valve travel limits.

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Various sized actuators are used on the smaller to larger Centac products. While one actuator may be physically smaller or larger all are generally constructed the same way. Larger sizes are necessary to accommodate the increased loads on the larger valves. The spring is not adjustable. The maximum air pressure to the single acting diaphragm controlled actuator is 65 PSIG (448 kPa). Diaphragm rupture or premature failure will result from excess signal pressures.

Normally closed or normally open valve rotation is obtained by simple rotation of the valve drive from one side to the other. The inlet valve opens with increasing air signal while the bypass valve closes with increasing air signal. The spring alone will shut the inlet or open the bypass. The spring provides fail safe operation of the valves. Except for setting of the travel stops, there are no adjustments on the actuator.

Actuator Position for Inlet or Bypass Use

To utilize the actuator for the bypass valve the driver position is as shown in Figure 9. For inlet valve use the actuator is simply reversed as shown in Figure 9A.

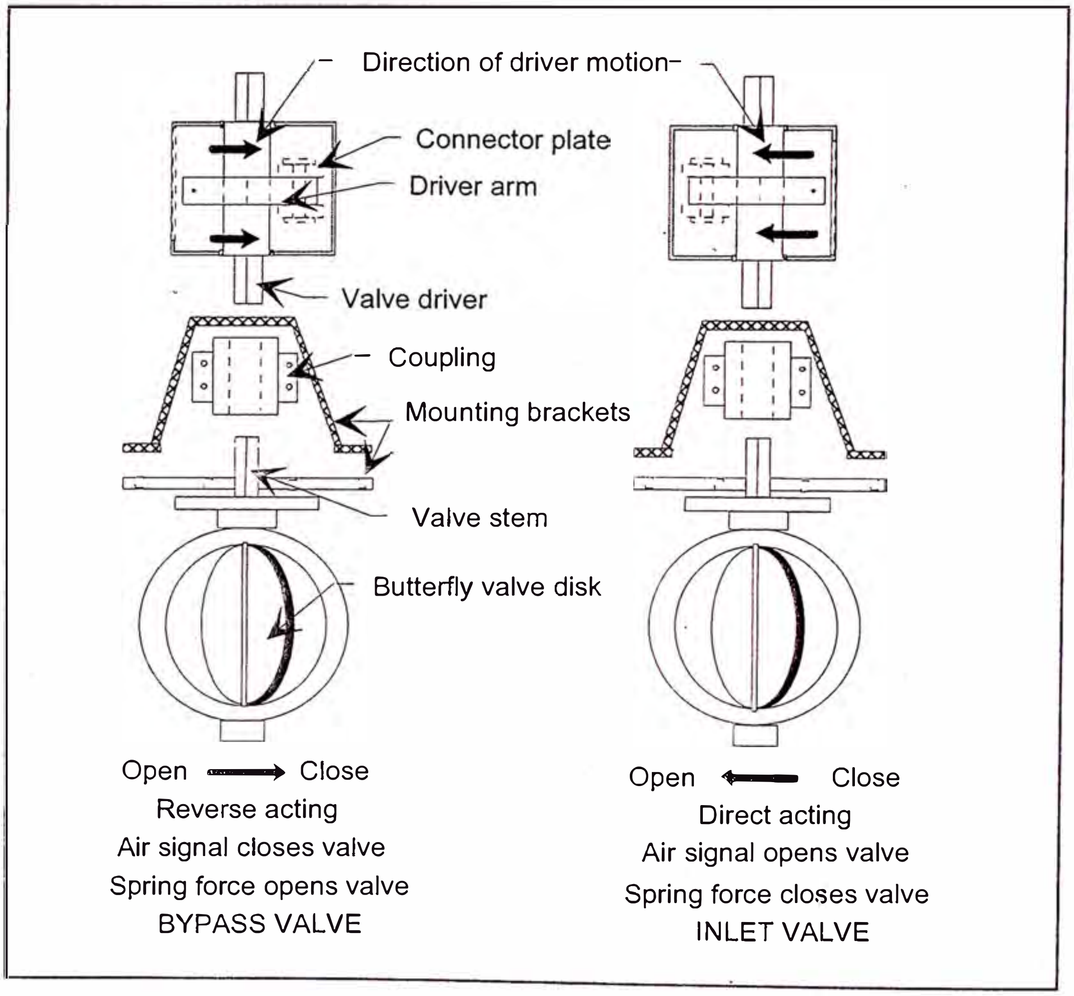

Figure 9. Bypass valve *Figure 9A. Inlet valve*

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Actuator Parts Identification List

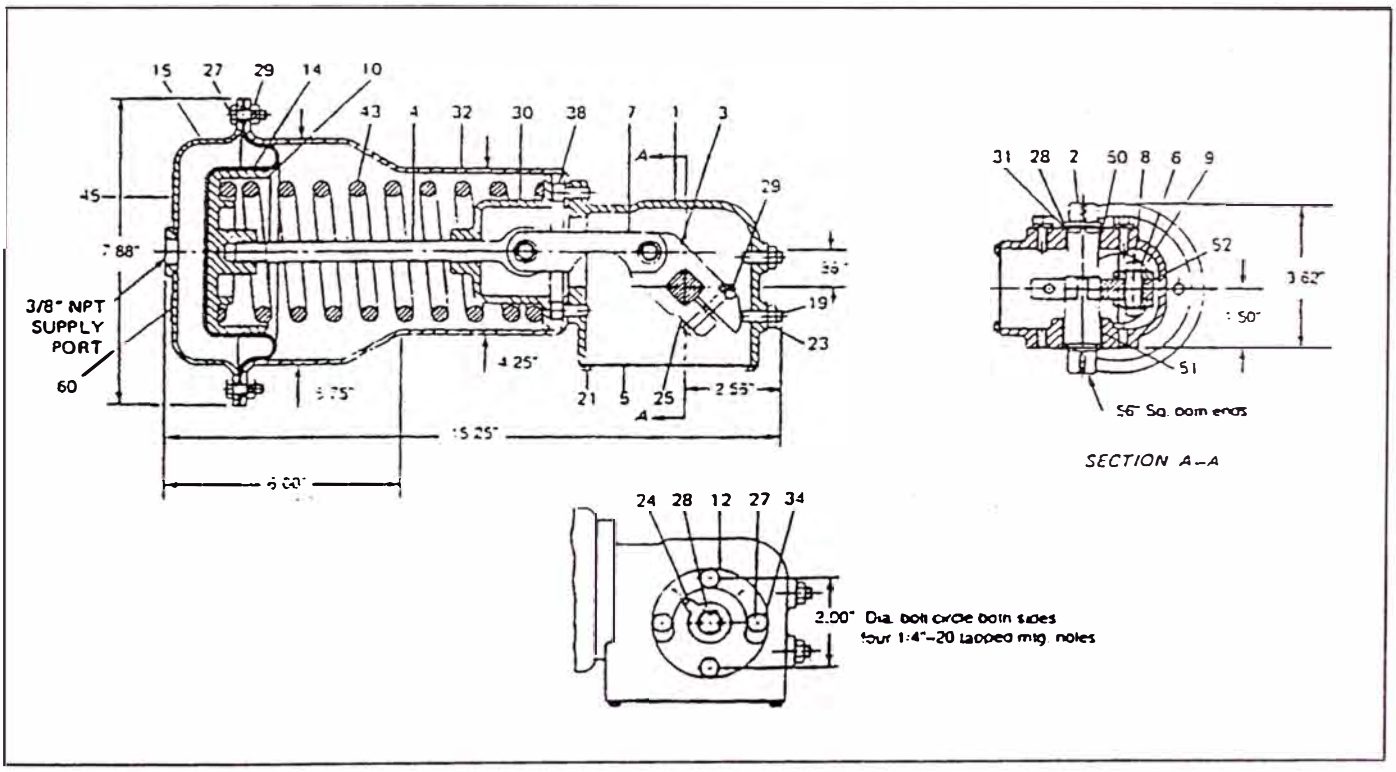

Figure 10

1	Housing
2	Driver
3	Driver arm
4	Actuator rod
5	Cover
6	Pivot pin washer
7	Connector plate
8	Pivot pin
9	Pivot pin retainer
10	Diaphragm plate
12	Position indicator plate
13	N/A
14	Diaphragm
15	Upper casing
19	Stop screw
20	N/A
21	Cap screw
23	Jam Nut
24	Indicator pointer
25	Cap screw
26	N/A
27	Cap screw
28	Driver retainer
29	Lock nut
30	Spring retainer
31	Thrust washer
32	Spring housing
33	N/A
34	Lock washer
36	N/A
38	Cap screw
39	N/A
43	Compression spring
45	Plate
50	Top driver bearing
51	Bottom driver bearing
52	Pivot pin bearing
53	Name plate
54	Tie rod
55	Hex nut
60	Plate

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Part III: The Valves

Standard Butterfly Inlet Valve

The standard inlet butterfly valves are swing through valves which have no internal stop. The valve has a bi-flow characteristic and is not flow direction sensitive. Figure 11 below shows a typical valve.

The packing is normally Graphited Teflon Braid and requires little to no maintenance over the life time of the compressor. The valve shaft is stainless steel and rides in a Graphited Bronze bearing.

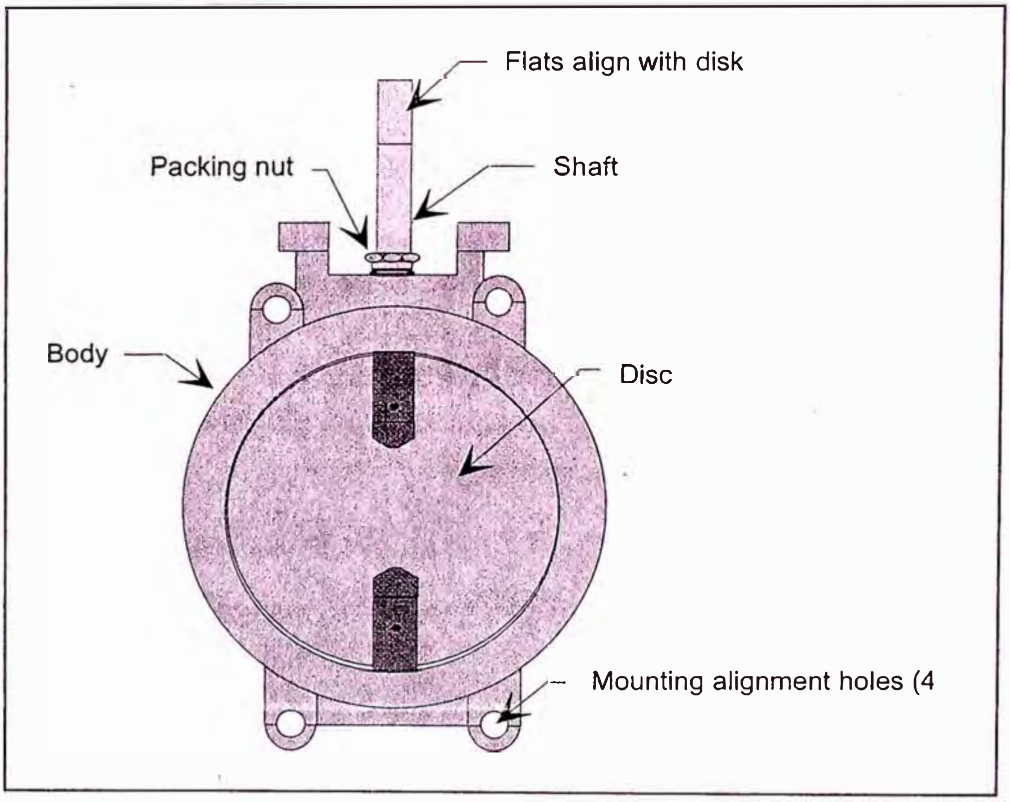

Figure 11. Butterfly valve

The standard valve is designed for temperatures up to 450° F (232° C). Special valves are available for higher temperature applications.

When the valve is attached to the actuator, the actuator travel stops are adjusted so that the valve corresponds to the open and closed position of the actuator.

Adjustment procedure for the valve with its attached actuator is contained in Part V, Adjustment of the assembly.

Segmented Ball Bypass Valve

Along with the introduction of the single acting diaphragm operated actuator, the segmented ball valve was introduced as a standard on the smaller Centac frame sizes and was made optional for all other Centac products. The segmented ball valve provides more stable control characteristics then the butterfly valve and has been found to be an excellent control valve in the lower flow demand applications.

Figure 12 is a representation of the operating positions and major components of the segmented ball valve.

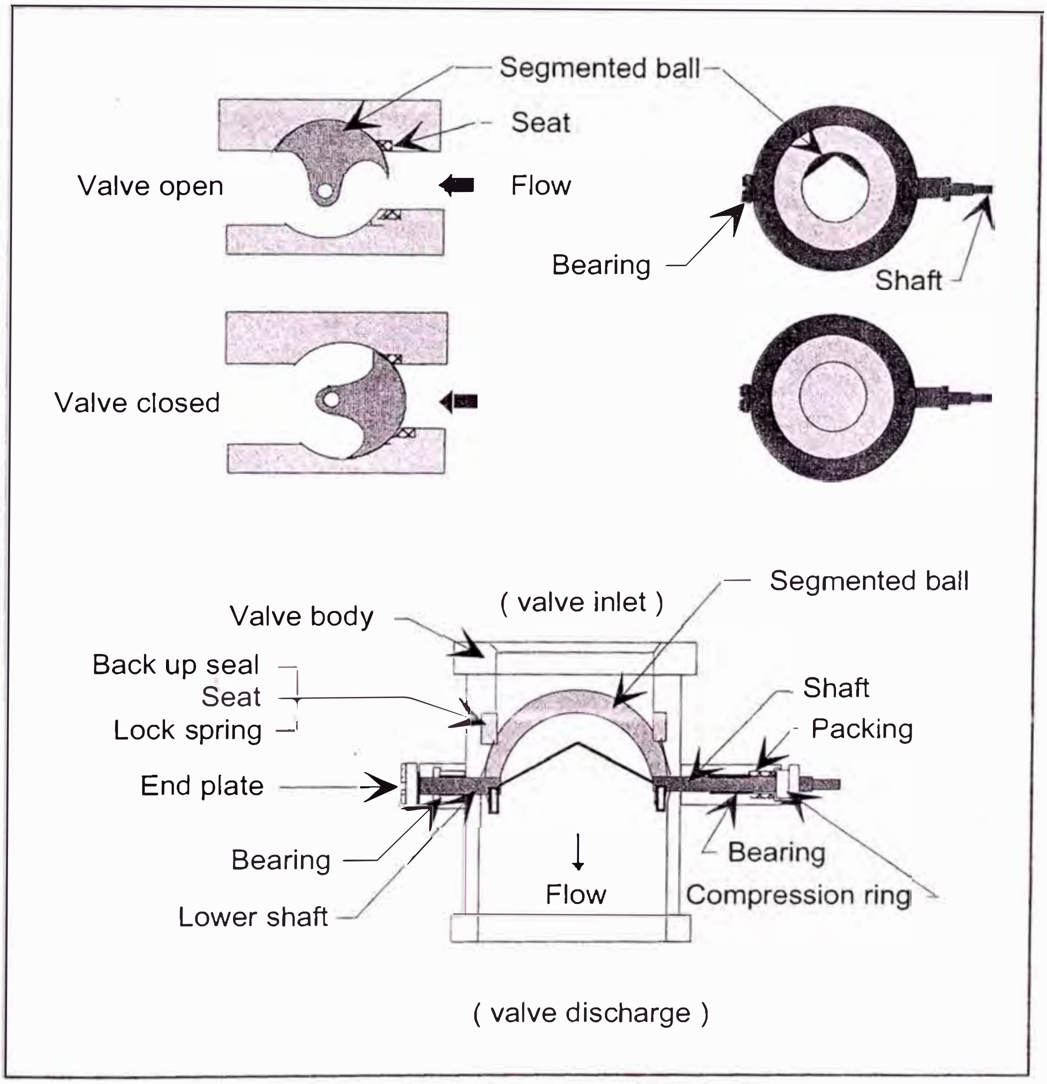

Figure 12. Segmented ball bypass valve

The valve does not contain internal stops at the 90° position. The actuator travel stops must be adjusted so that a 90° rotation seats the segment.

The valve discharge has a larger diameter than the inlet and the valve is flow direction sensitive. Flow is against the segment as shown in Figure 12.

Standard "Wafer" Type Butterfly Bypass Valve

The standard butterfly bypass valve unlike the inlet butterfly is a seated valve. The seated valve allows for positive stoppage of flow when the valve is closed.

The bypass valve wafer (or disk) is offset from the center lines of the valve body and the seat. The eccentric location of the wafer pivot point provides a means for the disk to lift away from and clear the seat as it starts to open. See Figure 13 where the relationship of pivot to center lines is shown. The TFE lip seal seat flexes to provide a leak tight seal and the construction allows for self compensation for wear. The seat is removable should it ever need replacement.

Thrust washers on the shaft keep the disk centered. The pin that holds the disk to the shaft is welded to insure no chance of loosening.

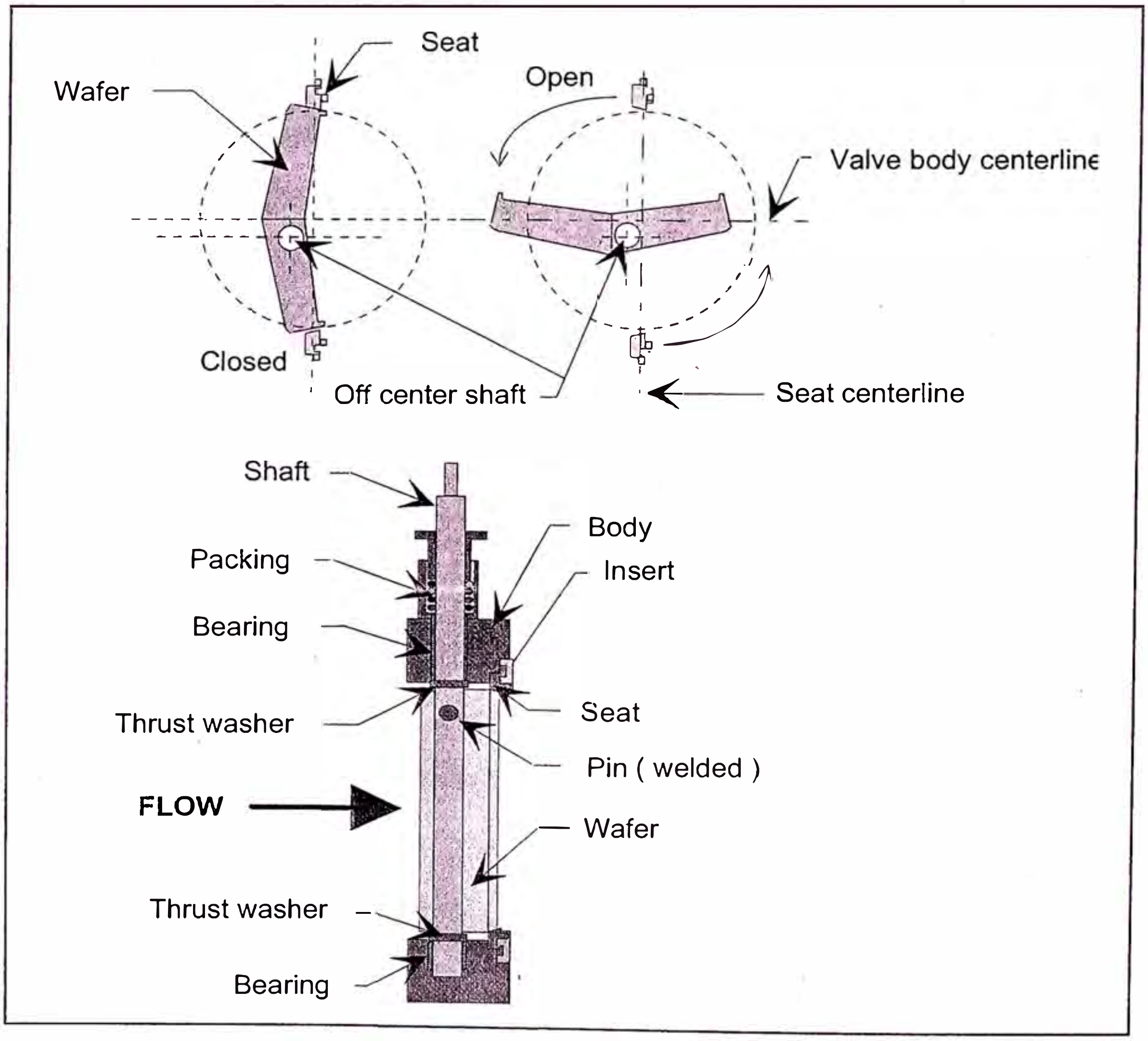

Figure 13. Wafer style butterfly valve

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Part IV: The Regulator and Coalescing Filter

Supply Air Regulator

The supply air regulator is used to reduce the supply air pressure from a maximum inlet design pressure of 120 PSIG (827 kPa) down to the maximum operating pressure of the actuator. Actuator operating pressure is 60 PSIG (414 kPa) with a maximum of 65 PSIG (448 kPa). The regulator has an integral 5 micron filter with drip well for the collection of moisture. A drip well drain is provided. The regulator is adjustable over the range of 0 to 60 PSIG (0 - 414 kPa) and will normally be operated at 60 PSIG (414 kPa). The principle of operation of the regulator is balanced force where a calibrated spring force is balanced by the discharge air pressure against a diaphragm. Refer to Figure 14.

Outlet air pressure is set with the adjusting screw. Once set the regulator maintains the setting. The range spring, which has been compressed by the adjustment screw, causes the pintel to move downward, opening the pintel valve and allowing air flow.

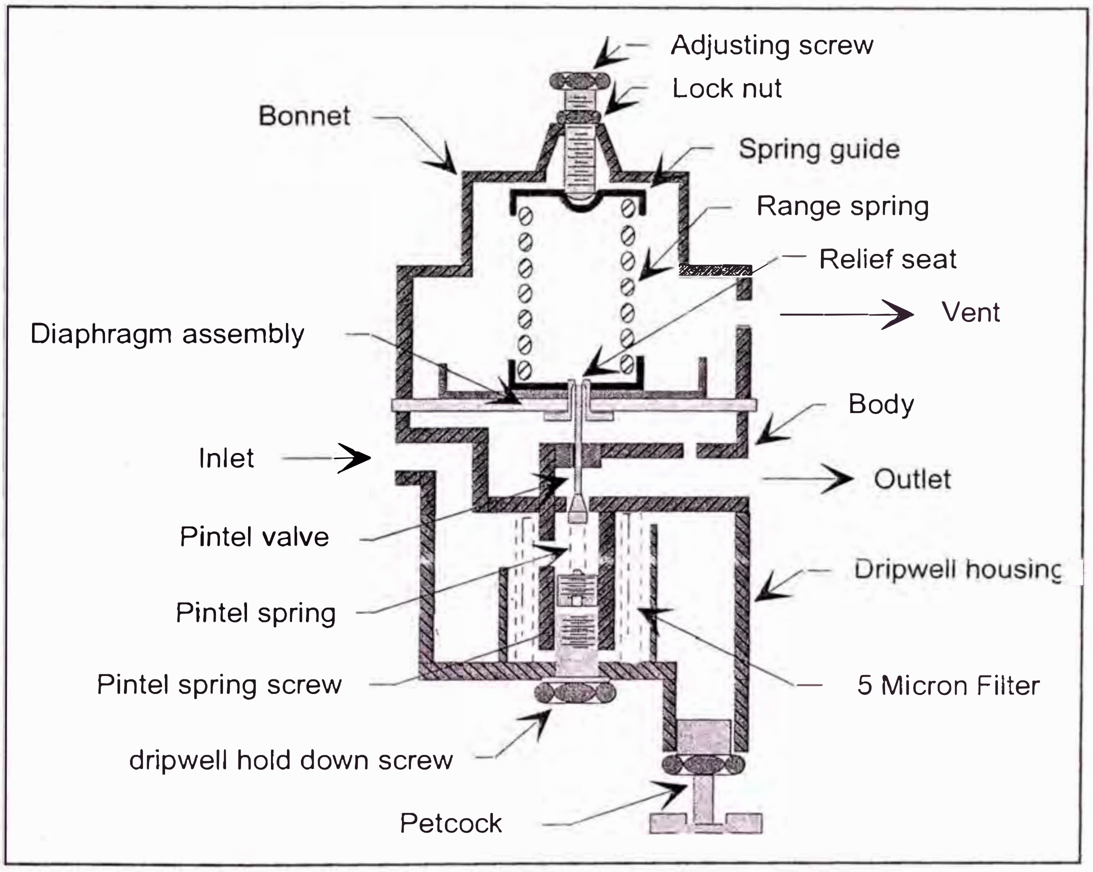

Figure 14. Air regulator

The pressure builds up against the control diaphragm until the pintel valve closes to a point of equilibrium between the spring and the air pressure on the diaphragm.

Once the set pressure is reached it is maintained as described below.

Downstream pressure drop: A drop in down stream pressure reduces the air pressure on the diaphragm. The equilibrium is upset and the pintel valve opens to the point where equilibrium is again established.

Downstream pressure increase: A sudden increase in downstream pressure acts on and lifts the diaphragm off the pintel, causing the relief pintel seat in the diaphragm assembly to lift opening the chamber below the diaphragm to the vent. The excess pressure drops almost instantaneously to the equilibrium point at which time the relief pintel seat seals once again on the pintel.

The 5 micron filter is nylon mesh with self cleaning assisted by porting to the drip well area. The filter and drip well should be removed and cleaned on a periodic basis.

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Coalescing Filter

Directly attached to the downstream side of the valve assembly supply air regulator is a coalescing filter. The purpose of the final filter stage (the regulator provides the first stage of filtration) is to remove any mist or particles that may have been passed by the first stage filter.

The coalescing filter will remove 99.9 % of all mist or particles down to .01 micron size. The filter media is contained in replaceable tube form. The filter cannot be cleaned by back flush or other means. When the pressure drop reaches 10 PSIG (61 kPa) the filter tube should be replaced.

Except for periodic filter tube changes the other parts that may need replacement from time to time are the seals. Lubrication on an "O" ring facilitates its installation. The "O" ring seals are obtained in kit form from Centac Aftermarket. Figure 15 shows the relative position of the "O" ring seals. Note that air flow is through the center of the filter tube.

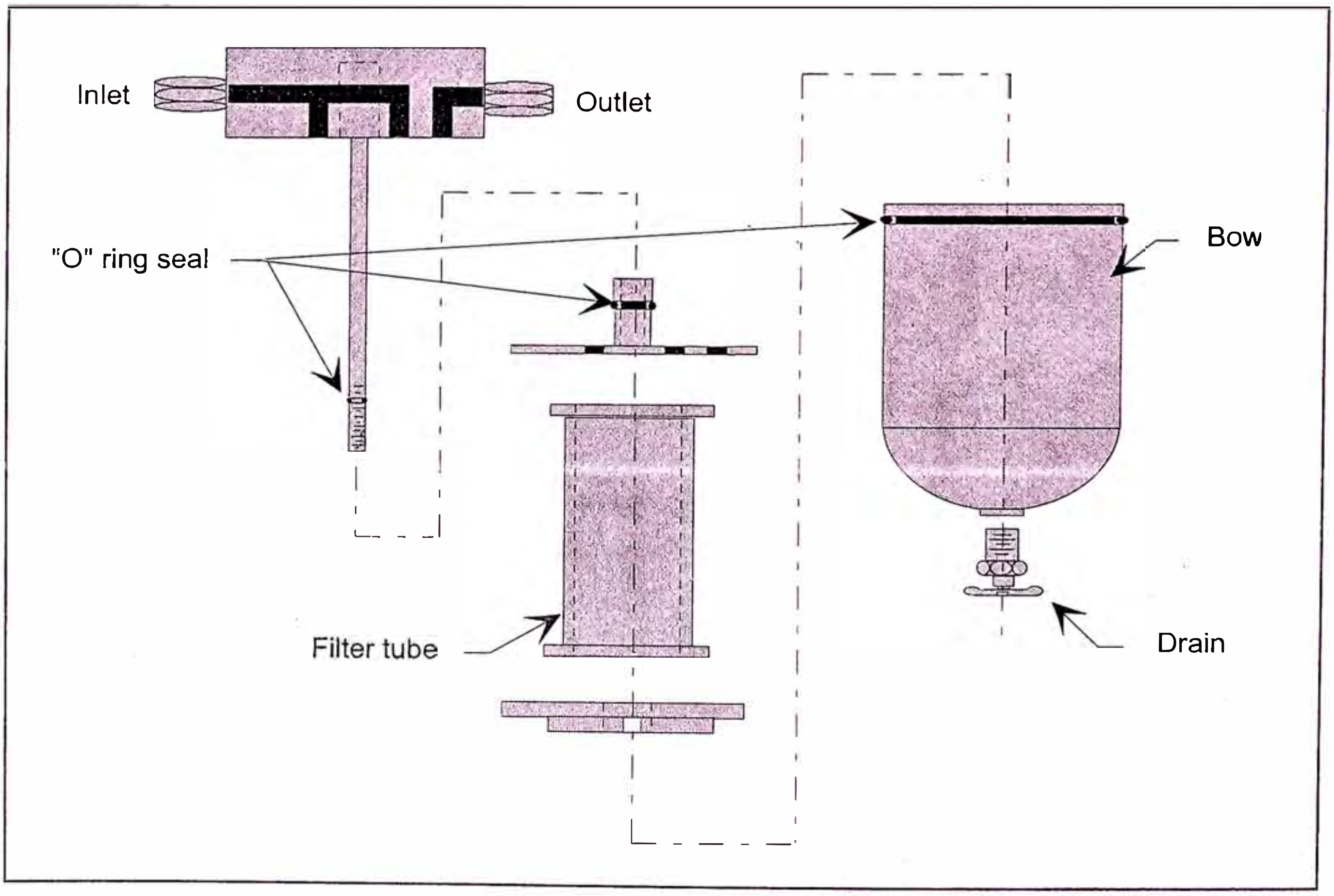

Figure 15. Coalescing filter internals

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Part V: Adjustments and Maintenance

Tools and Materials Needed

The following tools are needed to efficiently adjust the standard single acting valve assembly.

1. 4 – 20 mA source
2. Flat blade screw driver (small)
3. Clean, dry air supply (instrument air provided by customer)
4. Allen wrench set
5. Reliable 0 – 100 PSIG (0 – 700 kPa) pressure gauge

Verifying Proper Operation of the Valve Assembly

The procedure for verifying operation of the inlet or bypass valve assembly is the same. Valve action should be as noted below.

Verify air supply:

Remove regulator adjustment screw cap and back off on the adjustment screw until pressure indicated on the outlet pressure gauge is Zero. Increase pressure to the operating pressure of 60 PSIG (414 kPa).

Verify positioner cam position:

INLET valve: Cam should be on side B with the arrow of the 0 – 100% range pointing to the left as the cam is viewed.

BYPASS valve: Cam should be on side A with the arrow of the 0 – 100% range pointing to the right as the cam is viewed.

Attach a 4 – 20 mA source (+ to + and - to -) to the positioner; (Use I-R test box). Adjust the source so that 4 mA is being sent to the positioner and observe valve action.

INLET and BYPASS valve action: Should not have moved as a result of applying the 4 mA.

Adjust source to 20 mA. Note valve action

INLET valve action: Should open 90°. The positioner indicator should show 90° rotation.

BYPASS valve action: Should close 90°. The positioner indicator should show 90° rotation.

If valve action occurs as noted, the valves are properly stroked and ready to receive control signals from the MP3 microcontroller.

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Stroking the Inlet and Bypass Valve Assembly

With 4 mA supplied to the positioner. Rotate ZERO adjustment nut wheel until:

INLET valve is fully closed.

BYPASS valve is fully open

Increase to 20 mA and adjust the SPAN adjustment on the positioner terminal board until.

INLET valve moves to fully open

BYPASS valve moves to fully closed

Decrease source to 4 mA and check zero adjustment position of the valve.

Repeat zero and span procedure until valves are fully open and closed at their respective mA values.

Troubleshooting Indications

Air continuously venting from the vent port on the regulator indicates that the diaphragm has ruptured.

Air continuously venting from the positioner pilot valve assembly indicates that the spool valve is not seating and may have worn components.

Air venting from the area of the positioner diaphragm housing indicates a ruptured lower diaphragm.

A high volume of air escaping from the positioner nozzle is an indication of a ruptured upper diaphragm.

NOTE

A low volume of air is normal and required for proper operation.

Air venting from any place on the actuator indicates a ruptured diaphragm or loose actuator upper casing.

Routine Maintenance

Routine maintenance on the control valve assembly is limited to the following:

- The filters require periodic cleaning and replacement. This period must be established at each compressor site since it is the site air quality that dictates when the cleaning and replacements are required.
- A daily draining of the regulator and coalescing filter will indicate severity of any air contamination problem.
- Checking the calibration (stroking) of the control valves is done, as a matter of routine, in accordance with the compressor Operators Manual on an every six month basis.

CENTAC®

Inlet Guide Vane Valve Operators

INGERSOLL RAND®
AIR COMPRESSORS

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PART I: Standard Electronic IGV

Introduction

The Ingersoll-Rand standard electronic actuator assembly was made applicable to both the linkage and cable driven inlet guide vane (IGV) valves in 1992. The principle of operation of the actuator, positioner, regulator, and filter in the IGV application is the same as the standard Inlet and Bypass valves.

The feed back cam in the linkage IGV is a different shape than that used in the standard valve. The cam is driven by a feed back take off arm arrangement off of the up down motion of the actuator rod. The motion is linear as compared to the rotary motion in the standard valve arrangement.

The adjustment and stroking of the cable driven IGV is the same as a butterfly type valve. The cable IGV uses a 90° rotary motion. Its positioner cam and driver are the same as the standard butterfly valves.

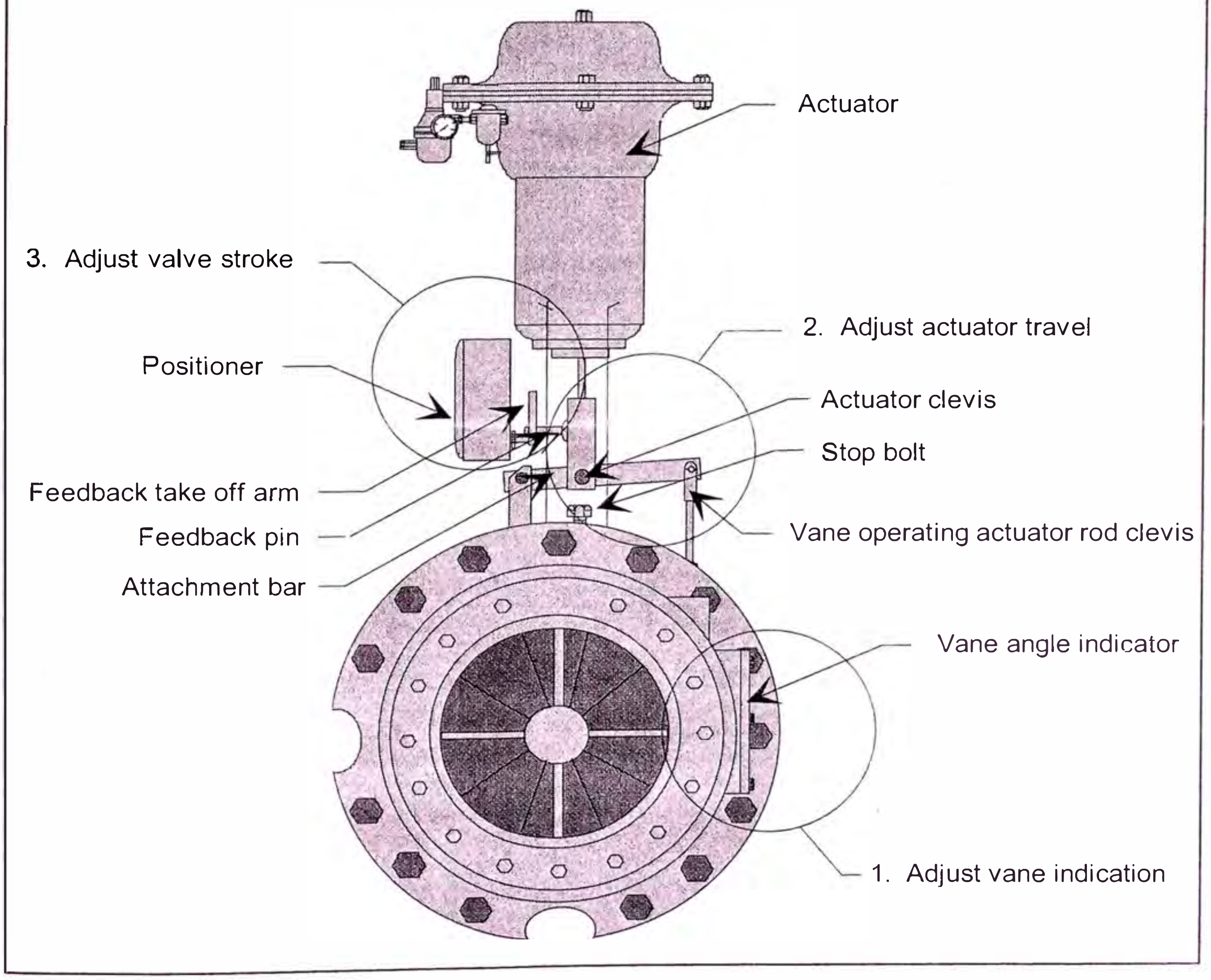

Figure 1-1. Inlet Guide Vane (toggle rod driven vanes)

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There are three major separate adjustments to properly set up the linkage type IGV. These adjustments and the major components involved in the adjustments are labeled and identified in Figure 1-1.

This booklet will describe how to make the necessary adjustments. The adjustments are completed in the 1, 2, 3 order noted above in Figure 1-1.

The IGV is adjusted at the Centac factory. There is no need to redo the factory adjustment but it is a good practice to check all settings before compressors initial run. Adjustments are made whenever the settings are found to be disturbed. A complete IGV adjustment will be required if a standard electronic actuator assembly is retrofitted to an IGV or a complete IGV is retrofitted.

Adjusting the Vane Indicator

The desired end result condition after making this adjustment is to have the IGV vanes positioned so that they are parallel to the inlet air stream with the indicator pointer at + 8 degrees. Perform the following steps to adjust the vane indicator to +8 degrees.

1. Disconnect the vane operating actuator rod clevis from the attachment bar.
2. With the vanes open and the flat side parallel to the air stream:
3. Loosen the hold down nut and move the pointer so that it indicates + 8 degrees. See Figure 1-2.

CAUTION

⚠ Do not allow the vanes to exceed -10 degrees. Lock up of the IGV arm and knuckle mechanisms will occur after -10. Disassembly of IGV is required to unlock the arms and knuckles.

4. Tighten the pointer hold down nut. The vane indicator and vanes are now adjusted.

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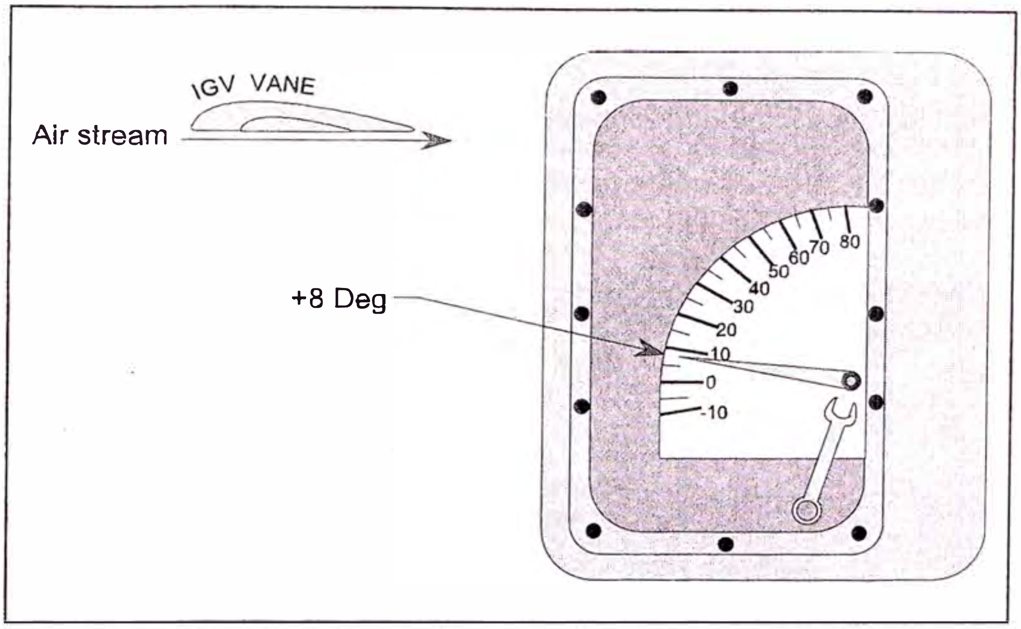

Figure 1-2. Vane angle indicator Adjusting actuator travel.

The desired end result condition after making this adjustment is to have the full travel limits (See Table 1-1) of the actuator set and the IGV indication showing proper vane motion of 0 to + 88 degrees. Perform the following steps to adjust the actuator travel.

1. Connect a regulated air supply (maximum of 40 PSIG) to the top of the actuator. Check the vane operating actuator rod to see that it is disconnected from the attachment bar. With 0 air pressure the actuator is at top of stroke. Figure 1-3 shows the clevis at the top of stroke.
2. Apply air pressure; the actuator clevis will travel downward. At the travel distance shown on Table 1-1, the actuator rod clevis and attachment bar should just touch the stop bolt. Adjust the stop bolt as necessary to achieve the correct full stroke travel.

Table 1-1.

Model	Rod travel (stroke)	Mid stroke travel
2CII	3/4 in (190 cm)	3/8 (.95 cm)
3CII to 5CII	7/8 in (2.22 cm)	7/16 in (1.11 cm)

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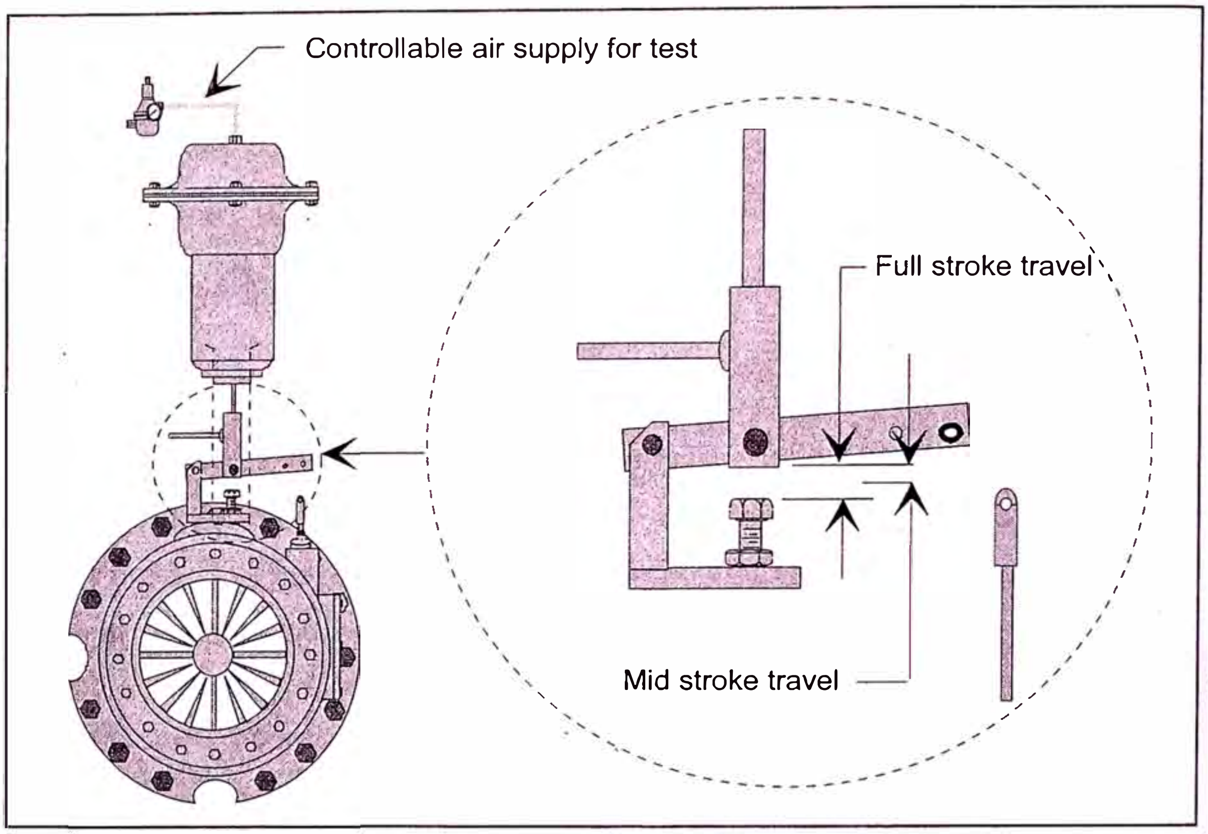

Figure 1-3. Adjustment of stroke distance

3. Once the full stroke travel limit is set, the next step is to set the actual IGV vane motion limits. To do this, apply air pressure to the actuator and position the clevis and attachment bar on the stop bolt. The position of the attachment bar in this condition is where it will be when the IGV is full open.
4. Attach the vane operating actuator rod clevis to the attachment bar while the air pressure is holding down the attachment bar on the actuator, note indicator reading. Adjust the vane operating rod clevis as necessary to achieve zero (0°) open indication on the dial.
5. When the dial is at zero degree (0°) indicated, the valve is at the full open position.
6. When the air pressure is removed from the actuator the IGV should spring return and indicate greater @ 88° , vanes touching in the closed position. Indicator markings stop at 80.

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Adjusting Valve Stroke.

The desired end result condition after adjusting valve stroke is to have the positioner properly located with respect to the feed back pin on the actuator clevis. The positioner feed back cam will be properly installed and the IGV will be stroked for 4 mA, fully closed, @88° indicated and 20 mA, fully open, 0° indicated. The positioner is mounted by means of a bracket. Movement of the positioner on its bracket adjusts the location of the positioner feed back arm with respect to the actuator feed back pin. Figure 1-4 shows actuator rod clevis in the 12 mA or 1/2 full travel position for pin to arm adjustment. Perform the following steps to adjust the valve stroke.

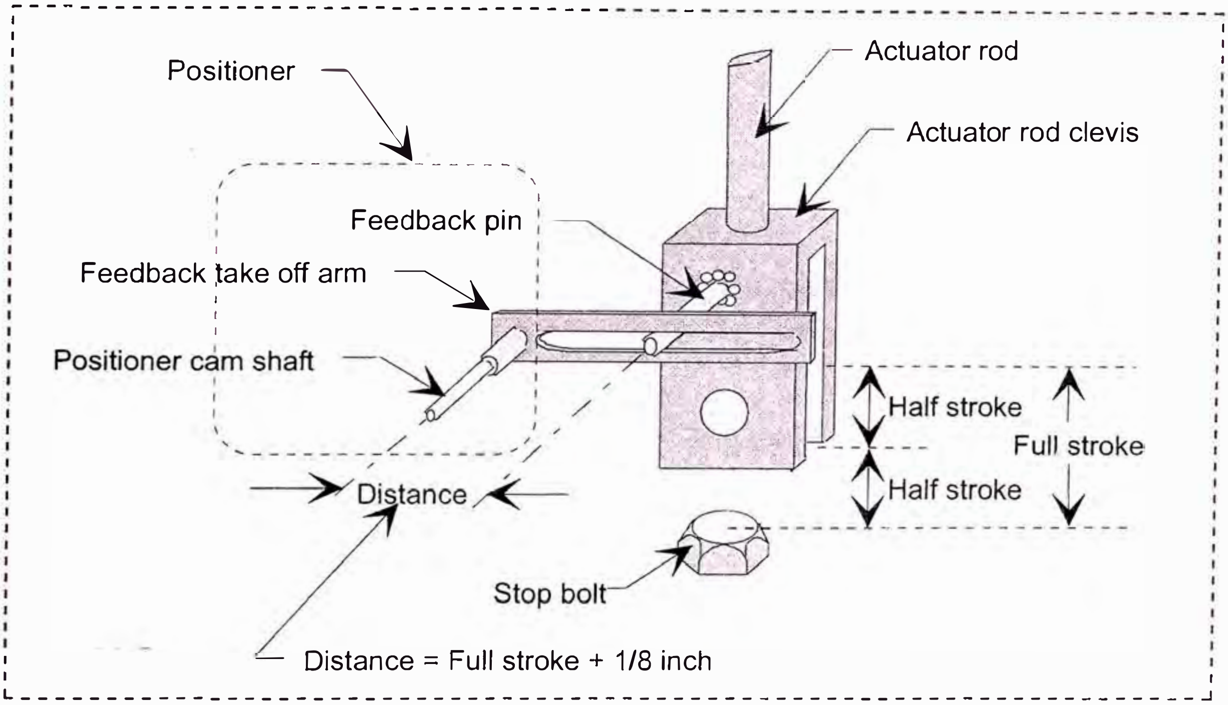

Figure 1-4. Setting rod clevis at half stroke for positioner locating

1. Apply hand regulated air (do not exceed 40 psi) to the actuator and position the attachment bar and actuator clevis at 1/2 full stroke, i.e., If full stroke is 3/4 (190 cm), half stroke is 3/8 (95 cm). A small rule or other measuring tool is required to determine stroke distance.
2. Loosen the positioner bracket attachment bolts and move the positioner so that the feed back take off arm is horizontal, i.e. at 90° angle to actuator rod clevis. Once the positioner is horizontal the distance between the positioner cam shaft and the clevis feed back pin is adjusted. See Table 1-1. The distance between the shaft and pin should be Distance = Table 1-1 Full stroke + 1/8 inch (32 cm). [e.g. 7/8 = 3/4 + 1/8 or 8/8 = 7/8 + 1/8] See Figure 1-4
3. Once the location of the positioner is adjusted and fixed, the hand regulated air supply to the actuator can be removed. Reconnect the normal 35 to 40 psi supply to the installed regulator filter.
4. The feed back cam can now be installed or checked for correctness and the positioner can be stroked. The shape of the cam in the linkage IGV is different than the standard butterfly valve or cable driven IGV positioner cam. Figure 1-5 is a representation of the linkage IGV linear action cam. This cam is set on the 0 to 100 scale in the position that causes the cam to raise as input signal increases.

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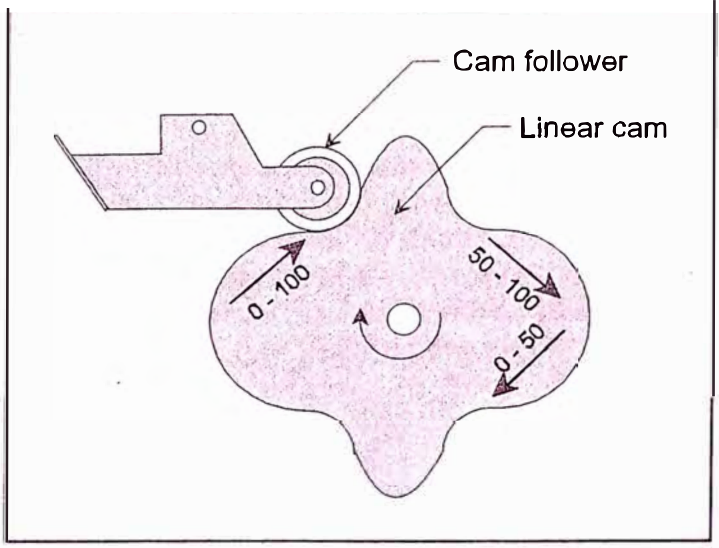

Figure 1-5. IGV linear cam

5. Stroking is accomplished in the same manner as in the Standard Inlet and Bypass Valve Assembly. Zero is set with the mechanical screw knob on the positioner diaphragm assembly and span is electrically set with the adjustment potentiometer on the positioner terminal card. With a 4 mA signal to the positioner the IGV should be closed with @ 88° indicated. At 20 mA signal the IGV is open with 0° indicated, attachment bar just touching the stop bolt.

NOTE
For some applications a different maximum vane opening degree may be specified in the instructions a for specific compressor. Air separation applications usually call for adjusting the IGV so that the indicator shows 78° (vanes actually 10° open) when the IGV is closed and -10° indicated when the IGV is fully open

NOTE
See PART II Electro-pneumatic IGV control for adjustment of a system that has a MP3 supplying a Honeywell actuator positioner assembly.

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PART II: Electro-pneumatic IGV Control

Introduction

The pneumatically controlled IGV used on Centac has historically been a Model 870010 Honeywell positioner with a Honeywell Type 01 AIR-O-MOTOR actuator. See Figure 2-1. The purpose of this manual is to describe the procedure for field calibration of the Honeywell assembly as used in Centac IGV control.

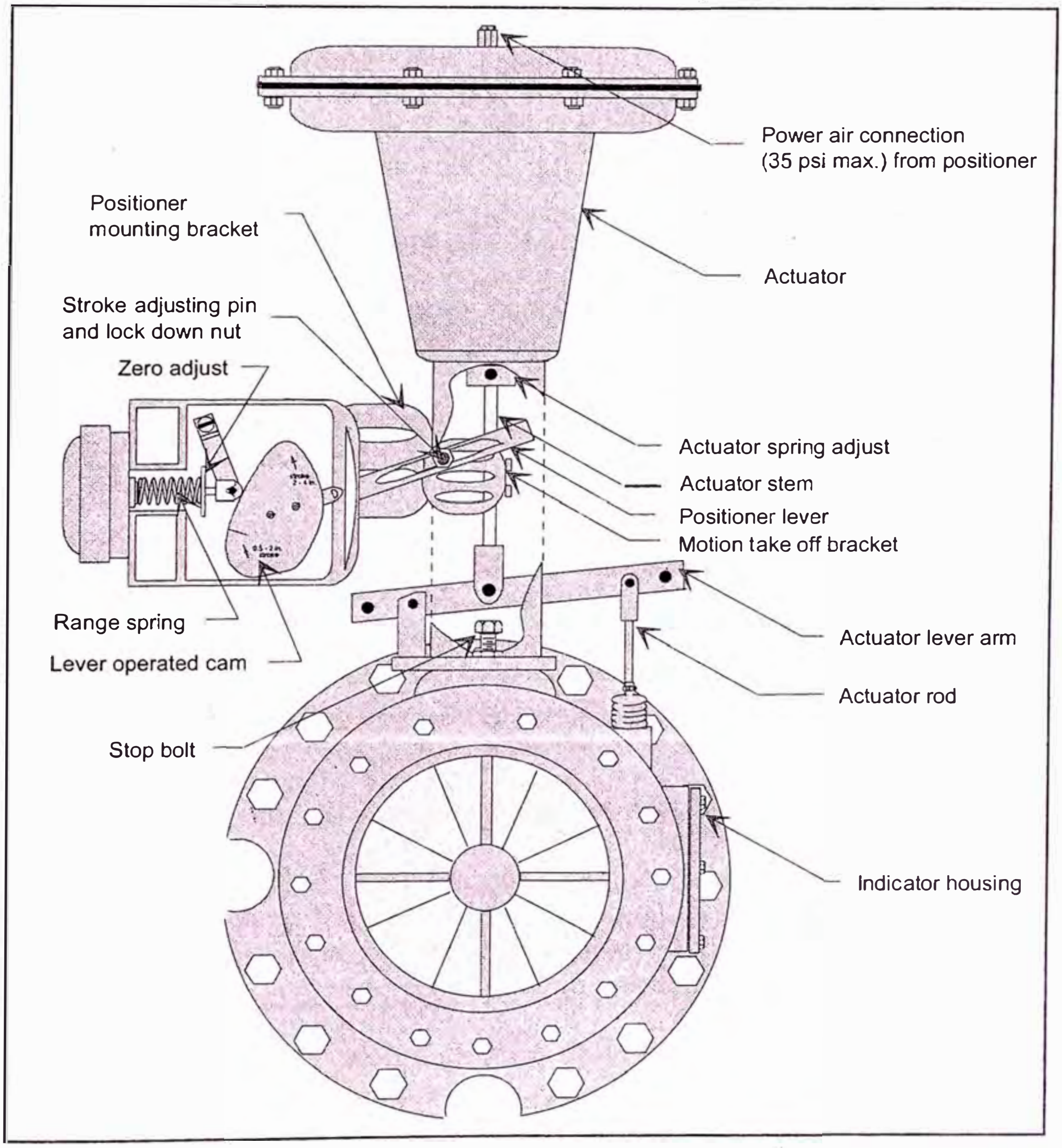

Figure 2-1. Major IGV pneumatic control components (IGV closed)

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Description of the Electro-Pneumatic IGV Positioner

The Honeywell Type 01 AIR - O - MOTOR actuator is a spring return single acting diaphragm device. The maximum air pressure permissible to the diaphragm is 35 PSIG. Pressures above 35 PSIG will rupture the diaphragm of the actuator. Normal operating pressure of the actuator is 6 to 30 PSIG. This pressure is dictated by the return spring in the actuator. An air regulator is supplied as an integral part of the actuator positioner assembly. This regulator is set at 30 PSIG to avoid over pressurization of the actuator. The actuator receives its' operating air pressure signal from the Honeywell Model 870010 positioner.

The Model 870010 positioner is significantly different than other positioners used on the Centac. The major difference is that the feed back cam is operated by a lever rather than rotary motion. The zero setting is similar to other positioners where a zero adjust wheel acts on a feed back spring that is tensioned by the movement of the feedback cam.

The feed back spring in the Honeywell Model 870010 is a critical component. This spring controls the input signal range effect on the positioner. On other positioners the number of active coils of the feedback spring control range. The Honeywell positioner does not use this method. The entire spring is used and it has no active coil adjustment. Range is fixed by the tension of the fixed spring. The positioner is used for many different ranges of input signal and there is a specific spring for each of these ranges, see Table 2-1. A WHITE coded 9-15 psi range spring is used on the IGV positioner when a standard Centac pneumatic controller is providing the control signal.

The standard Centac control air signal is 3 to 15 PSIG as sent from an AMETEK proportional controller. This single 3 to 15 PSIG output signal is fed to both the inlet and bypass valve positioners. Inlet and bypass valve control is achieved by split ranging of the valves. Split ranging is where the bypass valve is stroked 3 to ≈11 PSIG (pressure varies with conditions) with the inlet valve normally stroked 7 to 15 PSIG. Use of the Honeywell positioner provides for an exception to the normal 3 - 11, 7 - 15 split range signal condition. When a Honeywell positioner is used the inlet valve is stroked 9 to 15 PSIG (WHITE Spring). The split ranging at 9 to 15 PSIG is necessary to accommodate the range spring selection that is available. The 9 to 15 span presents no problem because at minimum throttle, at ≈ 11 psi, the IGV is controlled by the LLR and on unload the 3PR controls the valve so a range of 9 to 15 provides all the spanning needed. At the minimum throttle point the IGV ceases closure because LLR rather than the controller starts providing a fixed signal,≈ 11 psi, to it. The bypass valve continues to receive the controller output and opens from ≈ 11 psi to full open at 3 PSIG control signal. Control pressures above ≈ 11 psi have no effect on the bypass valve. The unloaded positioning of the inlet valve occurs between the IGV being fully closed at 9 psi and the minimum throttle opening at ≈ 11 psi range. Device 3-PR provides the fixed unloaded opening signal.

Table 2-1.

IGV POSITIONER FEED BACK SPRING COLOR CODE	
COLOR	**CONTROL PRESSURE**
GREEN	3 - 15 psi
BLUE	6 - 30 psi
ORANGE	3 - 9 psi
WHITE	9 - 15 psi

A GREEN coded 3-15 psi range spring is used on the IGV positioner when a Centac electronic controller (MP3) is providing the control signal via an I/P to the Honeywell positioner. The electronic controller provides a separate control signal to the bypass and inlet valves; split ranging is not done. The inlet minimum throttle and unload positions are controlled by the controller and not a separate device as is the case with LLR and 3PR in the pneumatic system.

The other range springs may also be found in use. As an example, some Centac owners use a 3 to 30 PSIG control air standard. The IGV positioner in this instance would use a BLUE, 6 to 30 psi, feedback range spring. The ORANGE spring would be used if the control signal range were 3 to 9 psi.

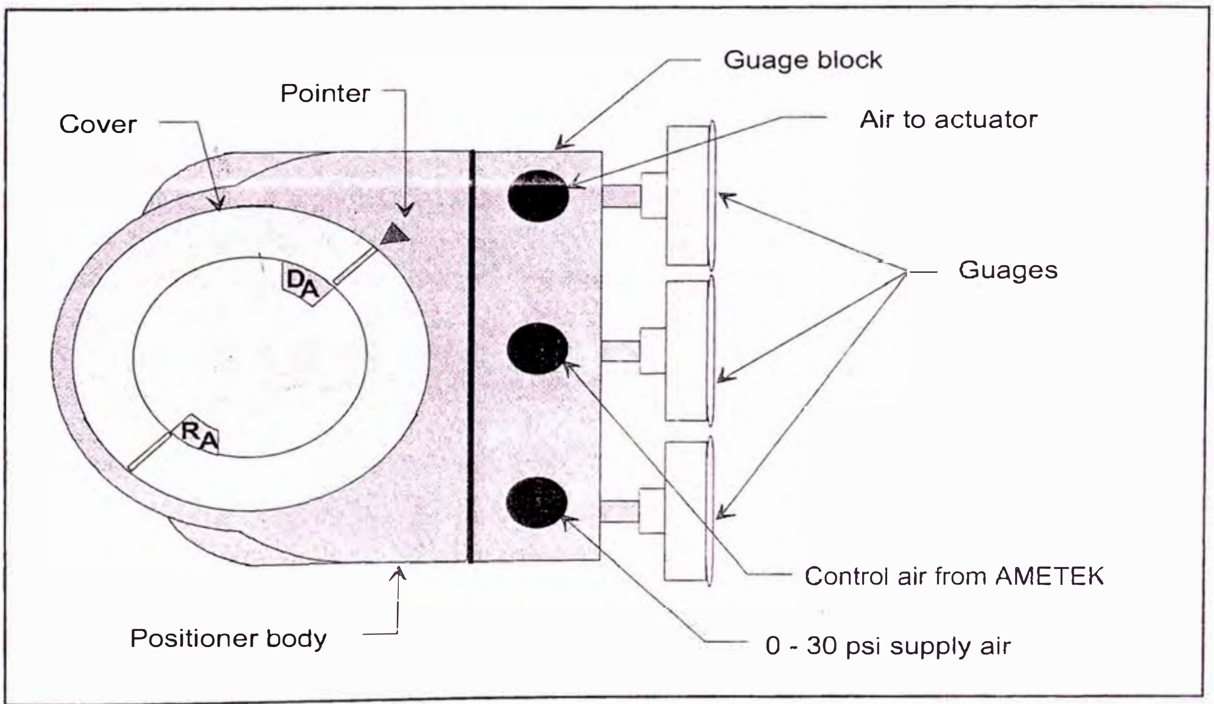

Figure 2-2. Left end view of positioner

The positioner is capable of being used as a direct or reverse acting device. In direct acting mode the output signal of the positioner increases as the input signal from the controller increases. The IGV opens with increasing signal. Direct mode of operation is indicated by the letters "DA" on the pilot assembly being aligned with the pointer on the positioner body as illustrated in Figure 2-2. Centac utilizes the direct acting mode. To change from Reverse acting to Direct acting the cover is removed and rotated 180° to align the letters "DA" with the pointer. The range spring is removed to facilitate rotation of the cover.

The positioner has three attached gauges. Reading from top to bottom while looking at the front of the positioner the gauges are, the air to the actuator, the air from the AMETEK (or other controller) and the supply air to the positioner/actuator. Figure 2-2 identifies these locations.

The actuator stroke distance varies with size of IGV. The IGV is physically smaller on the smaller frame sizes requiring a different stroke travel distance. Table 2-2 lists the stroke distances for the various frame sizes of Centac. The mid point distance given in Table 2-2 is provided for convenience. The mid point distance is used in setting up the IGV when mounting new actuator. The stroke distance will be checked and adjusted as part of the routine calibration procedure that is provided later in this manual.

Table 2-2.

IGV STROKE DISTANCE	
Centac FRAME	**TOTAL TRAVEL/MID POINT**
OC, 1C, 1ACII	5/8 INCH / 5/16 INCH
2C, 2CII	3/4 INCH / 3/8 INCH
3C, 3CII	7/8 INCH / 7/16 INCH
4C, 5CII	7/8 INCH / 7/16 INCH

The proper lever operated cam working surface must be selected for correct operation of the positioner. On Centac the cam will be mounted for stroke distances of 0.5 to 2 in. The cam stroke distance relates to the 5/8 to 7/8 inch strokes required by the IGV's on the various frame sizes. The arrow on the cam indicates direction of actuator stem motion with increasing input signal. The scribe mark on the cam is used to indicate when the cam is at mid-stroke. The cam is at the mid-stroke position when the scribe mark aligns with the center of the cam follower roller. The correct positioning of the cam, with arrow down on the 0.5 to 2 inch stroke side, is illustrated in Figure 2-1. The valve in Figure 2-1 is shown in the closed position and in Figure 2-3 the valve is shown at mid stroke.

The Electro Pneumatic Positioner Principle of Operation

Figure 2-3 corresponds to the following description of the principles of operation. The positioner is a single acting force balance type control device. It is side mounted on a pneumatic control valve. The positioner uses an auxiliary air supply and feedback cam to position the valve by means of an air signal from the controller.

An increase in input signal (from the controller) forces the pilot stem to open the supply flapper. The supply flapper admits air to the actuator forcing the actuator stem to move downward. The actuator stem movement causes the motion take off bracket to move. The positioner lever is caused to move by the stroke adjusting pin sliding in a slot of the motion take off bracket. The cam is attached to the positioner lever by way of a pivot point pin. As the actuator stem moves downward the cam is caused to move upwards. This motion of the cam is clockwise as the actuator moves downward. The moving cam causes the range spring to compress through the roller that rides along the cam working surface edge. When the range spring force equals the force being applied by the controller signal, the supply flapper will close and the actuator stem will cease motion. The IGV follows the motion of the actuator stem. When the controller signal reduces, the actuator spring force begins to close the IGV as the actuator stem moves upward. The cam movement follows the actuator stem and a new balance position is

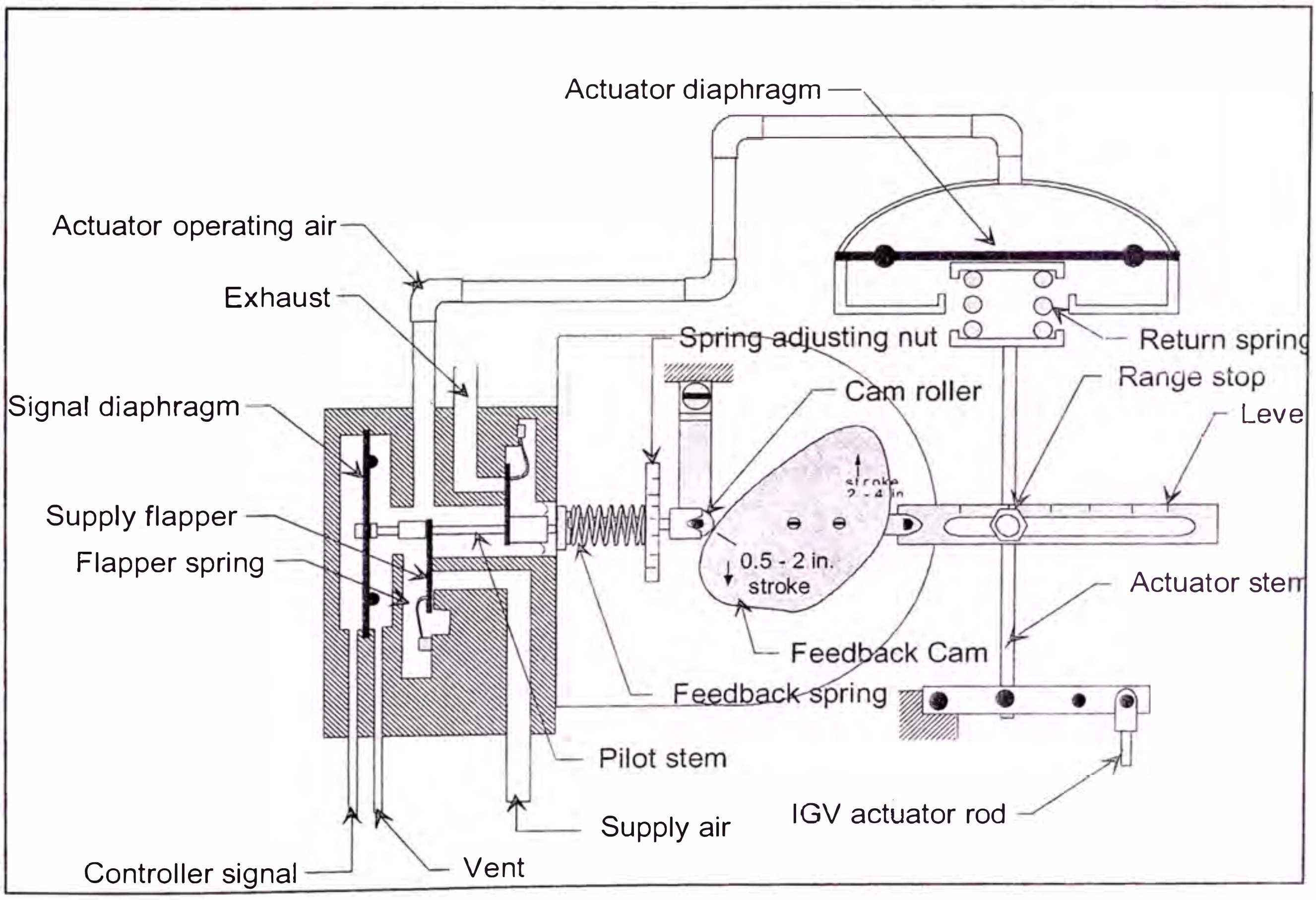

Figure 2-3. Direct acting positioner principle of operation diagram.

Overview of Procedures for Calibrating and Stroking the Inlet Guide Vane

There are three general procedures that are accomplished in calibrating the IGV. These are:

1. Mechanical setup of the IGV vane angle indicator and length of travel.
2. Establishing mid-stroke alignment of the positioner and cam
3. Adjusting the positioner zero and span.

The procedures for calibrating and stroking require that an external source of air be connected directly to the actuator through a controllable regulator. Figure 2-4 illustrates the external air connection.

Mechanical Setup of the IGV Vane Angle Indicator and Length of Travel

The end results of making the checks and calibrations in this section will have the vane indicator adjusted to indicate 0° to closed (@+88°) vane angle and the travel distance (stroke) of the actuator rod adjusted to the length specified in Table 2-2.

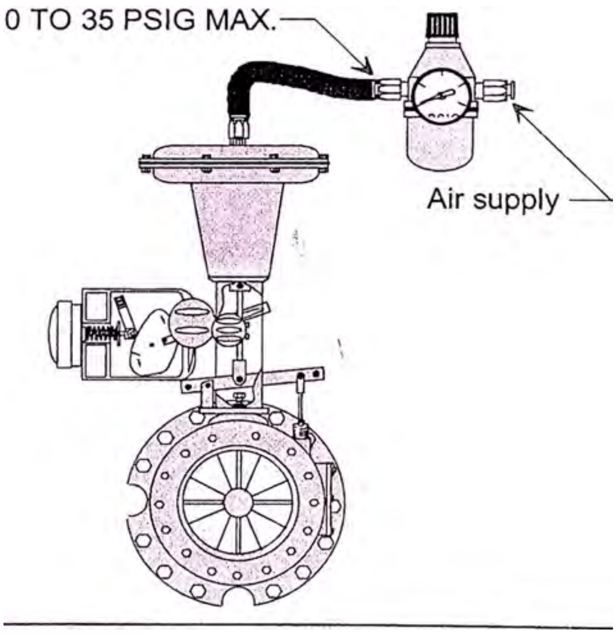

Figure 2-4. IGV calibration test set up

1. Insure zero PSIG at the actuator. The actuator spring operates to close the IGV. With no pressure on the actuator, the stem is in its' upper most position and the vanes should be touching. If the vanes do not touch, proceed as listed below.

A. Disconnect the actuator rod clevis from the actuator lever arm. Do not allow the actuator rod to fall. Rod movement downward is the open vane direction. **If the IGV vanes open in excess of -10°, jamming of the vane linkages will occur.** Disassembly of the IGV may be necessary to un-jam the vanes.

B. Extend the actuator rod until the IGV is closed (vanes touching). Adjust the actuator rod length with the rod clevis until the hole in the clevis lines up with the hole in the actuator lever arm that is nearest to directly above the actuator rod. Connect the rod clevis to the lever. The IGV is closed when the air pressure on the actuator diaphragm is zero.

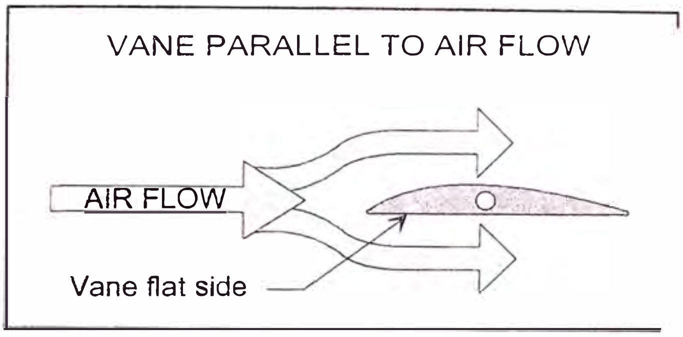

Figure 2-5. Vane parallel to air flow

2. The fully closed position of the IGV should result in an indicator scale reading of +88°. The IGV indicator pointer will be off the scale with the IGV fully closed and may be indicating any degree if it is not in calibration. The procedure below calibrates the indicator to the specified vane position.

   A. Attach an air regulator directly to the actuator as in Figure 2-4. **Do not exceed 35 psi max. on the actuator**. Slowly increase pressure to the actuator while observing the IGV vanes and the vane indicator. Continue to open the IGV vanes until the flat side of the vanes are parallel to the air flow. Figure 2-5 illustrates what a vane looks like when it is parallel to the air flow. **DO NOT EXTEND THE VANES BEYOND -10°.**

   B. While keeping the vane flat side parallel to air flow, loosen the hold down nut on the IGV indicator pointer. Adjust the pointer so that it registers +8° on the indicator scale. Tighten the pointer hold down nut.

   C. Check IGV operation and the indication adjustment made in step B. by reducing the signal to the actuator to zero. Then, slowly increase the signal pressure to the actuator until the indictor pointer reads +8°. Check vanes parallel to flow. Repeat step B if indication is not correct.

3. In this step the travel distance of the stroke will be verified and the IGV vane motion will be fixed so that there is full vane travel with the indicator accurately following the motion. At the completion of the following procedure the IGV indicator will point to 0° when the IGV is fully open and @+88° when it is fully closed. The distance traveled from IGV fully open to fully closed varies with the size of the IGV and is specified in Table 2-2.

   A. Start at step 2.C above where signal pressure is on the actuator and the indicator is at +8°. Slowly increase the signal pressure on the actuator until the indicator reads 0 °. This is the full open position of the IGV.

   B. With signal pressure on the actuator holding the IGV at 0°, adjust the stop bolt under the actuator lever arm until it touches the lever arm. This adjustment limits the travel motion of the actuator. The distance traveled can be checked by holding a piece of stiff paper, on which the specified distance has been marked off, next to the actuator stem and observing the motion as the actuator is cycled between full open and full closed.

   C. The spring in the actuator is calibrated for 6 to 30 PSIG. If stem travel (See Table 2-2) is insufficient to open the IGV when 30 PSIG is applied to the actuator, adjust the actuator spring adjuster located on the bottom of the actuator. Turn the spring adjuster with a spanner wrench or a 1/4" hardened rod. Screwing the spring adjuster out (CCW rotation) reduces actuator spring tension.

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When step 3.C is completed the IGV is mechanically adjusted. The next procedure calibrates the positioner so that when a 9 PSIG controller signal is fed to the IGV it will just start to open and when a 15 PSIG signal is provided the IGV will be fully open. If an electronic controller is used the signal pressures normally will be 3 to 15 PSIG.

Overview of Procedures for Calibrating the Positioner

The positioner zero (the input signal that causes the valve to start to move) is set by adjustment of the zero adjust nut on the range spring. The range (the input signal that causes the valve to achieve full travel) is fixed by the spring. The cam motion provides the feedback and is adjusted by the effective length of the positioner lever. The effective length of the positioner lever is adjusted by moving the stroke adjust pin. If the effective length of the lever is not correct the feedback (tensioning of the range spring) will be incorrect and calibration of the positioner within the range will be difficult if not impossible.

NOTE

The IGV must be in mechanical adjustment prior to calibrating the positioner.

The positioner is attached to the actuator assembly with a positioner mounting bracket. Slots in the mounting bracket allow the positioner to be moved. Movement of the positioner may be necessary to attain the proper effective length on the positioner lever and to prevent binding or interference of the moving parts.

A motion take off bracket is attached to the actuator stem. If necessary, it can be moved to prevent binding or interference of moving parts. The motion take off bracket is slotted. The stroke adjust pin is fixed to the positioner lever and slides in the slot to convert stem motion into positioner lever and cam motion. The motion take off bracket is adjusted to have the positioner cam align with the follower roller when at mid-stroke travel.

There are two general procedures in calibrating the Honeywell Centac IGV positioner. The first procedure is used to properly align the positioner linkages to the actuator stem. The second procedure spans the positioner for full opening and closure of the IGV.

Establishing Mid-Stroke Alignment of the Positioner and Cam

1. At the completion of this procedure the positioner will be properly aligned with the stem to accept full travel and align the positioner for completing the zero and span calibration. The externally supplied air to the actuator is used in this procedure. Set up a regulator as in Figure 2-4 with zero PSIG to the actuator.

   A. Check cam and remount it as necessary. Correct position of the cam is when the arrow stamped on the cam is pointing downward on the 0.5 - 2 in side. See Figure 6 for correct orientation of cam.

   B. Loosen the nut on the stroke adjust pin and adjust the pin so that it is centered under the correct guide number for the IGV being calibrated. The correct guide number is the distance specified in Table 2-2. (5/8, 3/4 or 7/8 inches). Tighten the stroke adjust pin nut to lock the pin to the positioner lever.

   C. Slowly increase air pressure to the actuator. Watch the indicator and stop the IGV at +40°. This is the mid point-of the valve and positioner travel. If necessary, loosen the bolts holding the motion take off bracket and align the positioner lever so that the scribe line on the cam points through the center of the cam follower roller when the lever is horizontal. Figure 2-6 illustrates the correct alignment of the lever.

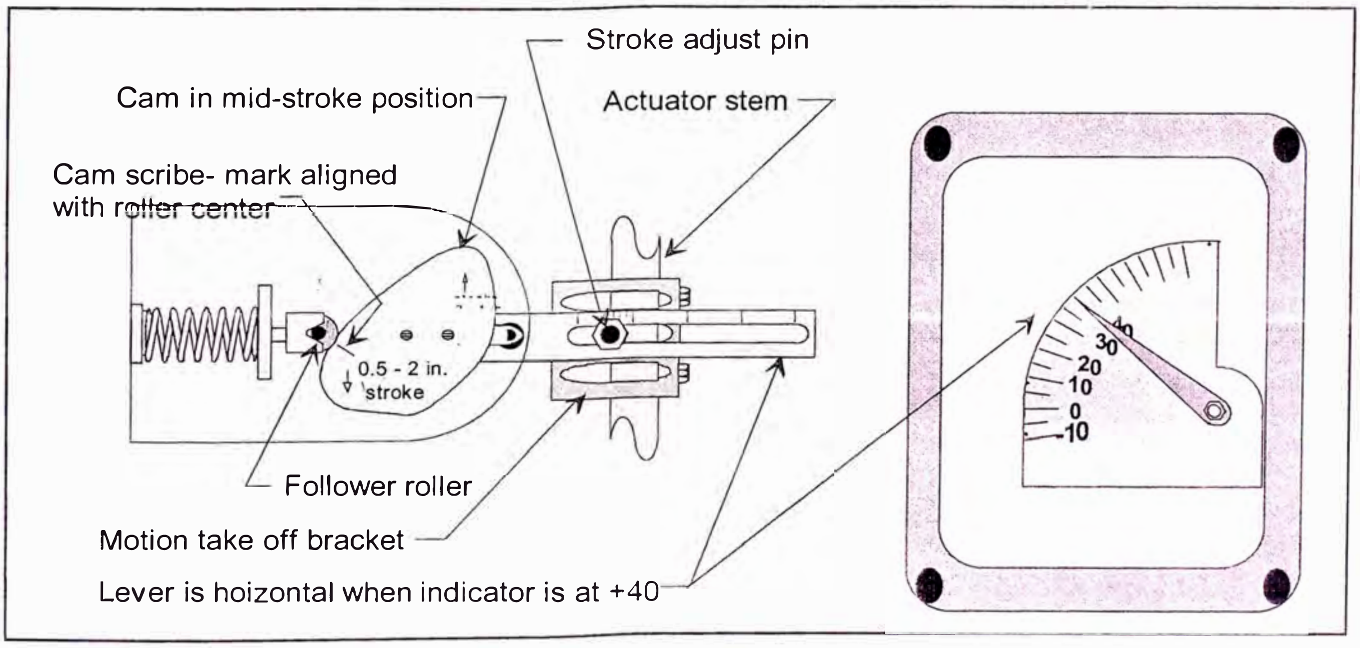

Figure 2-6. Mid-stroke alignment of Honeywell IGV positioner

   D. Operate the IGV throughout its' full travel. If there is any binding or interference of moving parts, readjust until all parts function freely. Reduce pressure to zero and remove the IGV test air source.

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Adjusting the Electro-Pneumatic Positioner Zero and Span.

1. The procedure that follows calibrates the positioner zero and span. At the completion of this procedure the IGV will be controllable between full open to full closed with signal pressures between 9 and 15 PSIG (or 3 and 15 PSIG). The controller output is the desired source of signal air in performing the zero and span calibration. If the controller signal is not available, set up a test source. Figure 2-7 illustrates one method of providing signal air. Providing 30 PSIG supply air to the positioner and variable pressure signal air is required throughout the zero and span procedure.

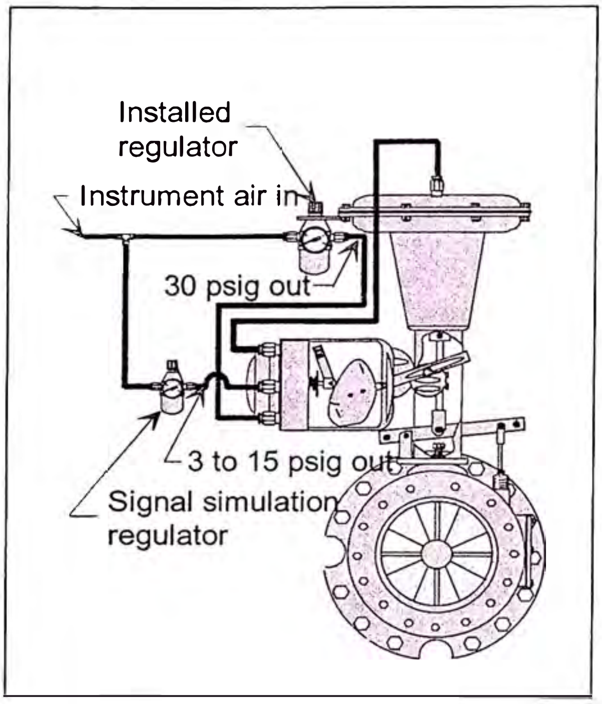

Figure 2-7. Test set up

A. Supply 9 PSIG (or 3 PSIG) to the signal air connection of the positioner. Turn zero adjust wheel (increase or decrease range spring tension as required) until IGV just starts to open.

B. Increase signal pressure slowly to 15 PSIG. The IGV should be fully open at 15 PSIG signal with indicator reading 0°. If IGV is fully open before 15 PSIG is reached the stroke adjusting pin needs to be adjusted towards the positioner. A slight change in the stroke pin position has a large change effect. If the IGV is not full open at 15 PSIG the stroke adjust needs to be moved slightly further away from the positioner. Moving the stroke pine changes the effective length of the positioner lever.

CAUTION

⚠ The stroke adjust pin can be moved only when the IGV is in the closed position with zero air to the actuator.

C. Each time the stroke pin is moved the zero needs to be checked and re-established. Alternate between moving the stroke pin and adjusting zero until the IGV is just closed at 9 PSIG (or 3 PSIG as required) and just fully open at 15 PSIG, indicator at 0°.

NOTE
When the final adjustments have been made the positioner lever markings above the stroke adjust pin may indicate a travel different than the 5/8, 3/4 or 7/8 inch travel specified for the IGV. This is a normal condition since the markings on the positioner lever are provided only as a guide.

NOTE
For some applications a different maximum vane opening degree may be specified in the instructions for a specific compressor. Air separation applications usually call for adjusting the IGV so that the indicator shows 78° (vanes actually 10° open) when the IGV is fully closed and -10° indicated when the IGV is fully open.

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Part III. Operation and Assembly of Six and Ten Inch Inlet Guide Vanes.

Procedure

1. Verify all parts against the Bill of Materials.
2. Place all bearings in the freezer for one hour.
3. Install the outer bearings by using a small brass hammer or bearing tool as shown in Figure 1 on the next page.
4. Install the inner bearing carefully. Do not cock the bearing. See Figure 2 on the next page.
5. Install the vanes with the flat side down for ease of installation as shown in Figure 3 on the next page.
6. After all the vanes are installed, turn the vane until the flat side is to the left. Start with the vane pulley cable that terminates on the install pulley. Attach with the hardware that is specified on the Bill of Material. See Figure 4 and 5 on the next page.
7. Install the idler pulley with cap screws. Place a block between the vanes during the tightening process to keep the vanes from turning as shown in Figures 6 and 7.
8. Place the cable on the starting pulley. Extend the cable 1/8 inch and clamp in place as shown in Figure 8.
9. Route the cable to the left, through the vane pulley and idler. See Figure 9.
10. Hook the cable to the starting pulley and torque the pulley nut to 100 in/lb See Figure 10.
11. Install IGV coupler to cable pulley. Use the cable tie to secure extra cable to the pulley. See Figure 11.
12. Starting with the main coupling vane, position all the vanes straight. See Figure 12.
13. Place a square edge at the tip of the vane and adjust the vane using a 9/16" wrench while turning the cable pulley. Check each vane. See Figure 13.
14. Place the cable clamps on the pulley and tighten in place as shown in Figure 14.
15. Install the shroud and tighten in place.
16. Install an actuator bracket to the actuator with the long end toward the pressure regulator. Center the plate before tightening in place. See Figure 15.
17. Verify that the vanes are closed, then install an actuator on the IGV assembly. Square up and tighten in place. See Figure 16.
18. Check the vanes again for flatness. If a correction is needed, make the adjustment with the screws on the actuator. See Figure 17.

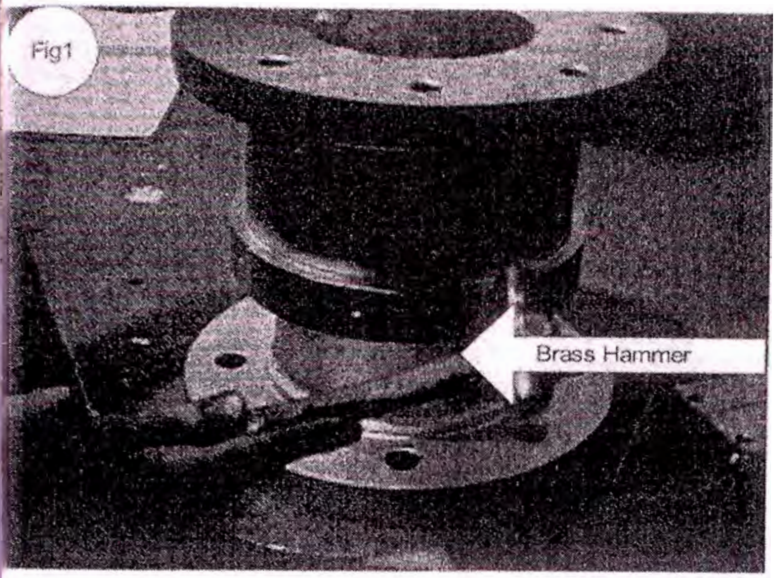


Fig1
Brass Hammer

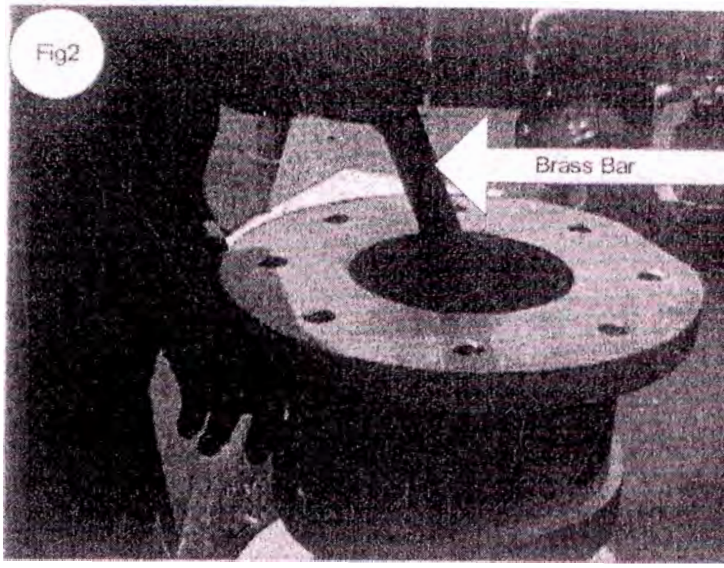


Fig2
Brass Bar

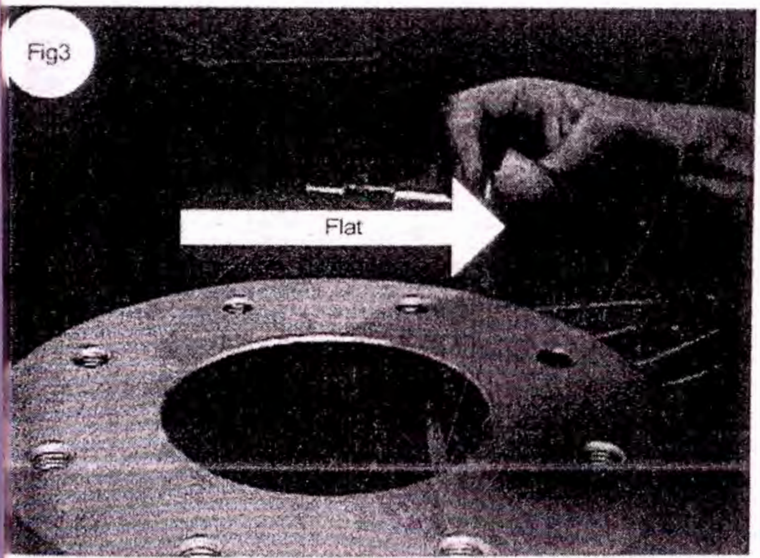


Fig3
Flat

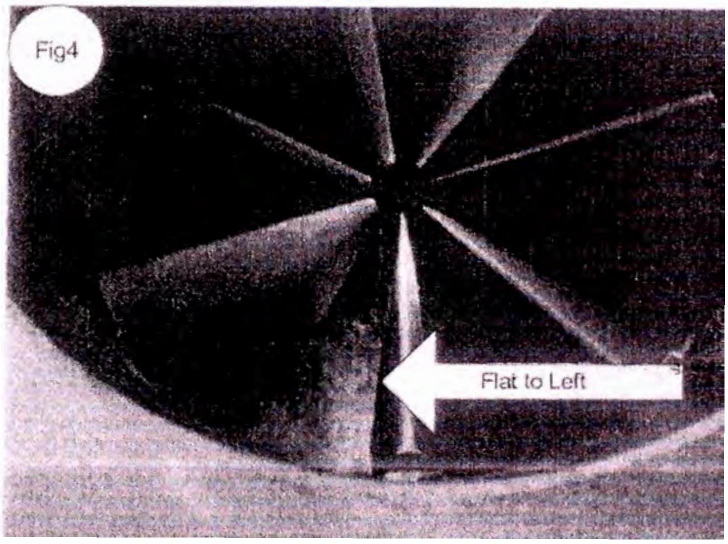
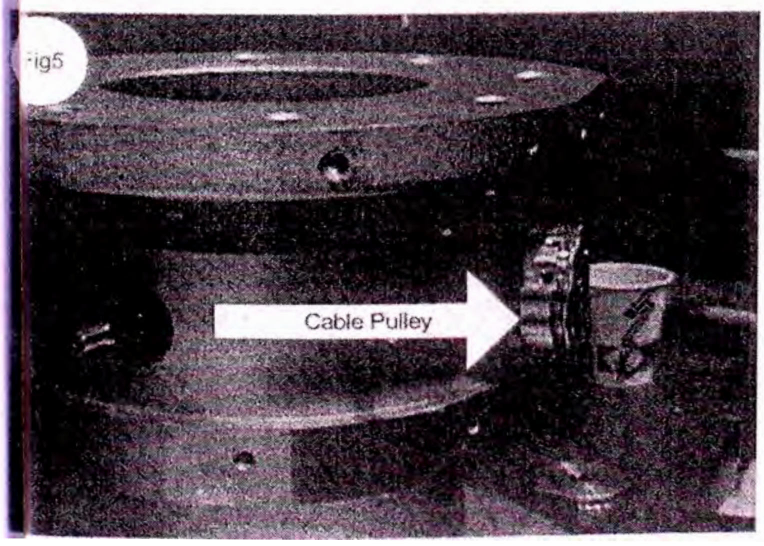


Fig4
Flat to Left


Cable Pulley

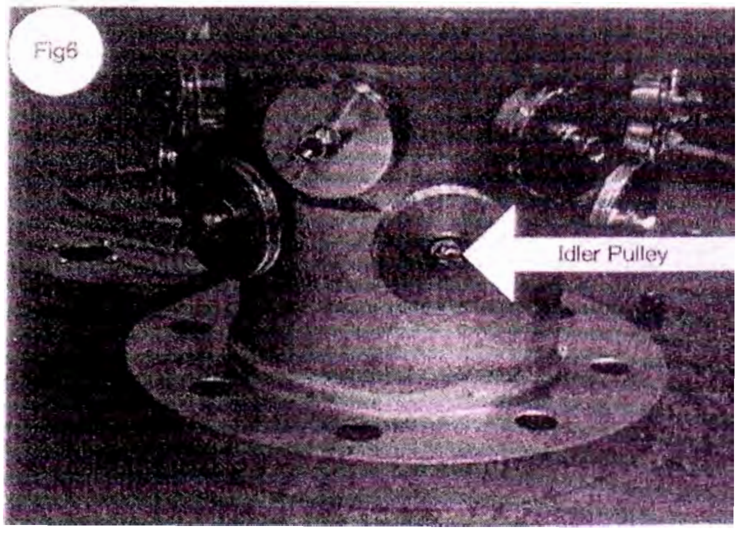
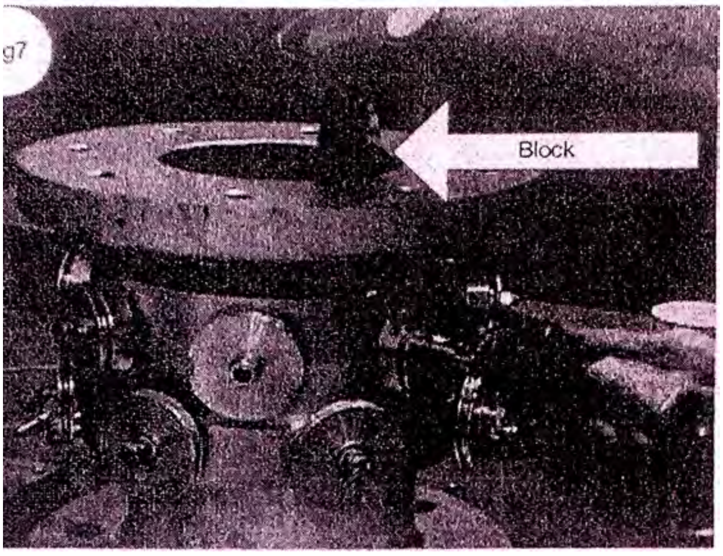


Fig6
Idler Pulley


g7
Block

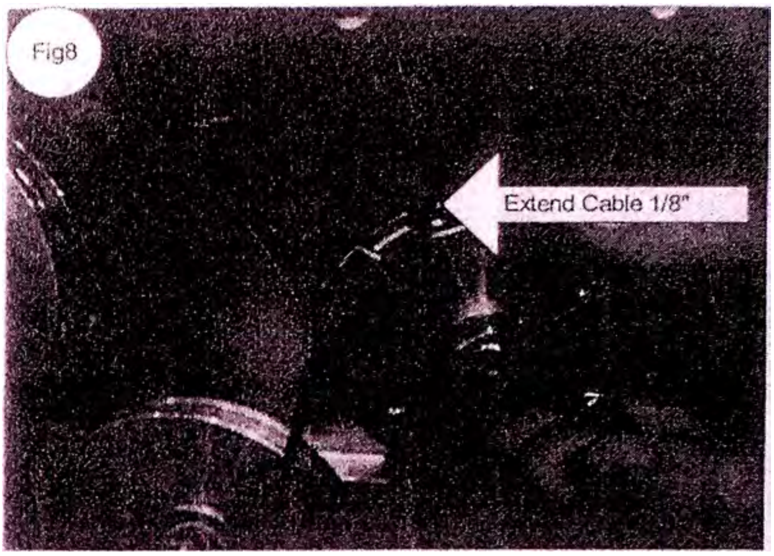
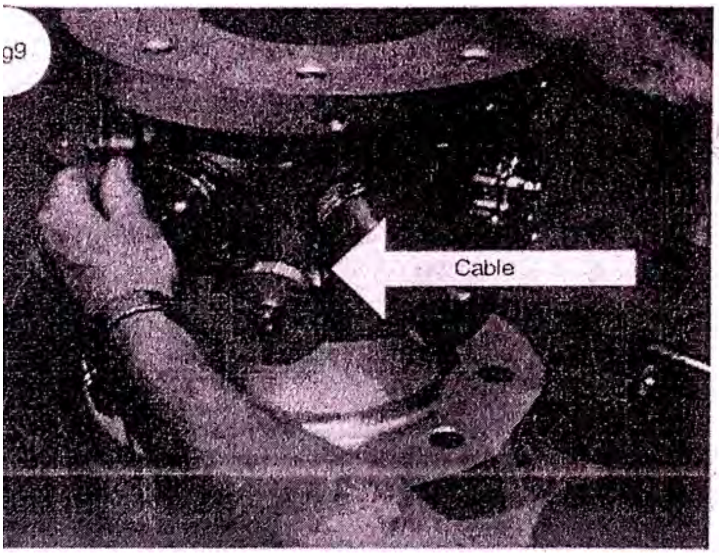


Fig8
Extend Cable 1/8"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Cable

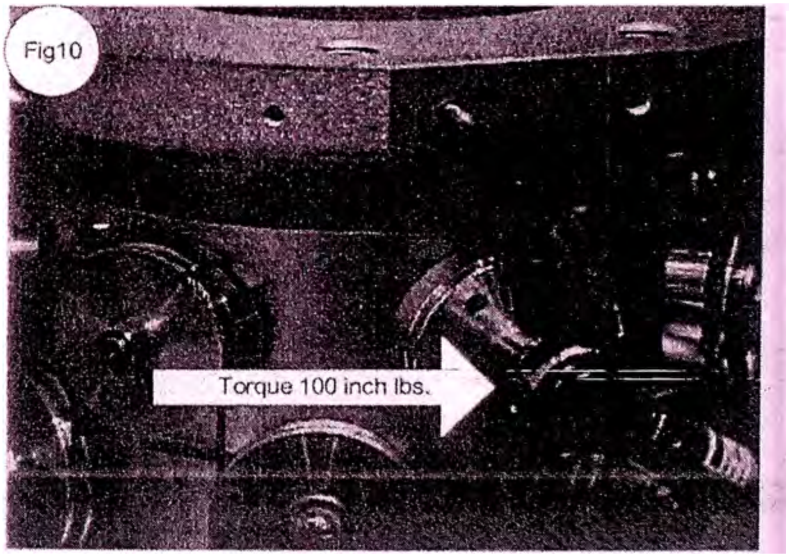
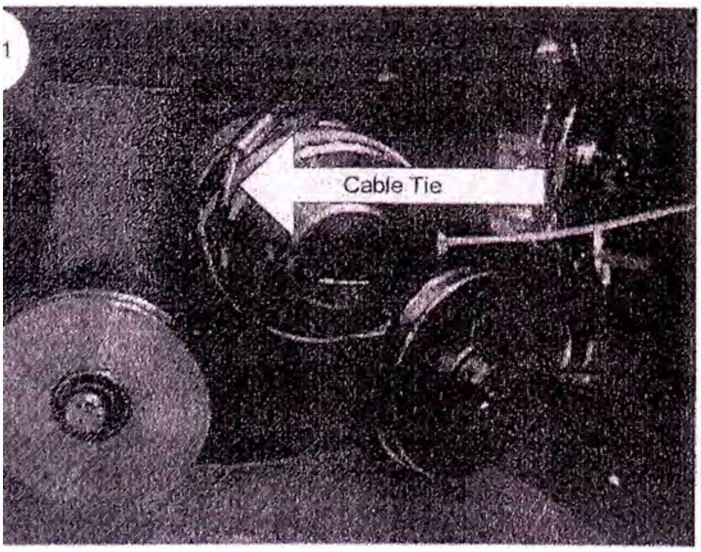


Fig10
Torque 100 inch lbs.


1
Cable Tie

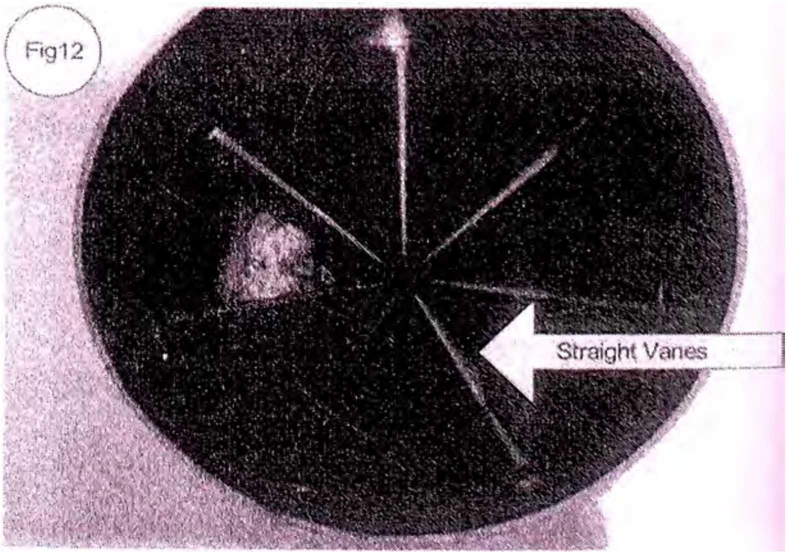
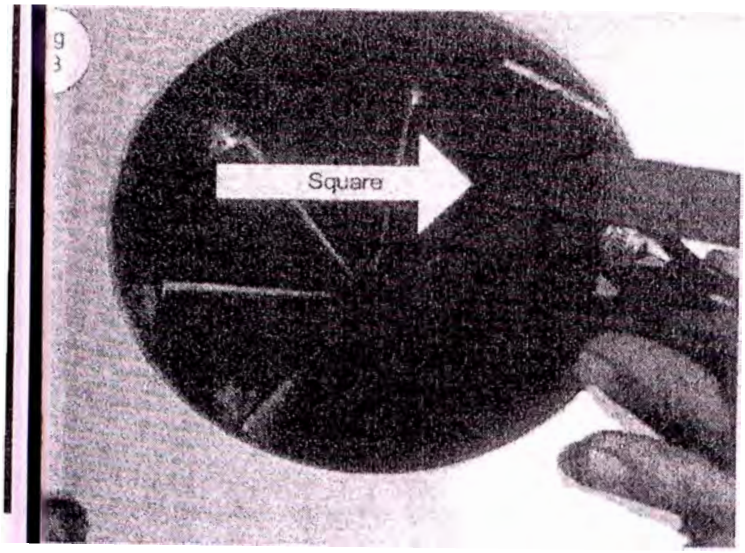
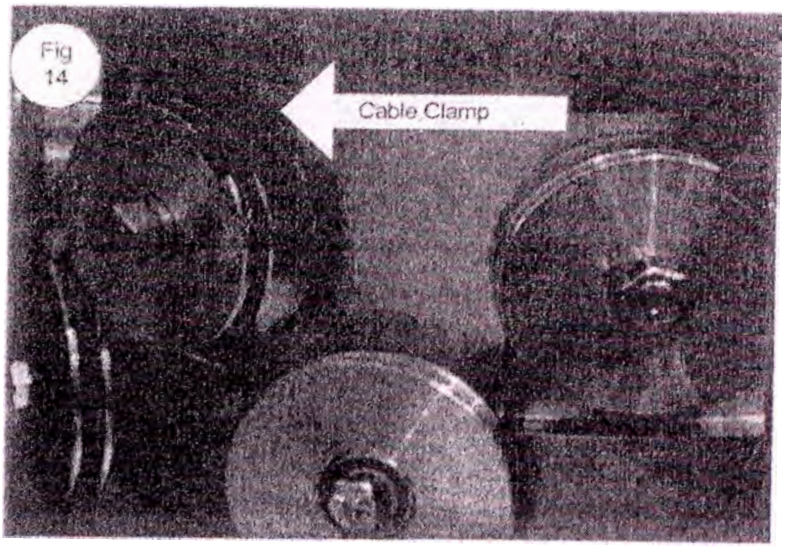
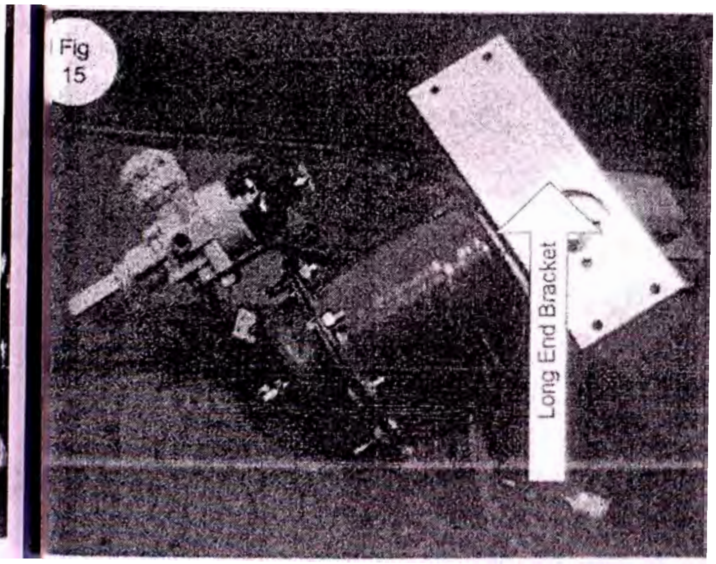
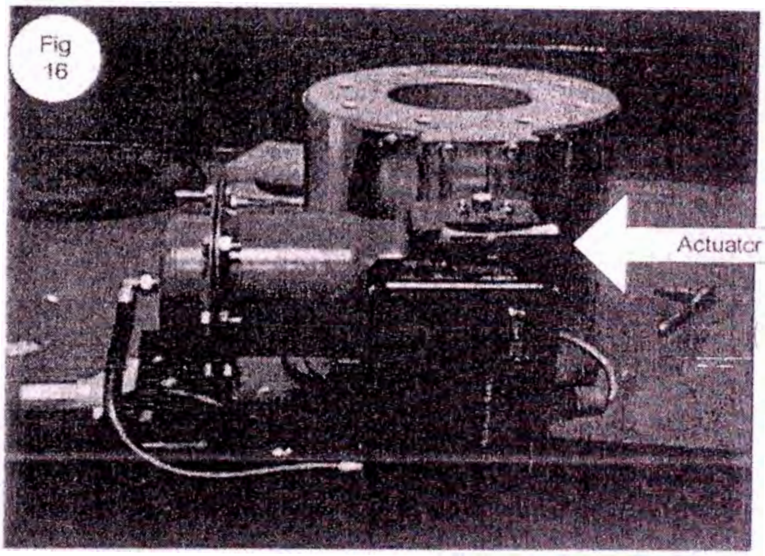


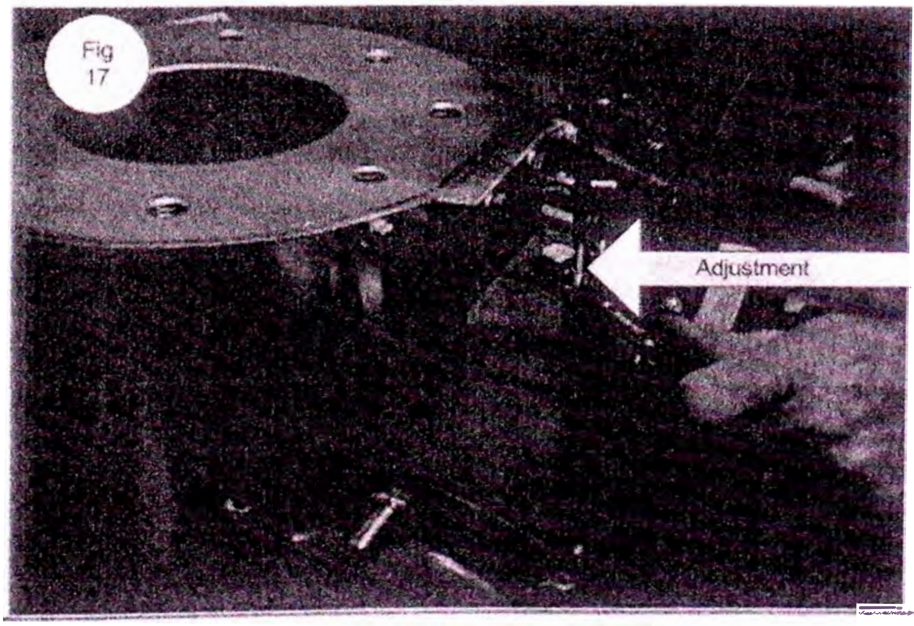
Fig12
Straight Vanes











Date of issue: 10 October, 1999 Supersedes: All previous

CENTAC®

Electropneumatic Positioner Series NE700

INGERSOLL RAND®
AIR COMPRESSORS

Valve Positioner Operating Principle

The Ingersoll-Rand valve positioner consists of a common housing that contains a 4 - 20 mA current to pressure (I/P) transducer that controls the attached pilot valve. The pilot valve feeds power air to the valve actuator. Valve motion feedback-linkages, which are necessary to provide the correct valve position feedback signal, are an integral part of the positioner. The positioner output is limited to the maximum allowable input to the actuator.

The actuator is supplied power air from the positioner that is proportional to the microcontroller 4 - 20 mA output. The actuator provides the power to drive the valve open or closed in proportion to the microprocessor output control signal.

Refer to Figure 1 in following the description of the principle of operation. Operation of the positioner is based on the balanced torque principle.

Force coil (1), which is powered by the microcontroller-4 - 20 mA output signal, is located in the field of the permanent magnet (2). The signal provided to the force coil creates a force through magnetic repulsion.

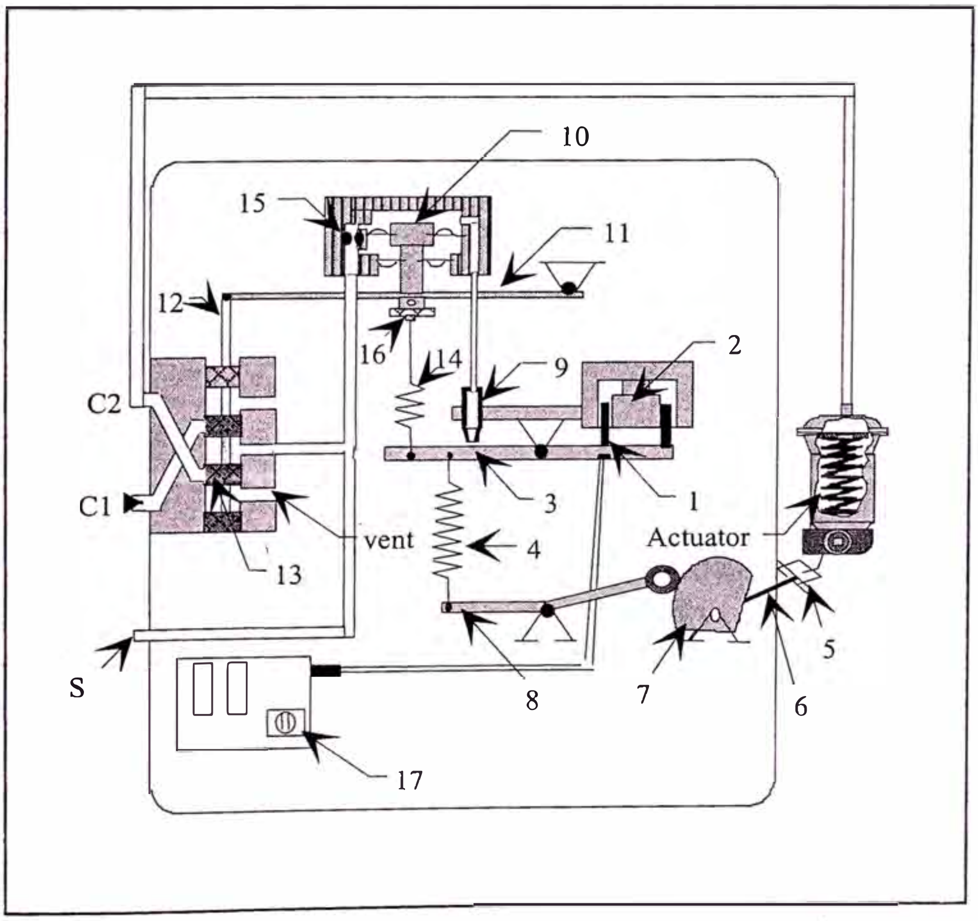


Figure 1. Positioner schematic

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A force that is proportional to the mA signal is applied to the balance beam (3) and the balance beam moves to close off the nozzle (9).

The nozzle (9) is sensitive to the position of the balance beam (3). As the signal increases, the balance beam will close off the nozzle and cause the pressure above the diaphragm piston (10) to increase. The diaphragm piston (10), beam (11), and the pilot valve spool (12) will move downward. The pilot valve assembly (12 & 13) distributes the airflow to the topside of the actuator diaphragm. When the pressure exceeds the resistance of the actuator return spring, the piston in the actuator moves down and the output shaft rotates. As the shaft turns, it imposes a counter-force on the lower end of the feedback spring (4) through the coupling (5), feedback shaft (6), cam (7), and lever (8). The forces on the balance beam (3) are now in balance.

The spring (14) causes a negative feedback between the first amplification stage nozzle (9), restriction (15), and the diaphragm piston (10) and the second amplification stage consisting of the pilot valve assembly (12 & 13) and the actuator. By changing the lower fastening point along the balance beam (3), the dynamics of the positioner can be adapted according to the actuator size. Differential diaphragms effectively compensate for the influence of supply pressure variations. Zero is adjusted with a nut (16) and the range with is adjusted with a potentiometer.

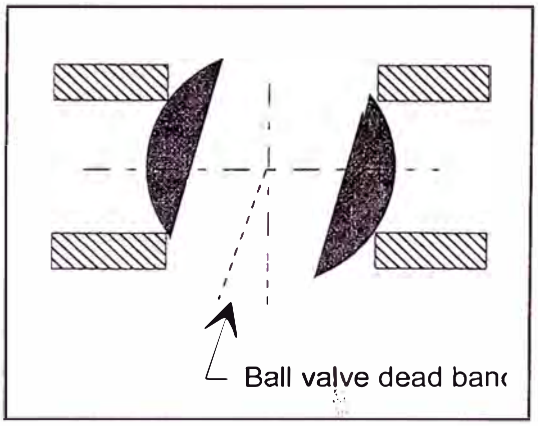

Figure 2 Dead band

The **zero adjustment** (16) is mechanical and the **span (range) adjustment** (17) is electrical.

Feedback Cam

The numbers stamped on the cam are input signal ranges expressed in percentage. For example the 0 to 100 corresponds to a 4 to 20 mA range. The other ranges are not used, for your information the 0 to 50 range refers to an input signal of 4 to 12 mA, and 50 to 100% refers to 12 to 20 mA. The 0 to 100 range is used on all standard Centac Microprocessor applications. The arrow stamping refers to the direction of turn of the valve shaft. For Centac application, the **A side is for the bypass** and the **B side is for the inlet valve**.

Figures 3 and 3A show details of the A and B sides of the cam.

Figures 4 and 4A show position of the lever arm roller for correct cam positioning. No dead band is required.

The areas on the cam between the dots are non-rising with respect to the lever arm wheel. The purpose of this area is to provide a feedback "dead band" for the first few degrees of motion of a ball valve (see Figure 2 above). The dead band is not used on standard Centac compressors.

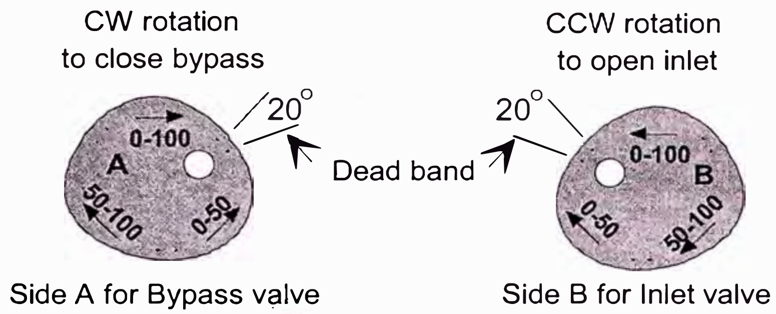

Figure 3 **Figure 3A**

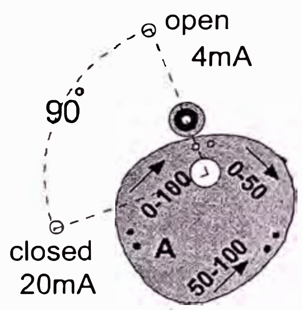

Figure 4

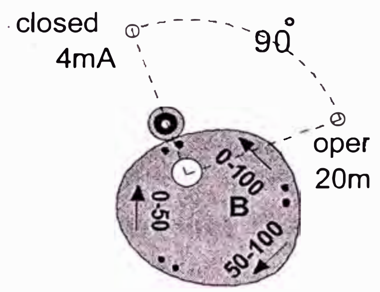

Figure 4A

The center line of the roller should align with the Zero dead band dot on the cam.

If the cam is removed for any reason, insure upon its re-installation that it is correctly seated against the land on the operating shaft. The shaft may slide towards the actuator when the cam is removed. In this event there is no positive means to know that the cam is properly seated.

To properly seat the cam, loosen the set screw on the positioner to the actuator shaft. Hold the shaft towards the positioner while tightening the cam and locking wheel.

See Figure 4 below for correct configuration of the cam on its shaft.

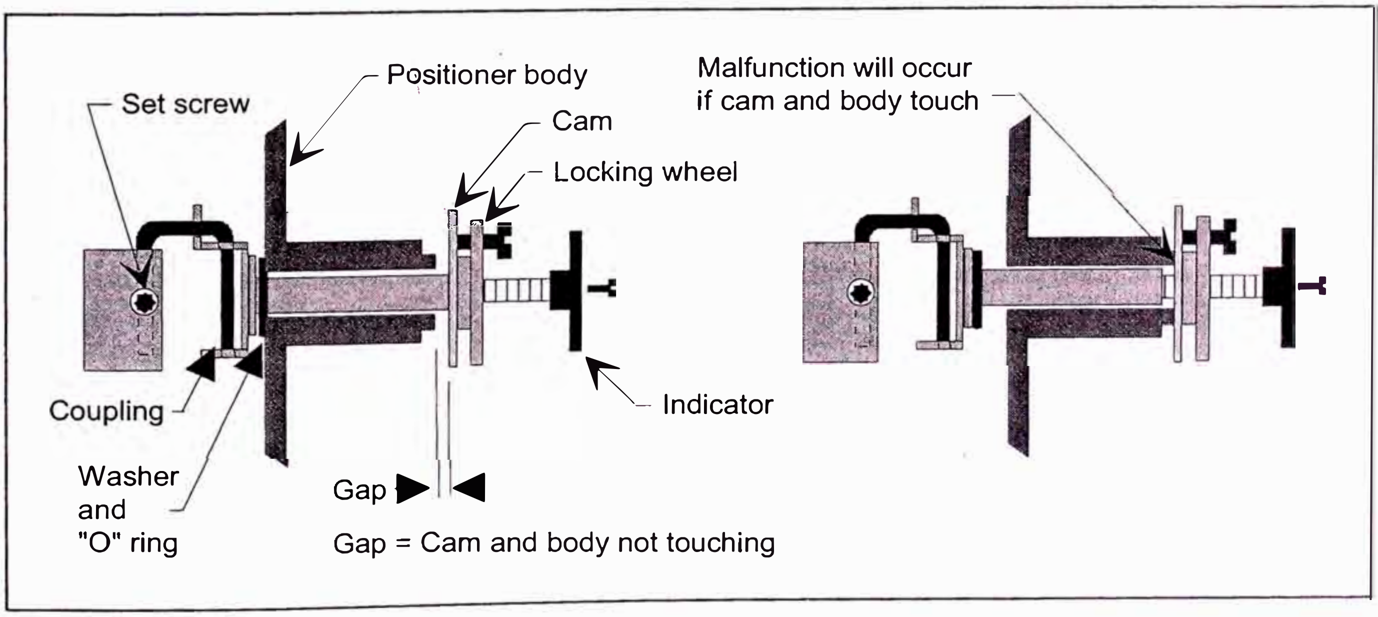

Figure 5. Correct position of cam on shaft

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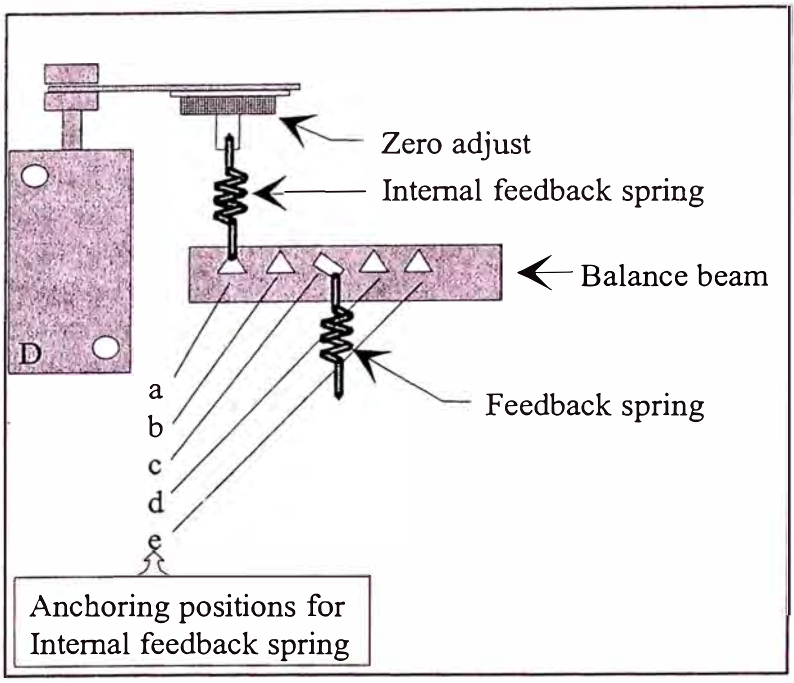

Figure 6. Feedback spring attachment

Internal Feedback Spring

The internal feedback spring is identified on Figure 1 as item (14). Figure 6 above is an expanded view of the attachment mechanism for this spring.

The internal feedback spring anchoring point (a – e) is preset for the particular size of the actuator being used.

The amplification of the positioner increases as the spring anchor is moved from position a to e.

The anchoring position of the internal feed-back spring is set when the assembly is tested. This is done under ideal conditions with specific air supply pressures, etc. Conditions in the field at customer sites may be different than the set up test conditions. The spring may need to be re-adjusted. If it is found during operation that the valve overshoots or moves too slowly, the spring can be moved in the required direction. The amplification of the positioner increases as the spring is moved from position ‘a’ to ‘e’. If a new (replacement) positioner is being installed on an existing installation, insure the internal feedback spring is anchored in the same position as on the old positioner. The internal feedback spring must be positioned before doing the zero and span adjustments to the positioner.

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Terminal Card Assembly

The terminal card assembly contains the span potentiometer, electrical filters and test points (See Diagram 1). The electrical condition of the positioner can be measured without shutting down the compressor. Remove the pin jumper (upper right hand corner or terminal card). Using the exposed terminals attach a voltmeter and ammeter as shown in Diagram 1 to the pins to perform checks. See Table 1 for indications. Insure the jumper is correctly reinstalled at completion of tests.

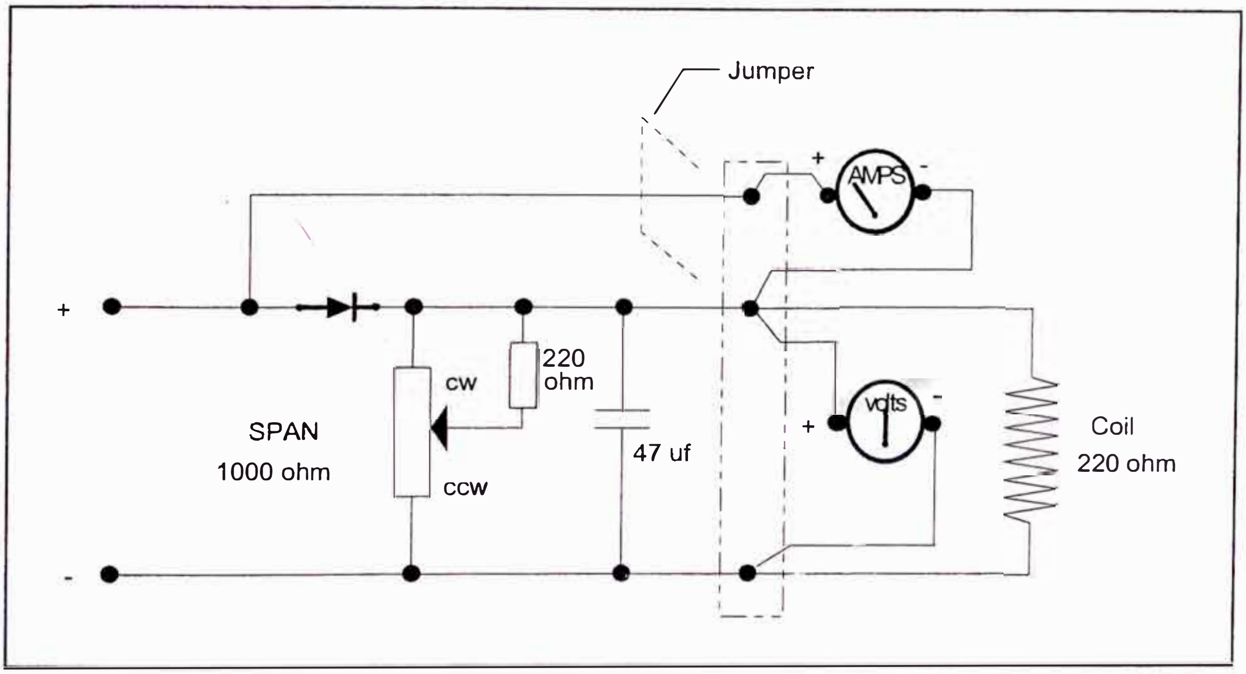

Diagram 1. Terminal card schematic

Measurement		
Volts	Amps	Possible faults
None (0)	Meter goes negative	Signal wire wrong polarity.
None (0)	None (0)	Signal wire defect Wire not connected
Greater than 4 volts	When Amps=20 mA	Coil connections or coil opened. 220 ohm shunt resistor open.
None (0)	Some amp reading	Coil or shunt resistor shorted

Table 1

Positioner Specifications:

Input signal [direct current from microcontroller]	4 to 20 mA or 0 to 20 mA
Split range capability [Not used]	4 to 12 mA and 12 to 20 mA
Input resistance	Max. 190 ohms
Turning angle of feed-back shaft	max. 90 degrees
Relationship between turning angle and signal	Linear
Supply air pressure	414 kPa (20 PSIG) minimum 620 kPa (115 PSIG) maximum
Supply air quality [Instrument air quality]	Clean, dry and oil free
Ambient temperature	-13 to 185° F (-25 to 85° C)
Construction materials:	
Case	Anodized aluminum
Cover	Poly carbonate
Internal parts	Stainless steel
Springs	Aluminum and Stainless steel
Diaphragms and seals	Nitrile rubber.
Positioner air signal output	0 to 60 PSIG (414 kPa) maximum. Proportional to 4 – 20 mA input signal between zero and span setting

NOTE

The positioner itself is capable of accepting a maximum of 793 kPa (115 PSIG) instrument air pressure. The actuator can withstand a maximum of 689 kPa (100 PSIG). The actuator is the limiting device in the air supply pressure specification for the entire Standard Valve Assembly.

CAUTION

⚠ DO NOT EXCEED 689 kPa (100 PSIG) INSTRUMENT AIR SUPPLY TO THE POSITIONER ACTUATOR ASSEMBLY.

Valve positioner exploded view and parts identification list:

1 Housing assembly

2.1 Cover assembly
2.3 Name plate
2.4 Seal
2.5 Screw
3 Protective cover
4 Screw
5 Beam assembly
6 Plate
7 Screw
8 Lower diaphragm plate
9 Middle diaphragm plate
10 Upper diaphragm plate
11 O -- ring
12 O -- ring
13 Diaphragm
14 Diaphragm
15 Screw
16 Hex nut
17 Diaphragm housing assembly
18 O -- ring
19 O -- ring
20 O -- ring
21 O -- ring
22 Diaphragm cover
23 Screw
24 Restriction assembly
25 Screw
26 Shaft assy
27 Washer
28 o -- ring
29 Cam plate
30 Locking wheel
31 Screw
32 Pointer
33 Lever arm
34 Ring
35 Terminal card assembly
36 Screw
37 Force coil nozzle
38 Screw
39 o -- ring
40 Internal feed-back spring
41 Feed-back spring
42 Spring
43 O -- ring
44 Pilot valve assembly
45 Gasket
46 Change over piece
47 O -- ring
48 Protective plate
49 Hex nut
50 Filter
51 Plug
52 Coupling
55 Gasket

57 Grub screw
58 Upper support plate
59 Gasket
61 Zero adjustment nut

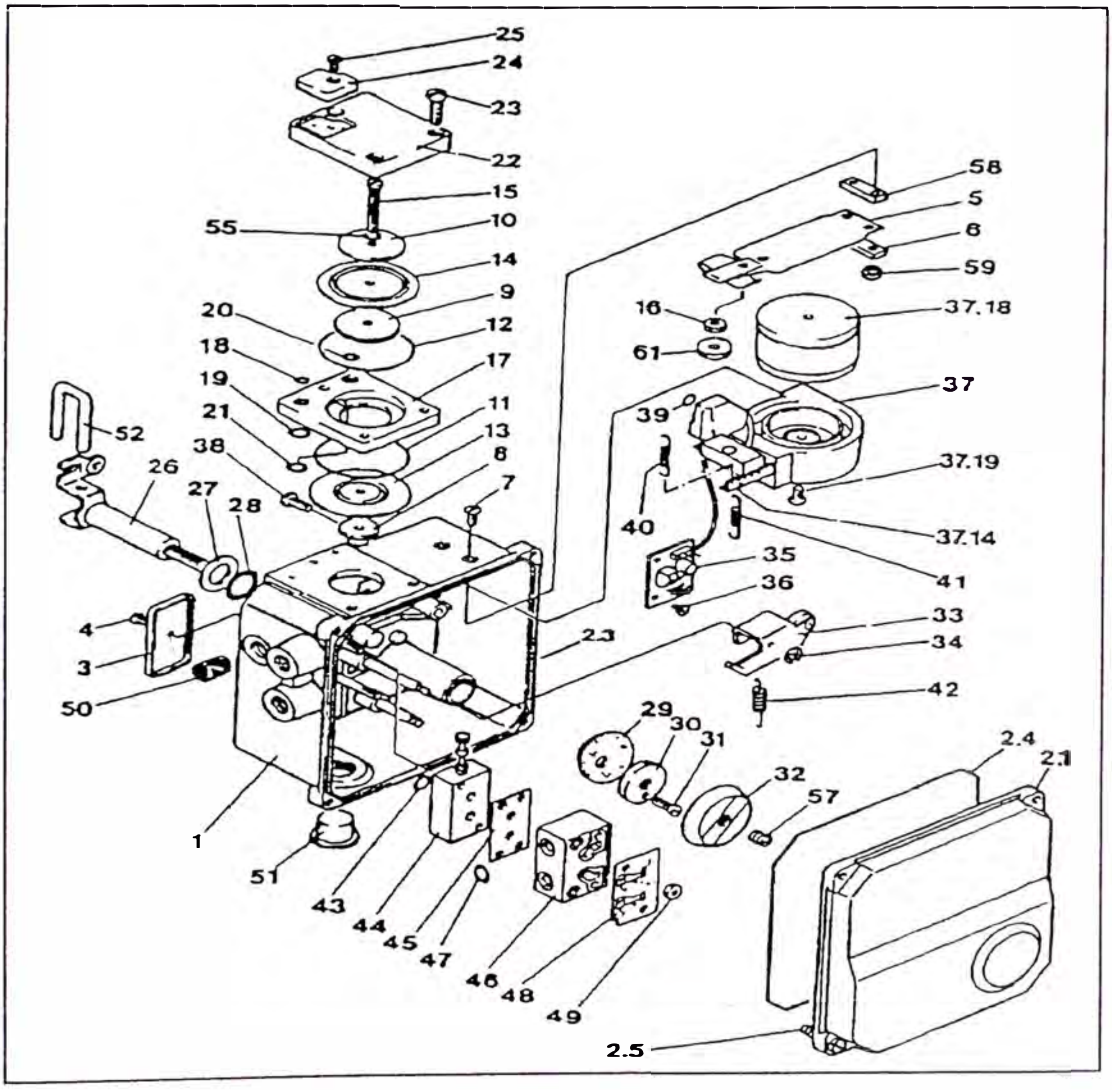

Figure 7

Date of issue: 21 January, 2000

CENTAC COMPRESSOR®

Field Storage, Long Term Storage and Inspection Procedures

INGERSOLL-RAND®

AIR COMPRESSORS

Field Storage

1.0 Purpose

The purpose of this document is to provide instructions to follow for protecting Ingersoll-Rand (I-R) Centac compressors and accessories from the corrosive effects of the environment while in **storage**. (This procedure does not apply to X-Flo Single Stage Compressors.)

2.0 Scope

The field storage procedures provided apply to Centac compressors and shipped loose parts that will be in storage for any length of time after shipment from Ingersoll-Rand. The procedures include storage instructions for compressors designed for both indoor and outdoor installations. All compressors designed for indoor installations must be stored indoors regardless of the time period that the compressor is to be in storage. Compressors designed for outside installations may be stored outdoors after Customer preparation for storage according to Ingersoll-Rand's instructions for the environmental conditions at the storage site.

The procedures explain the compressor warranties applicable to given site conditions and time delays before compressor start-up. For both standard and extended shelf life warranties, this document describes the steps that both Ingersoll-Rand and the Customer must take in order to protect the equipment and accessories being purchased.

Any equipment manufactured elsewhere and purchased through Ingersoll-Rand is subject to the storing requirements as specified by the equipment manufacturer. This applies to all motors, steam turbines, expanders, diesel or natural gas engines, starters, auxiliary equipment, and accessories purchased through Ingersoll-Rand. All necessary storage procedures for this equipment will be provided and must be adhered to for adequate protection from the environment. If the equipment manufactured by others is not started up before the equipment's shelf life period expiration, then customer must work through Ingersoll-Rand to try to place the equipment into "as shipped" condition and extend the warranty at the customer's expense.

3.0 Procedure

3.1 180-DAY STORAGE – **CONTROLLED ENVIRONMENT** CONDITIONS

This procedure refers to both U.S. domestic and U.S. export shipments. (See Definition 4.2)

The compressor, as it is shipped from the factory (flanges banked and desiccant bags placed at inlet and discharge), can be stored on a level surface in a controlled environment for up to 180 days after the ship date tagged on the compressor unit without requiring long-term storage preparation. The unit must be started within the first 180 days following shipment from Ingersoll-Rand to assure the full 12-month operational warranty after start-up.

At the termination of the storage period, the motor should be given continuity and insulation tests before connecting to a power line. Specific motor start-up instructions provided by the motor supplier must be adhered to.

Store all loose/spare parts in a controlled environment for adequate protection prior to usage.

Date of Issue: 23 November, 1999

3.2 180-DAY STORAGE – **ADVERSE ENVIRONMENT** CONDITIONS

(See Definition 4.3)

The following procedures apply to compressors which will either be stored indoors, but under adverse environment conditions, or to compressors that have been specially engineered for outdoor operation and will be stored outdoors. All of the procedures listed below may be necessary to protect the compressor from the environment, but the complete set of precautions that the Customer must follow depends on the actual site conditions. The Customer must contact the Ingersoll-Rand representative located nearest to the Customer site to obtain the complete set of precautions required to protect the compressor while in storage.

3.2.1 Ensure that desiccant bags are replaced 2 months after the unit is received at the jobsite and verify all openings to the compressor internals are tightly covered using gasketing. The desiccant bags should be placed on top of a polyethylene plastic film inside the inlet and discharge connections.

3.2.2 Place a lighted 100-watt incandescent lamp or similar heating device in the control panel to maintain a constant, above-ambient temperature and to drive off moisture, or energize the panel space heater where applicable.

3.2.3 Keep the compressor covered when storing in an area where there is exposure to an environment of dust, dirt, rain, or snow.

3.2.4 Keep all loose/spare parts boxed and stored indoors. Follow storage instructions as specified by the equipment manufacturer.

3.2.5 Remove demister and plug connection.

3.2.6 Bleed (continuous purge) dry nitrogen gas through the machine to absorb and displace moisture and eliminate the presence of oxygen.

3.2.7 Energize motor space heaters (if provided) while in storage or place a 100-watt incandescent lamp close to the air ducts.

3.2.8 Access and manually spray the compressor bullgear and pinions with compatible rust inhibitor oil. **Do Not Rotate the Machine.**

3.2.9 Prepare the compressor and accessories for long-term storage if the above procedures cannot adequately protect the machine internals for the given site conditions.

3.2.10 Consult the local Ingersoll-Rand office for the complete list of measures required to fully protect the compressor.

3.3 **LONG-TERM STORAGE** – PREPARED AT INGERSOLL-RAND'S FACTORY

(See Definition 4.4)

Centac compressors, which will not be started within a 180-day period from date of shipment, must be prepared for long-term storage (subject to an additional price adder to Customer) prior to shipment from the Ingersoll-Rand factory. Long-term storage preparation provides an additional 12-month shelf life machine protection against corrosion due to the environmental conditions. (i.e., warranty is 12 months from startup or 30 months from shipment, whichever first occurs). Long-term storage may be purchased for an extended shelf life period, subject to additional price adders. Motors are not included, unless the additional storage period has been purchased from the manufacturer and added to Ingersoll-Rand's proposal as a separate line item. The following sections describe the responsibilities of both Ingersoll-Rand Company and the Customer for preparing the machine for long-term storage.

3.3.1 INGERSOLL-RAND'S FACTORY RESPONSIBILITY

The Ingersoll-Rand factory responsibilities for long-term storage preparation before the compressor ships are as follows:

3.3.1.1. Open the Centac compressor and remove diffusers, diffuser covers, rotors, and drain traps. Plain bearings are left in-place inside the compressor.

3.3.1.2. Blow dry air through water manifolds, oil coolers, and through all intercoolers that were not removed in Step 3.3.1.1. Install desiccant bags in the cooling water manifolds.

3.3.1.3. Coat each rotor component with Tectyl 400C, a cosmoline type rust preservative, and pack securely in a carton. Label each carton with machine rotor assembly information for easy identification.

3.3.1.4. Wipe and dry all unprotected internal machined surfaces. Coat all surfaces with a rust preservative including diffuser and intercooler bores.

3.3.1.5. Thoroughly dry the intercoolers. Reinstall diffuser covers, diffusers, and intercoolers.

3.3.1.6. Distribute a number of 8-ounce Drierite desiccant bags in the inlet and discharge of the Centac compressor according to the machine frame size (See Table 1) and close the machine.

3.3.1.7. Compressor inlet and discharge air openings are sealed with gasketed steel flanges. All openings for instrument and control air connections on control panel are sealed with steel plugs.

3.3.1.8. Remove the demister and plug the connection. Coat the exposed portion of the bull gear shaft and coupling hub with cosmoline preservative.

3.3.1.9. Coat all external machined unpainted surfaces with cosmoline.

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TABLE 1: Desiccant Bag Distribution per Centac Compressor Frame Size

	Number of Eight Ounce Desiccant Bags Required (I-R Part Number 1X7481)	
FRAME SIZE	INLET	DISCHARGE
CV0/ CV1/ CV1A CH3/ CH4/ CH5/ CH6	2	2
CV2	3	3
2ACII	3	3
2CII	3	3
3CII	4	4
5CII	4	4
2C	4	4
3C	5	5
4C	5	5

3.3.2 CUSTOMER RESPONSIBILITY

3.3.2.1. Store the prepared compressor in an enclosed building at a constant temperature. Compressors that have been engineered for outdoor operation and prepared for long-term storage may be stored indoors. All loose/spare parts must be stored in an enclosed building at a constant temperature.

3.3.2.2. Install a 100-watt light bulb or a similar heating device in the control panel enclosure to keep the panel dry, or energize panel space heater where applicable.

3.3.2.3. Every 6 months, the inlet and discharge flange covers should be removed and all desiccant bags should be replaced with Drierite desiccant (W.A. Hammond Drierite desiccant, manufactured in Xenia, Ohio, USA) or equal. Immediately secure all flanges (bolt and gasket). (See Desiccant Bag Distribution Table)

3.3.2.4. Fill the sump with oil. Use only oil that meets specifications in the Planning and Installation Manual provided by Ingersoll-Rand. If the unit is to be stored for more than one year, the oil should be changed every 12 months. The condensed moisture must be removed from the top side of the oil reservoir at each 12 month interval using a dry cloth.

3.3.2.5. Adhere to storage requirements as specified by the motor manufacturer. All storage procedures attached from other suppliers must also be followed.

3.3.2.6. Immediately after the unit is received and every 3 months thereafter, the Centac compressor Frames 3C and 4C should be checked as described below.

- Remove the oil piping on the side of the bullgear casing. Blank off the center pipe feeding the plain and thrust bearings using shim stock.
- Place a red tag on the flange noting blank is inserted.
- The lube oil piping to the inboard and outboard bullgear bearings should remain in place. Fill the lube oil sump sufficiently to cover the lube oil heaters with a standard lubricating oil (refer to Prestart/Installation Manual oil specifications). Start the prelube pump. This will ensure the bullgear bearings are adequately lubricated before the bullgear is rotated by hand.
- Remove bullgear locking bolts to allow rotation of the bullgear. If oil pressure exceeds 40 PSIG, back off of the oil relief valve until the pressure drops below 40 PSIG.
- Remove the inspection covers on the side of the bullgear casing. Power spray the bullgear with standard lubricating oil (refer to Prestart/Installation Manual). Rotate the bullgear a few revolutions during the oil spraying operation to adequately cover the bullgear with oil. Replace inspection covers immediately.
- If the unit is fitted with oil heaters, turn on the oil heaters while the prelube pump is running. This will increase the effectiveness of the corrosion protection.

3.4 LONG-TERM STORAGE – PREPARED IN THE FIELD

Preparation for long-term storage at Customer's site, after shipment from Ingersoll-Rand must be supervised by the Ingersoll-Rand Service Department Representative nearest the Customer site. The Ingersoll-Rand representative must be present to supervise the preparation for long-term storage in the field, otherwise, warranty coverage will be forfeited. This service will be provided on a regular charge basis.

Customer must notify the Ingersoll-Rand Customer Service Department if a delay in start-up beyond 180 days from shipment is suspected. This notification is necessary to minimize any future expenses for the Customer resulting from necessary correction of corrosion damage prior to activating the machine warranty.

If the equipment has not been placed into long-term storage, and the date of the start up exceeds 180 days from shipment, then Customer will be responsible for the cost associated with placing the equipment into "as shipped" condition prior to start up.

Once the equipment is started, the balance of the originally purchased warranty period shall apply. (i.e., if started in month 10 from shipment, only 8 months operational warranty remain.) Extended operational warranty on the compressor air-end may be purchased. Extended operational warranty on the motors is subject to the motor vendor's price adders and discretion at the time of the request.

3.5 CENTAC COMPRESSOR REASSEMBLY AFTER LONG-TERM STORAGE

The Customer must reassemble the Centac compressor under Ingersoll-Rand supervision to qualify for remaining future warranty coverage. An Ingersoll-Rand Field Service Technician will be furnished on a regular charge basis.

Preparation for start-up at the end of the long-term storage period must be performed by the local Ingersoll-Rand Service Group to ensure the warranty provisions have been satisfied. An authorized Ingersoll-Rand Service Technician is required to supervise or actually clean protected parts and reassemble the machine. When the unit is ready for reassembly and start-up, steps that will be taken with Ingersoll-Rand supervision are as follows:

3.5.1 All loose parts shall be inspected, cleaned, or replaced as necessary and reassembled. Damaged parts will be replaced on a regular charge basis.

3.5.2 The lube system shall be flushed with clean oil bypassing the gear case. The oil will be drained, the reservoir will be cleaned and filter cartridges will be replaced before starting the unit.

3.5.3 The Service Technician will provide all instructions to the Customer pertaining to cleaning, assembly, flushing, and start-up.

3.6 PRE-INSTALLATION MEETING

One to two weeks prior to beginning preparation for installation, the Customer should request a service visit from an Ingersoll-Rand representative for an on-site pre-installation review.

The primary goal of the pre-installation meeting is to ensure that all concerned (Customers, contractors, etc.) have a clear understanding of the importance of proper installation for high reliability and reduced future maintenance costs of the compressor and to clarify any areas of uncertainty regarding the installation requirements.

Failure to fully incorporate all the specifications and recommendations for installation provided by Ingersoll-Rand will degrade the efficiency and dependability of the machine. The on-site meeting will help to determine the site readiness for the start-up and bring attention to any installation details that may have been overlooked. The meeting will also aid in preventing the need for contractor rework that could result from lack of communication.

It is highly encouraged that all specifications and recommendations for the Centac compressor installation be followed. The operating life of the machine, in large measure, depends upon proper installation.

3.7 WARRANTY

The standard operational warranty period for Centac compressor is 12 months after being placed in operation or 18 months after shipment, whichever first occurs. The addition of long-term storage will add 12 months of storage (or shelf) life to the equipment manufactured by Ingersoll-Rand. The warranty period after adding long-term storage is 12 months from start up or 30 months from the date of shipment, whichever first occurs. The number of months of storage life beyond the 12 that the Customer receives by adding long-term storage, depends upon the customer's storage needs, and is subject to an additional price adder. In addition, the extended shelf life for major accessories, such as motors and starters, may only be extended subject to approval by the manufacturer and subject to additional price adders.

Refer to Ingersoll-Rand's Form LD-102 (U.S.) and Form LD-110 (U.S. Export) for warranty coverage, which shall apply to this order. These forms outline Ingersoll-Rand's policies regarding the obligations of both the Customer and Ingersoll-Rand during the operational warranty period.

Form LD-126 entitled "Extended Warranty" outlines Ingersoll-Rand's policy regarding extended shelf life or deferred warranty.

> The Customer shall strictly adhere to any Long-term storage requirements as furnished by Ingersoll-Rand for the Customer and to secure (at the Customer's expense) the services of Ingersoll-Rand's Service Supervisor at six-month intervals after shipment of the equipment, and again prior to placing the equipment into operation, to determine that such equipment is in appropriate operating condition. The Customer shall reimburse Ingersoll-Rand for the Service Technician at the per diem rates in effect at the time such services are performed, plus travel and living expenses, and upon such terms and conditions as Ingersoll-Rand ordinarily furnishes such Service Technician.
> (See Ingersoll-Rand Form LD 146)
>
> It is also understood that any and all costs relating to the dismantling or reinstallation of the equipment, and any repairs or replacements deemed necessary to place such equipment into appropriate operating conditions shall be to the account of the Customer.

Long-term storage is an option that will not guarantee zero corrosion damage during field storage, but it will help to minimize such damage.

Failing to properly store the compressor and accessories and contracting inspections by an Ingersoll-Rand service supervisor as required, may jeopardize the performance as well as the warranty of the machine. It is the Customer's responsibility to hire the services of an Ingersoll-Rand service representative to restore the unit to an "as shipped" condition, at the Customer's expense, before start-up of the compressor.

Once the equipment is started, the balance of the originally purchased warranty period shall apply (i.e. if started in month 10 from shipment, only 8 months operational warranty remain). Extended operational warranty on the compressor air-end may be purchased. Extended operational warranty on the motors is subject to the motor manufacturer's price adders and discretion at the time of the request.

4.0 Definitions

4.1 A compressor is considered to be in **storage** for any of the following instances:

4.1.1 The equipment has been delivered to the jobsite and is awaiting installation.

4.1.2 The equipment has been installed, but operation is delayed pending completion of plant construction.

4.1.3 There are long periods (30 days or more) between operating cycles.

4.1.4 The plant (or department) is shutdown.

4.2 Storage in a **controlled environment** means storage in an enclosed building at a constant and uniform temperature with relatively clean air free of chemical fumes. To avoid the formation of condensate and, ultimately, corrosion, the ambient temperature must be maintained at least 10 degrees Fahrenheit above the dew point temperature and the relative humidity must not exceed 50%.

4.3 Storage in an **adverse environment** is one in which the temperature, humidity, and/or air quality of the enclosed building is uncontrolled. Any environment that does not meet the requirements above (4.2) is an uncontrolled climate. This storage option includes all compressors designed for outdoor operation.

4.4 **Long-term storage** procedures apply to any Centac compressor that will not be started within a 180-day period from date of shipment. All compressors that will not meet the required start-up date after shipment must be prepared for long-term storage (at an additional cost) in order to provide additional machine protection.

Centac Compressor Inspection Procedure

Centac compressors that leave Mayfield are prepared for a standard 180-day storage period unless otherwise specified by the order. At times, a Centac compressor will go over the 180-day storage period due to unforeseen circumstances. If this happens, the machine must be inspected. The following procedure is a guideline for inspection. It does not supercede the Centac Long-term Storage Procedure.

The purpose of the inspection is to insure the machine is in "as shipped" condition when started. The following steps will cover inspecting the unit in most instances. The Ingersoll-Rand Technical Representative performing the start-up should insure the Customer performs the following steps. If the Customer does not agree to the procedure, a release of liability must be obtained.

NOTE
Adverse conditions and controlled environment are defined in the attached Centac compressor LTS instructions.

Standard Inspection

(Minimum requirement for controlled environment units exceeding 180-day storage.)

WARNING

Observe all standard electrical and pneumatic safety precautions.

1. Open the inlet valve and inspect the first stage inlet bore and impeller for corrosion. In most instances, this will serve as an indicator as to the condition of the other stages. Remove desiccant from inlet and bypass valves areas.

   Remove each stage vibration probe and seal air tube. Using a maglite or other suitable light source, look into the cavities and inspect the seal and the pinion for corrosion. Also inspect the seal air tubes.

NOTE

If removing the probe or seal air tubes is not adequate for inspection, remove casing plugs as required to complete the inspection.

2. Remove a minimum of one thrust bearing. Inspect the bearing, thrust collar, and pinion. Rotate the bullgear one full turn (360^{o}) and inspect. Inspect unprotected surfaces in the casing.

WARNING

Do not exceed one rotation and do not turn machine backwards.

3. Inspect the motor and check insulation (megger) per the motor manufacturer's guidelines outlined in the motor instruction manual. (If in doubt, contact the motor manufacturer.)
4. If no signs of corrosion are found, reinstall the removed parts and proceed with normal start-up procedures.
5. If corrosion is found in any of these areas, total inspection is required as defined in the total inspection section.

Adverse Conditions – When storage on a compressor exceeds 180 days then do a standard inspection; if corrosion is found, proceed with a total inspection.

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Total Inspection

1. Remove all electrical connections, as well as associated air and water piping.
2. On Centac I models, split the casing and remove the coolers as applicable. On Centac II models, remove the cooler barrels.
3. Remove the diffusers, rotor assemblies, and thrust bearings. Inspect them for corrosion. Clean or replace as required to bring them to “as shipped” condition.
4. Inspect the thrust and plain bearings for corrosion. Inspect the seals at this time. If corrosion is found, remove the plain bearings and seals for clean up or replacement.
5. Inspect bullgear for corrosion. If severe corrosion (i.e. pitting) is found, clean or replace as required. (Inspect bullgear bearings and main oil pump at this time.) Clean casing as necessary.
6. Inspect the motor and check insulation (megger) per the motor manufacturer’s guidelines in the motor instruction manual. (If in doubt, contact the motor manufacturer.)
7. When the Service Technician is satisfied with the condition of the parts and the linebore, reassemble the unit and proceed with normal start-up.

Centac Compressor Warranty Responsibility Policy

1. The Customer has the ultimate responsibility to ensure that the 180-day inspection is performed and will be responsible for the cost of inspection by an Ingersoll-Rand Representative. Failure to inspect the compressor if it has gone beyond the 180-days could void the warranty. If an inspection is not preformed, any damage to the unit at start-up due to improper storage will result in the cost being born by the Customer.
2. If the Branch, Air Center, or Distributor is informed that a substantial delay beyond 180-days will occur, the unit should be prepared for long-term storage, or extended storage per the Centac compressor Field Storage and Inspection Procedure. The cost of this will be the responsibility of the Customer.
3. Most Centac air compressors are shipped with a standard 12/18 warranty (18 months from the day of shipment, 12 months from the date of start-up, whichever first occurs). The 12-month warranty requires the unit to be started within the 180-day (6-month) period. If the unit goes past the 180-day period, the actual warranty is lessened by that amount. Example: Unit is shipped with the standard 12/18 warranty. It sits for 240-days (8 months), is inspected, and then started. Operational warranty is now only 10 months because the unit went past the 180-day period. The warranty terms can be found by checking the order pages or by contacting the Centac Compressor Division.

NOTE
An inspection by a certified Ingersoll-Rand Technical Representative is still required in these situations.

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4. For the air end to have a 12-month operational warranty if it goes beyond the standard 12/18 period, the following guidelines apply.

NOTE

This also applies to units which are shipped in long-term storage and have extended shipping warranties (i.e. 12/24) and go beyond that period.

A. The Customer must pay for an inspection to put the unit in “as shipped” condition. This money will be paid to the local I-R service entity responsible for the compressor.

B. For machines that are not started prior to the shelf life purchased, the equipment must be inspected, placed into “as shipped” condition, and re-warranted, all at the Customer’s expense.

C. For the motor to have a full 12 month warranty, the motor manufacturer must be contacted to inspect and warranty the motor. The expense of such inspection and operational warranty extension will be the responsibility of the Customer.

Date of Issue: 23 November, 1999

CENTAC® Routine Maintenance & Troubleshooting Guide
INGERSOLL-RAND® Air Compressors

ROUTINE START/STOP

WARNING

The unit must not be operated unless the coupling guard is in place. Failure to observe this warning could result in personal injury to operating personnel.

CAUTION

Never attempt to restart until the compressor has completely come to rest.

Prior to starting, the operator should become familiar with the operation of the main driver. Refer to the driver manufacturer's instructions in the Operation Manual. The operator should also be familiar with all the accessory and optional equipment contained on the unit.

Personnel who are unfamiliar with the compressor package should not start, operate, or tamper with the equipment. Only fully trained personnel should be allowed to start and operate this compressor. The following procedure is a guideline for the fully trained operator.

Starting

1. Turn on the cooling fluid to the oil cooler(s), air cooler(s), and any optional heat exchanger. Vent the air coolers if not continuously vented.
2. Open the valve in the instrument air line to the control panel.
3. Check the seal air pressure gauge. The seal air pressure must be between 7-8 PSIG. Adjust the seal air regulator if necessary.
4. Check the main driver and compressor oil level.
5. Turn on the electrical power to the control panel. The prelube pump should start.
6. Check the oil pressure to the compressor casing. This should be 20 PSIG (nominal).
7. Check the oil temperature. This should be 95° F (nominal).
8. Check to see that the inlet valve is closed and the bypass valve is open.
9. Open the isolation block valve in the discharge air line.
10. Drain residual condensate from the compressor casing by opening each condensate trap bypass valve.
11. Drain any condensate from the air inlet piping drip leg.
12. Check the discharge pressure set point. Adjust if necessary.
13. Press the start button on the control panel.
    a. Oil pressure should increase to 25-30 PSIG at 110-115° F.
    b. The prelube pump should automatically shut off.
    c. If the compressor was started in "unload" mode, it will continue to operate in this mode until another control mode is selected.
    d. If the compressor was started in an operating mode other than "unload", the discharge pressure will increase to the discharge pressure setpoint after the starting time has expired.
14. Observe the oil pressure to the unit. If pressure is not within the recommended operating range, adjust the oil pressure-sensing valve at the sump return.
15. Observe vibration levels. If excessive vibration levels exist, the unit will automatically shut down.

16. Observe the supply oil temperature to the compressor casing. The oil temperature should be between 105-115° F with a water supply temperature of 95°F or less.
17. Observe the air cooler water flow rates. Generally water flow should maintain a 25°F water temperature rise across the cooler. At this setting, the air temperature leaving the cooler, with a full load, should be no more than 20°F of the inlet water temperature.

The Centac Compressor is automatic in operation and contains the following minimum protective devices:

- Low oil pressure shutdown.
- Oil temperature (high and low) shutdown.
- High air temperature shutdown.
- High pinion shaft vibration shutdown.
- Surge alarm.

Refer to the electrical and pneumatic schematics, and Controls section of the Operation Manual for any additional protective devices.

Stopping

Refer to the main driver manufacturer's instruction manual for any special instructions when stopping the main driver.

Simply pushing the "Compressor Stop" pushbutton will stop any Centac compressor. Refer to the electrical schematic and the Controls section for stopping units with special options.

Unload the compressor before it is shut down. This is the recommended method to allow the operating temperature to stabilize.

The prelube oil pump will start immediately when the compressor shuts down. The prelube pump should be permitted to operate 20 to 30 minutes after the compressor has stopped. Then the power to the control panel may be turned off, stopping the prelube pump. Some units may have optional equipment that automatically stops the prelube pump. Refer to the electrical schematic and the Controls section for details on the operation of the optional equipment. Post shutdown lubrication is required to allow internal heat to be carried away by the circulating oil.

Cooling fluid should also be permitted to flow about 20 to 30 minutes after the compressor has stopped. Some units may have optional equipment, which automatically stops the flow. This procedure is recommended to allow for controlled cool down of the compressor.

On turbine units, use precaution against overspeed. A sudden reduction in load on a turbine could, under certain conditions, cause a quick increase in speed to which the governor may not respond promptly. Governor "hang-up" can be caused by long periods of running at a fixed speed, which may allow contaminants in the steam to form deposits and buildup around normally movable parts, causing them to stick or bind.

To insure that the governor is fully operative, prior to unloading the Centac compressor, it is advisable to vary the pressure controller seting while observing the motion of the governor linkage and steam valve stem. Free movement of these items is an indication of normal governor performance.

MAINTENANCE

Maintenance Schedule

Then Centac compressor does not require constant attendance. However, a few items should be checked periodically. Scheduled preventive maintenance and inspection is essential for continued optimum performance and long service life of the compressor. The following are general requirements and schedules for inspection and preventive maintenance. Since unusual service conditions and environment affect equipment reliability, these items and schedules should be adjusted in time and content as necessary to suit your specific requirements.

Daily and Each Start-Up

1. Check and record instrument air pressure.
2. Check the compressor reservoir oil level.
3. Check and record the oil temperature to the compressor.
4. Check and record the compressor oil supply pressure.
5. Check the main driver oil level. (Does not apply to a driver with anti-friction bearings.) Refer to driver manufacturer's instructions contained in the Operation Manual.
6. Check the vibration level on each stage of the compressor.
7. Check and record all interstage pressures (if available).
8. Check and record all interstage temperatures.
9. Check and record the inlet air temperature.
10. Inspect for tubing/fitting leakage.
11. Check and record the air cooler water temperature, both to and from the coolers.
12. Check and blow down the condensate traps.
13. Check and record the inlet air filter differential pressure.
14. Check to make sure the air coolers are continuously venting. Vent valves are located on top of the casing.
15. Drain the condensate from the inlet air line drip leg. Do not open the valve with the compressor operating.
16. Drain the condensate from the discharge header drip leg.
17. Drain the condensate from the bypass air line drip leg.
18. Drain the drip legs on any other horizontal run of air piping.
19. Check for oil leaks. Correct as necessary.
20. Inspect for gasket/O-ring leakage.
21. Check for water leaks. Correct as necessary.
22. Open the control air line drip leg valve to remove any moisture that may have collected.
23. Check the instrument air line filter. Drain any moisture, which may have collected.
24. Check and record the oil filter differential pressure. Replace the filter element as necessary.

Quarterly Maintenance

1. Inspect instrument air filter.
   - Drain and clean the filter.
   - Replace the element.
2. Drain control air drip leg.
3. Inspect condensate traps.
   - Remove and clean. Replace parts as necessary.
   - Replace trap if necessary.
4. Grease motor bearings.
   - Use correct type and amount of grease.

- Use hand-pump grease gun only.
- Bearings should be greased with the motor stopped.

5. Visually inspect the inlet air filter.
   - Clean element.
   - Replace element as necessary.
   - Inspect seams of the filter for cracks for potential bypassing. Seal seams as needed.
6. Change oil mist arrestor element.
   - Add oil to U-tube.
   - Clean element housing.
   - Inspect old element for over-crushing. Add restricting nuts to prevent over-crushing.
   - Eliminate lock washer under wing nut, if installed.
   - Replace seal washer under wing nut.
   - Check to insure the element cover is making good contact with the element. The cover should fit squarely on the housing.
7. Inspect the Mist Eliminator element and replace as needed. Mist Eliminator elements are a long life item and should not require routine replacement.
8. Inspect control panel.
   - Watch for: loose wiring, wrong line filter, damaged line filter, and adequate arc suppressors.
   - Clean panel fan filters and panel.
   - Disconnect and tie back all unused wires from terminal strips.
   - Check the vibration transmitter wires to make sure they run directly to the microcontroller terminal strips.

Semiannual Maintenance

1. Lubricate the main driver coupling. Dry-type coupling components must be inspected.
2. Change oil filter.
3. Hydrotest the air coolers.
4. Follow the quarterly schedule.
5. Change the driver bearing lubrication on sleeve bearing units without force feed lubrication.
6. Obtain an oil sample and have it analyzed.
7. Check the control system per the procedure found in the Controls section of the Operation Manual.
8. Check the inlet and bypass valve calibration.

Annual Maintenance

1. Inspect the main driver per the manufacturer's instructions found in the Operation Manual.
2. Visually inspect the coupling. Align and lubricate as required. Replace any components that have excessive wear.
3. Manually rotate bullgear to feel for roughness on models with bullgear anti-friction bearings.
4. Inspect and clean the oil reservoir suction screens.
5. Visually inspect the oil coolers tubes. Clean the water side of the oil cooler if necessary.
6. Visually inspect the zinc anodes (pencils) in the oil cooler. Replace if necessary.
7. Visually inspect the inlet throttle valve.
8. Visually inspect the bypass valve.
9. Visually inspect the discharge check valve.
10. Sample and/or change the oil.

CAUTION

Servicing of the internal parts is not recommended without the presence of an Ingersoll-Rand service supervisor. For technical assistance, please call your local Ingersoll-Rand representative.

WARNING

Develop and use a "Red Tag" procedure or similar system whereby maintenance personnel can lock off the power switch during maintenance.

Replacement coolers, rotor assemblies, bearing, and seals are available in a variety of options:

- Exchange for factory trade-ins.
- Return the part for refurbishing.
- Return damaged parts for scrap and obtain credit toward new parts.
- Factory warranty program on all exchange parts.
- Rapid cooler cleaning and hydrotesting.

TROUBLESHOOTING

Symptom	Possible Cause	Corrective Action
Fail to start	Failure to clear shutdown or interlock devices.	Correct shutdown or interlock condition that is indicated by panel light
	No primary power to starter.	Check voltage to starter. Check fuses.
	No control panel power to compressor control panel or starter.	Check voltage to panel/starter. Check control transformer.
	Loose or corroded connection or defective power cables.	Check connections. Clean, tighten and replace as necessary.
	Defective motor starter or starting circuit.	Troubleshoot starter per manufacturer's recommendation.
Ineffective Prelube Pump	Improper adjustment of prelube pump relief valve.	Adjust relief valve for correct pressure.
	Pump not running.	Troubleshoot pump starter. Check for proper voltage.
	Defective motor.	Repair or replace motor.
	Defective pump.	Repair or replace pump.
	No seal air. (Seal air interlock is optional feature.)	Establish seal air.

Symptom	Possible Cause	Corrective Action
High Oil Temperature	Low or no water flow to oil cooler.	Establish correct water flow.
	Higher water temperature than realized.	Take necessary steps to lower the water supply temperature.
	Improper temperature device setting.	Calibrate instrument.
	Dirty or plugged oil cooler on water side.	Clean cooler tubes. Provide water strainers as necessary.
Low Oil Pressure	Improper adjustment of system pressure relief valve.	Adjust system pressure relief valve for correct oil pressure.
	Leaking or pinched oil line.	Repair or replace oil line.
	Dirty oil filter.	Replace with clean filter.
	Defective main oil pump.	Repair or replace main oil pump.
High Air Temperature	Low or no water flow to air cooler.	Establish correct water flow.
	Higher water temperature than realized.	Take necessary steps to lower the water supply temperature.
	Improper temperature device setting.	Calibrate device.
	Dirty or plugged air cooler on water side.	Clean water passages in cooler. Provide water strainers as necessary. Contact Ingersoll-Rand service representative.
Low Seal Air Pressure	Low instrument air pressure.	See "Low Instrument Air Pressure below.
	Improper adjustment of seal air pressure regulator.	Adjust regulator to obtain correct seal air pressure.
	Excessive bleed off valve adjustment (if supplied).	Reduce seal air bleed off.
	Worn Seals.	Replace seals. Consult Ingersoll-Rand service representative.

Symptom	Possible Cause	Corrective Action
Low Instrument or Valve Operating Air Pressure	No supply pressure, pinched or leaking air lines.	Establish instrument air supply pressure. Repair or replace air lines.
	Improper adjustment of air regulator.	Adjust regulator to obtain correct instrument air pressure.
High Vibration	Low oil temperature.	Allow warm-up period for oil.
	Driver to compressor misalignment.	Check and correct alignment (dowel motor feet after alignment).
	Worn coupling or spacer.	Lubricate. Replace coupling and/or spacer.
	Rotor assembly unbalance due to foreign matter build up.	Contact Ingersoll-Rand service representative. Cleaning and balance check required.
	Rotor assembly unbalance due to damaged components.	Contact Ingersoll-Rand service representative. Repair or replacement and balance check required.
	Induced vibration from driver.	Balance motor rotor.
Fail to Load	Mode selector switch in UNLOAD position.	Turn selector switch to Modulate or Auto-Dual operating mode.
	Low set point on pressure controller.	Adjust controller to desired operating pressure.
	Bypass valve not closed or inlet valve not open.	Correct improper operation of the inlet or bypass valve.
Low System Air	Compressor not loaded.	See "Fail to Load" above.
	Dirty inlet filter.	Change filter elements.
	Low surge.	See "Continual Surging" below.
	Greater demand than realized.	Repair ALL air leaks. Turn off unnecessary demands.

Symptom	Possible Cause	Corrective Action
Continual Surge (Pumping)	Discharge block valve closed.	Open block valve.
	Dirty inlet filter.	Change filter elements.
	Improper adjustment of throttle limit (LLR, CLL, TL).	Adjust throttle limit.
	High interstage air temperature.	Establish correct water flow to air coolers.
	Higher water temperature than realized.	Reduce the cooling water temperature.
	Worn or fouled aerodynamic parts.	Contact Ingersoll-Rand service representative.
Excessive Power Consumption	Lower ambient temperature than realized.	Reduce compressor load. Consult Ingersoll-Rand representative.
	Low primary voltage.	Consult power company. Check power source.
	Reduction in motor efficiency. Excessive load.	Consult motor manufacturer. Reduce load.
High Drive Motor Amperage	Low primary voltage.	Restore voltage to specification.
	High load.	Reduce load.

GENUINE PARTS & SERVICE

A substitute is not a replacement

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Call (800) 247-8640.

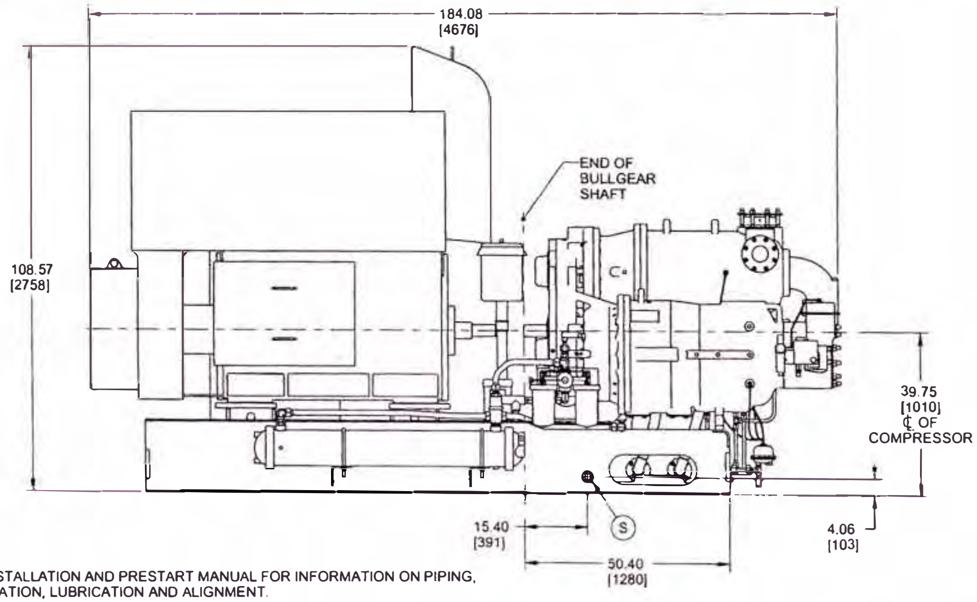
Ingersoll-Rand is committed to serving you. If you require information, service, or parts, we are strategically located to serve your needs. When you need support for your Centac compressor, contact your local Ingersoll-Rand representative or call the factory direct.

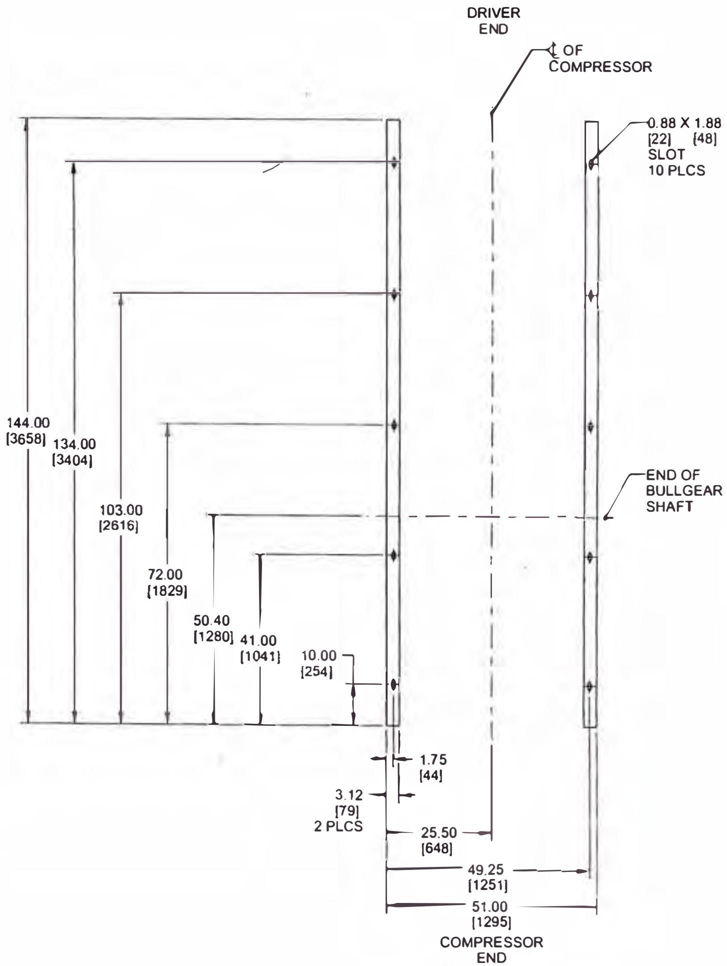
INGERSOLL-RAND
Centac Aftermarket Services:

- **Lubricants**
- **Performance Enhancements**
- **Control system Upgrades**
- **CMC® Microprocessor Controls**
- **ASC/ASM System Controller**
- **Pure Air Chemical Filters**
- **Cooler Cleaning and Repair Services**
- **Rotor Cleaning, Balancing, and Repair Services**
- **Remanufactured Centac Compressors**
- **Centrifugal Diagnostic Services CDS**
- **Centac Customer Training Schools**

REVISIONS

ITEM	QTY	DESCRIPTION	COMMENTS
A	1	AIR INLET VALVE	10"-150# ANSI FF FLANGE (12) M20 X 2.5-6H THD X 1.50⊽ ON 14.25" BC
B	1	AIR DISCHARGE	6"-150# ANSI FF FLANGE (8) M20 X 2.5-6H THD X 1.50⊽ ON 9.50" BC
C	1	AIR BYPASS	4"-150# ANSI FF FLANGE (8) M16 X 2.0-6H THD X 1.00⊽ ON 7.50" BC
D	1	AIR COOLER WATER INLET	2"-150# ANSI FF FLANGE (4) .75" THRU HOLES ON 4.75" BC
E	1	AIR COOLER WATER OUTLET	2"-150# ANSI FF FLANGE (4) .75" THRU HOLES ON 4.75" BC
DD	2	COOLING WATER INLET 1ST/2ND STAGE ONLY	2"-150# ANSI FF FLANGE (4) M16X2.0-6HX1.00 ⊽ ON 4.75" BC
EE	2	COOLING WATER OUTLET 1ST/2ND STAGE ONLY	2"-150# ANSI FF FLANGE (4) M16X2.0-6HX1.00 ⊽ ON 4.75" BC
F	1	OIL COOLER WATER INLET	2.00" NPT
G	1	OIL COOLER WATER OUTLET	2.00" NPT
H	1	PRELUBE PUMP	SEE WIRING SCHEMATIC
J	1	MAIN DRIVER	CONDUIT BOX - (SEE MOTOR OUTLINE)
L	3	VENT VALVE	.25" NPT
M	1	CONTROL PANEL	
N	5	CONDENSATE TRAP	.50" NPT
P	5	CONDENSATE DRAIN VALVE	.50" NPT
R	1	LUBE OIL HEATER	SEE WIRING SCHEMATIC
S	1	OIL RESERVOIR DRAIN	2.00" NPT PIPE PLUG
T	1	IA (INSTRUMENT AIR)	.50" NPT
U	1	CA (CONTROL AIR)	.50" NPT





BASEPLATE CONTACT SURFACE
(TOP VIEW)

NOTES:

1. SEE INSTALLATION AND PRESTART MANUAL FOR INFORMATION ON PIPING, FOUNDATION, LUBRICATION AND ALIGNMENT.
2. INLET PIPING SHOULD BE NON-FERROUS AND FLANGED FOR CLEANING AND INSPECTION. A MINIMUM OF (4) PIPE DIAMETERS OF STRAIGH RUN IS RECOMMENDED. USE PROPER SIZE PIPE AND SUPPORTS TO KEEP PIPE STRAIN BELOW THE VALUES LISTED IN THE INSTALLATION MANUAL.
3. LIFTING HOLE / FORK SLOT.
4. ALL FLANGE HOLES STRADDLE CENTER LINE.
5. WEIGHT OF HEAVIEST COMPONENT 8,819 LBS. (4000 KGS.) MOTOR
6. MAXIMUM WEIGHT OF UNIT 27,819 LBS. (12619 KGS.)
7. ALL DIMENSIONS GIVEN IN INCHES & [MM], +/- .12 [3]
8. COUPLING BETWEEN COMPRESSOR AND DRIVER SUPPLIED BY IR. DISTANCE BETWEEN SHAFTS 7.00 [178]
9. DRIVER ROTATION IS COUNTER-CLOCKWISE AS VIEWED FROM THE SHAFT END OF DRIVER.
10. COMPONENT LIFTING LUG ONLY.
11. ALL CONTROL PANEL CONNECTIONS ARE THROUGH THE BOTTOM OF THE CONTROL PANEL.

WARNING: THE EXPORT OR RE-EXPORT OF THIS DRAWING OR PRODUCT PRODUCED BY THIS DRAWING IS SUBJECT TO U.S. EXPORT ADMINISTRATION REGULATIONS AND OTHER APPLICABLE GOVERNMENT RESTRICTIONS OR REGULATIONS

DO NOT SCALE DRAWING

DRAWING CONFORMS TO ASME Y14.5M - 1994

CAD GENERATED DRAWING, NO MANUAL REVISIONS ALLOWED

UNLESS OTHERWISE SPECIFIED
- REMOVE ALL BURRS AND SHARP CORNERS
- WELD SYMBOLS TO BE IN ACCORDANCE WITH ANSI/AWS A2.4

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CHECKED	RJG	2008JUN16
APPROVED	R.J.GRISE	2008JUN16

Ingersoll Rand

GENERAL ARRANGEMENT,

SIZE		DWG NO	REV
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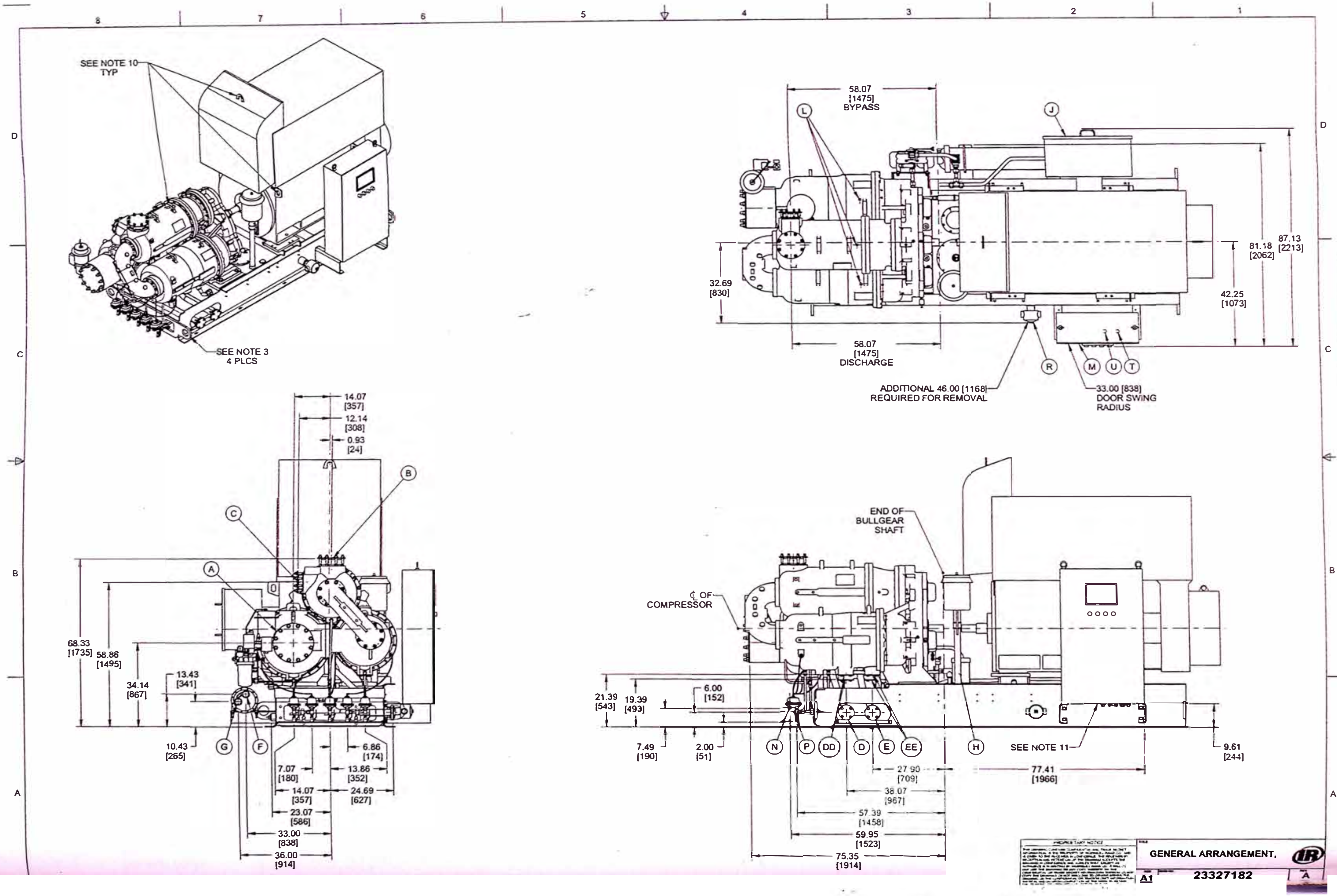
UNLESS OTHERWISE SPECIFIED PRINTED DOCUMENT IS UNCONTROLLED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[867]
13.43
[341]
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6.86
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33.00
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[914]
END OF
BULLGEAR
SHAFT
℄ OF
COMPRESSOR
21.39
[543]
19.39
[493]
6.00
[152]
7.49
[190]
2.00
[51]
N
P
DD
D
E
EE
H
SEE NOTE 11
9.61
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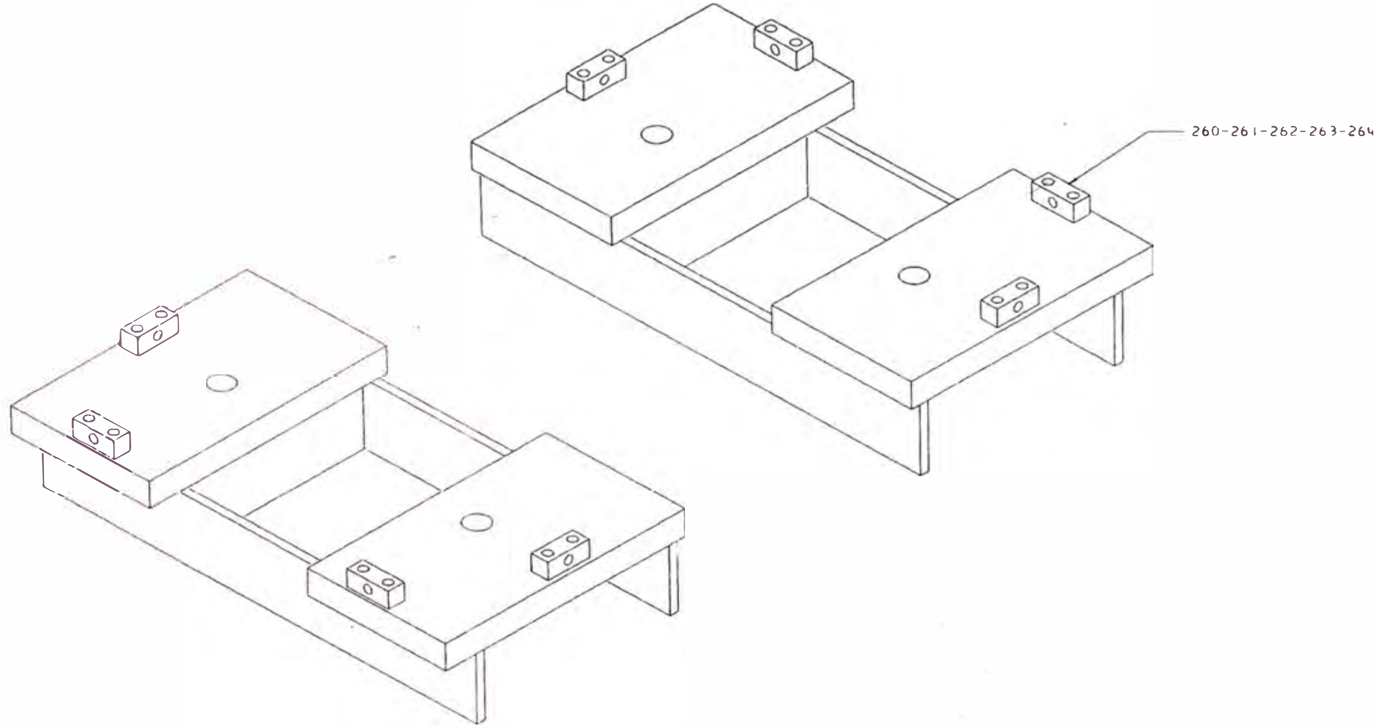
[709]
77.41
[1966]
38.07
[967]
57.39
[1458]
59.95
[1523]
75.35
[1914]
PROPRIETARY NOTICE
GENERAL ARRANGEMENT,
A1
23327182
A

DWG. NO. 22246177	SHEET 1

REVISION

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	ORIGINAL RELEASE. ECN#70281	SH 2-03	JRB 2-03



ITEM	QUAN	DESCRIPTION	PART NUMBER	MATERIAL	WT

LIST OF MATERIAL

MANUAL REVISION TO THIS DOCUMENT IS PROHIBITED

CADDS PART: ENG.OP.22246177

Ingersoll Rand Air Solutions

TITLE: EXTERIOR ASSEMBLY ADD-ON

DRAWN	DATE
SH	2-03
CHECKED JRB	2-03
APPROVED JRB	2-03
ENG APPVL	

SIZE | CODE IDENT NO. | DWG NO. 22246177 | REV A

SCALE: | SHEET 1 OF 1

PLOT DATA:

FILE DATE: 05-02-04
FILE TIME: 11:47:31

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UNSPECIFIED TOLERANCES

CASTING

DIMENSION	TOLERANCE
UNDER 2" (50 mm)	±.062" (1.5 mm)
2-5" (50-125 mm)	±.125" (3.3 mm)
5-8" (125-200 mm)	±.187" (4.5 mm)
ABOVE 8" (200 mm)	±.250" (6.0 mm)

FILLETS & RADII TO BE .125 (3 mm)

MACHINING

REMOVE BURRS & SHARP CORNERS.
COUNTERSINK TAPPED HOLES TO BODY SIZE.
MACH FIN. 125 RMS
DIMENSION & TOLERANCE CONVERSION REQUIRES INCH VALUES TO HAVE ONE MORE DECIMAL PLACE THAN METRIC VALUES

IN.	DEC. PLC.	mm
N/A	0 PLACE	±1.0
±.06	1 PLACE	±0.3
±.01	2 PLACE	±0.15
±.005	3 PLACE	±0.015
±.0005	4 PLACE	N/A

INT. CORNER .030 (.8 mm) R MAX.
EXT. CORNER .015 (.4 mm) R MAX.
ANGULARITY ±1°
TORCH CUT ±1/16 (1.5 mm)

GEOMETRIC TOLERANCES — SYM

FLATNESS; CIRCULARITY; CYLINDRICITY; PROFILE OF LINE; PROFILE OF SURFACE; ANGULARITY; PERPENDICULARITY; PARALLELISM; POSITION; CONCENTRICITY; CIRCULAR RUNOUT; TOTAL RUNOUT

USE REFERENCE: C950

REFERENCE DRAWING

WEIGHT

PATTERN NO.

MATERIAL

HEAT TREAT

HARDNESS: MAX / MIN

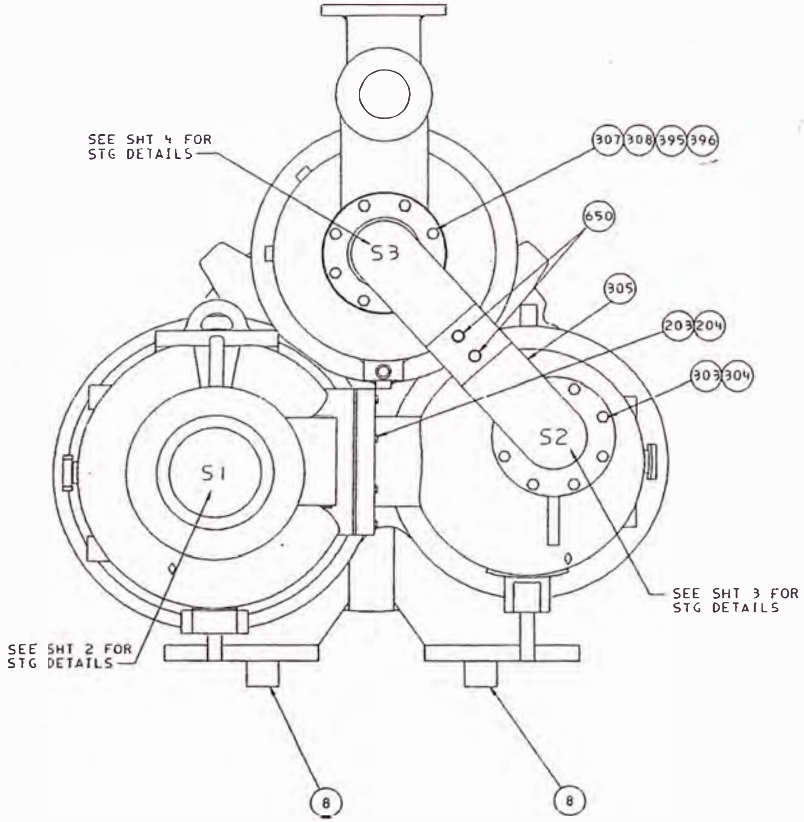
MET APPVL

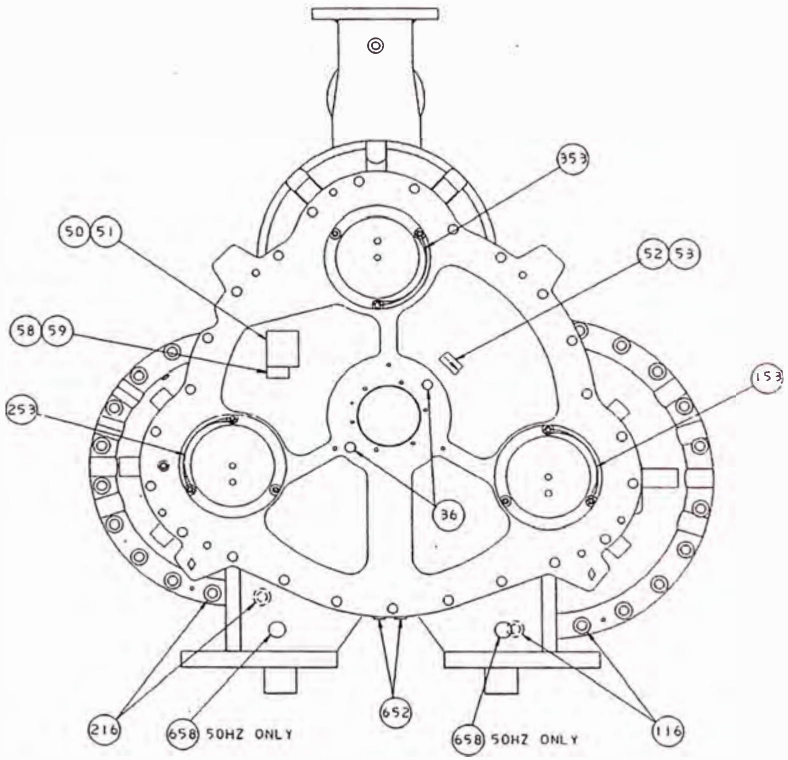
NOTES

1. SPRAY IMPELLER POLYGON WITH "TIOLUBE 70" SOILD LUBRICANT 1X10114. PRIOR TO SPRAYING, CLEAN WITH AN OIL FREE SOLVENT. THIS IS TO BE DONE AT ASSEMBLY DURING FINAL INSTALL-ATION OF THE ROTOR ASSEMBLY.
2. THIS IS A COMPOSITE DRAWING. IT CONTAINS OPTIONS THAT ARE AVAILABLE PER CUSTOMER ORDER. SEE P&I DIAGRAM AND BILL OF MATERIAL FOR PERTINENT ITEMS.
3. WHEN INSTALLING BEARINGS, MAKE SURE THAT THE HOLE IN THE SHELL LINES UP WITH THE CASING HOLE SUCH THAT THE TUBE SEGMENT WILL GO INTO THE COUNTERBORE IN THE BEARING SHELL. WASHER IS TO TIGHTEN AGAINST ADAPTER ONLY AND SHOULD NOT CONTACT THE CASING.

DWG. NO. 00453993 SHEET 1

REVISION				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	ITEM 657 WAS 357 SHT 5	MEH 4-99	JRB 4-99
	B	ADDED SEQ. #658 (QTY. 2) LOC. SHT. A-384: ADDED SEQ. #659 (QTY. 8) SHT.5	MG 1/00	JRB 1/00
B44	C	ITEM NO 309 WAS 311 PER ECR 20030006: CONVERTED DRAWING NUMBER FROM 7X15009 TO CORRESPONDING CCN 00453993 PER GLOBAL POLICY	DEEPAK 05/03	GB● 05/03





FORMERLY 7X15009

ITEM	QUAN	DESCRIPTION	PART NUMBER	MATERIAL	WT

LIST OF MATERIAL

MANUAL REVISION TO THIS DOCUMENT IS PROHIBITED

CADDS PART:ENG.DP.00453993 DRA:1

PROPRIETARY NOTICE

UNSPECIFIED TOLERANCES

CASTING	
DIMENSION	TOLERANCE
UNDER 2" (50 mm)	±.062" (1.5 mm)
2-5" (50-125 mm)	±.125" (3.0 mm)
5-8" (125-200 mm)	±.187" (4.5 mm)
ABOVE 8" (200 mm)	±.250" (6.0 mm)

FILLETS & RADII TO BE .125 (3 mm)

MACHINING

REMOVE BURRS & SHARP CORNERS.

COUNTERSINK TAPPED HOLES TO BODY SIZE.

MACH FIN. 125 RMS

DIMENSION & TOLERANCE CONVERSION REQUIRED: INCH VALUES TO HAVE ONE MORE DECIMAL PLACE THAN METRIC VALUES.

IN.	DEC. PLC.	mm
N/A	0 PLACE	±1.0
±.06	1 PLACE	±0.3
±.01	2 PLACE	±0.15
±.005	3 PLACE	±0.015
±.0005	4 PLACE	N/A

INT. CORNER .030 (.8 mm) R MAX. EXT. CORNER .015 (.4 mm) R MAX. ANGULARITY ±1° THREAD CUT ±1/16 (1.5 mm)

GEOMETRIC TOLERANCES	SYM
FLATNESS	⏥
CIRCULARITY	○
CYLINDRICITY	⌭
PROFILE OF LINE	⌒
PROFILE OF SURFACE	⌓
ANGULARITY	∠
PERPENDICULARITY	⊥
PARALLELISM	//
POSITION	⌖
CONCENTRICITY	◎
CIRCULAR RUNOUT	↗
TOTAL RUNOUT	⌰

USE REFERENCE: 2AC11 3ST-3 COOLER 50/60HZ

REFERENCE DRAWING: 7X14065

WEIGHT

PATTERN NO.

MATERIAL

HEAT TREAT

HARDNESS MAX MIN

MET APPVL

Ingersoll Rand. Air Solutions

DRAWN	DATE
JOP	11/98
CHECKED JB PIERCE	11/98
APPROVED GBD	11/98
ENG APPVL	

TITLE

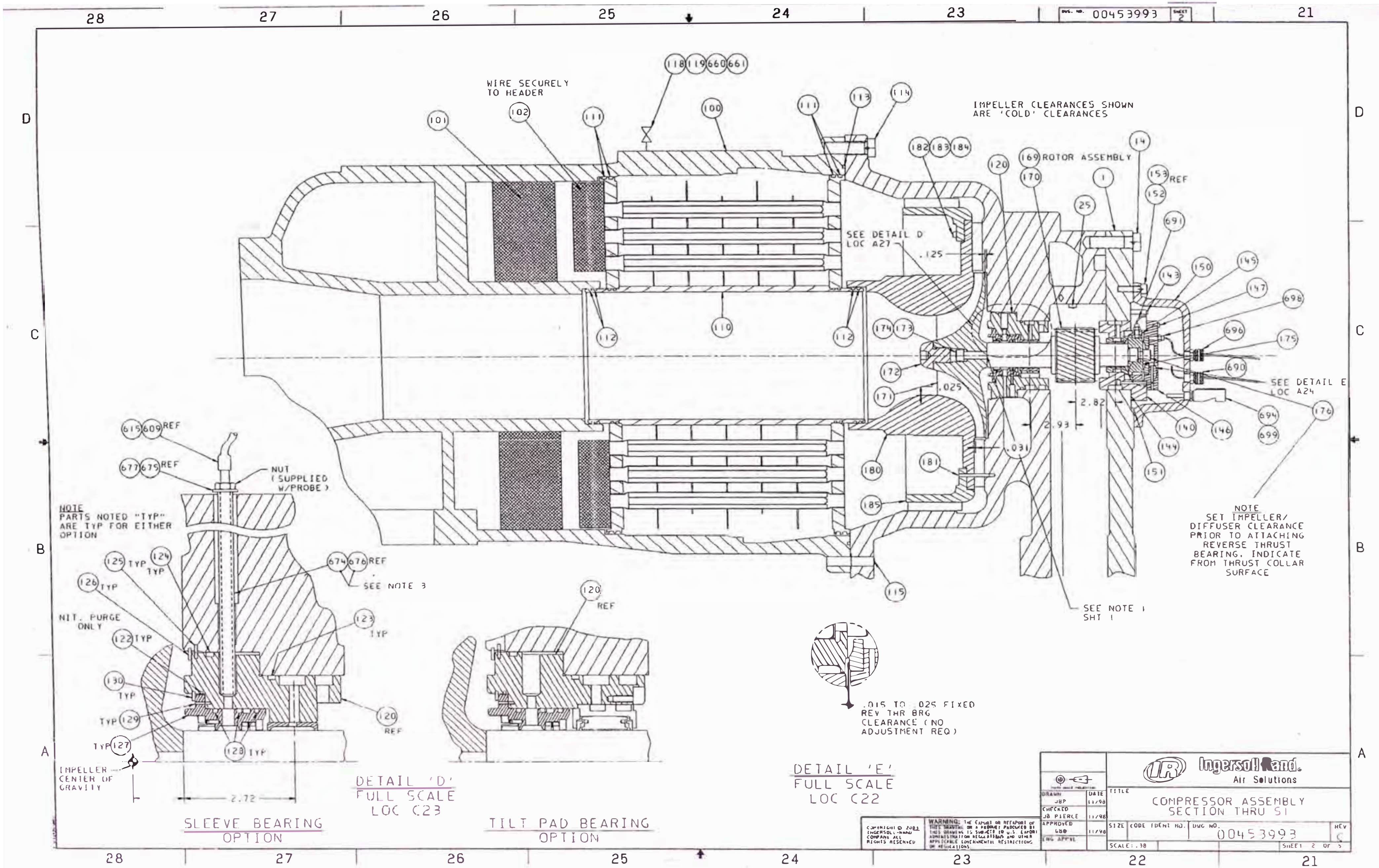
COMPRESSOR ASSEMBLY FRONT & REAR VIEWS

SIZE | CODE IDENT NO. | DWG NO. 00453993 | REV C

SCALE: .18 | SHEET 1 OF 5

PLOT DATA: W S L 1-150 W Z L 251-252

FILE DATE: 03-05-12 FILE TIME: 8:20158



DWG. NO. 00453993 SHEET 2
WIRE SECURELY TO HEADER
IMPELLER CLEARANCES SHOWN ARE 'COLD' CLEARANCES
169 ROTOR ASSEMBLY
153 REF
SEE DETAIL D LOC A27
.125
.025
.031
2.82
2.93
SEE DETAIL E LOC A24
615 609 REF
677 675 REF
NUT (SUPPLIED W/PROBE)
NOTE
PARTS NOTED "TYP" ARE TYP FOR EITHER OPTION
674 676 REF
SEE NOTE 3
125 TYP
124 TYP
126 TYP
NIT. PURGE ONLY
122 TYP
123 TYP
130 TYP
TYP 129
TYP 127
128 TYP
120 REF
IMPELLER CENTER OF GRAVITY
2.72
SEE NOTE 1 SHT 1
NOTE
SET IMPELLER/ DIFFUSER CLEARANCE PRIOR TO ATTACHING REVERSE THRUST BEARING. INDICATE FROM THRUST COLLAR SURFACE
.015 TO .025 FIXED REV THR BRG CLEARANCE (NO ADJUSTMENT REQ)
SLEEVE BEARING OPTION
DETAIL 'D' FULL SCALE LOC C23
TILT PAD BEARING OPTION
DETAIL 'E' FULL SCALE LOC C22
Ingersoll Rand. Air Solutions
TITLE COMPRESSOR ASSEMBLY SECTION THRU S1
DRAWN JBP 11/98
CHECKED JB PIERCE 11/98
APPROVED
ENG APPVL
SIZE CODE IDENT NO. DWG NO. 00453993 REV C
SCALE: .38 SHEET 2 OF 5
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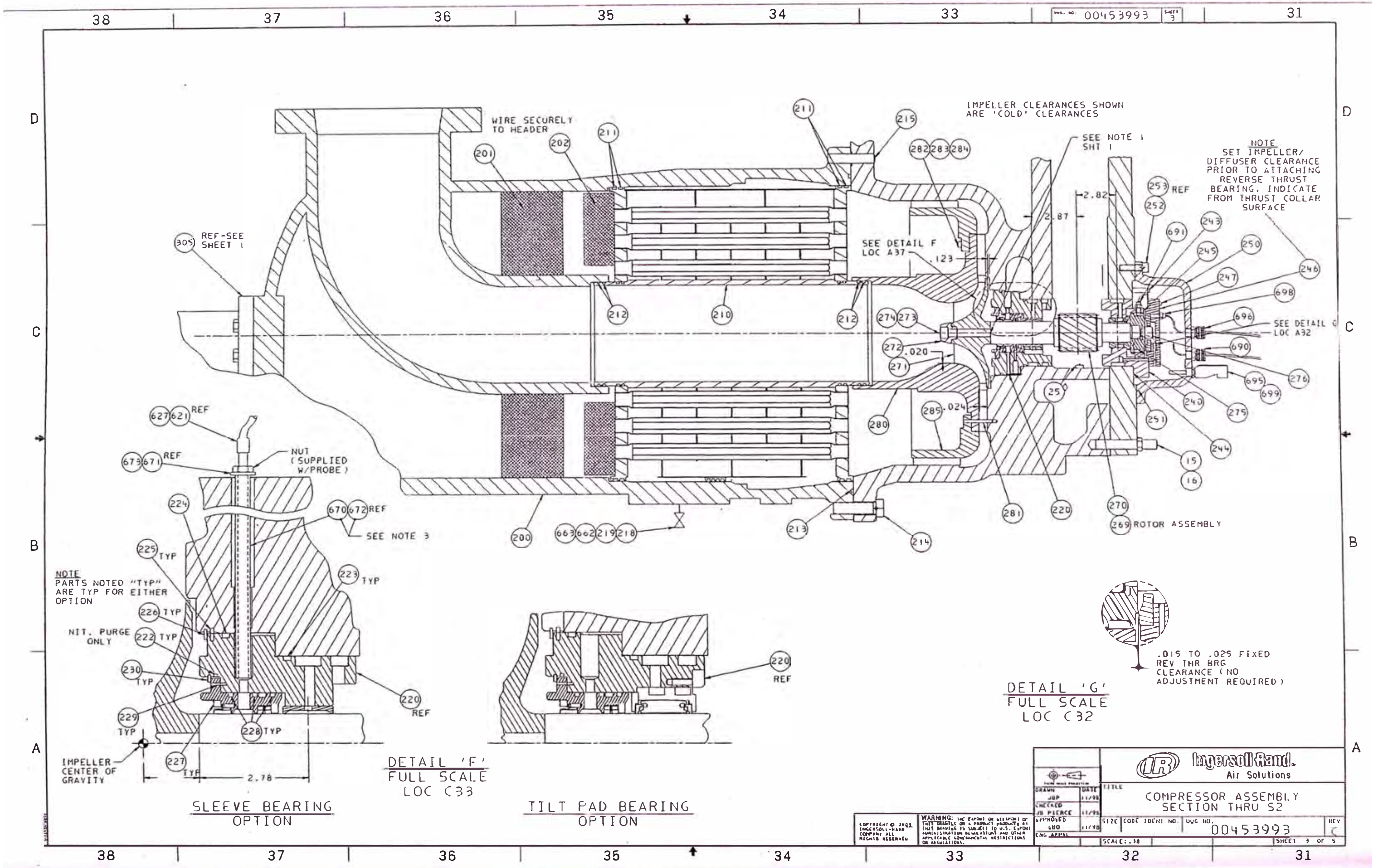

DWG. NO. 00453993 SHEET 3
IMPELLER CLEARANCES SHOWN ARE 'COLD' CLEARANCES
WIRE SECURELY TO HEADER
SEE NOTE 1 SHT 1
NOTE
SET IMPELLER/DIFFUSER CLEARANCE PRIOR TO ATTACHING REVERSE THRUST BEARING. INDICATE FROM THRUST COLLAR SURFACE
REF-SEE SHEET 1
SEE DETAIL F LOC A37
SEE DETAIL G LOC A32
ROTOR ASSEMBLY
NUT (SUPPLIED W/PROBE)
SEE NOTE 3
NOTE
PARTS NOTED "TYP" ARE TYP FOR EITHER OPTION
NIT. PURGE ONLY
IMPELLER CENTER OF GRAVITY
2.78
2.82
2.87
.123
.020
.024
.015 TO .025 FIXED REV THR BRG CLEARANCE (NO ADJUSTMENT REQUIRED)
DETAIL 'G' FULL SCALE LOC C32
DETAIL 'F' FULL SCALE LOC C33
SLEEVE BEARING OPTION
TILT PAD BEARING OPTION
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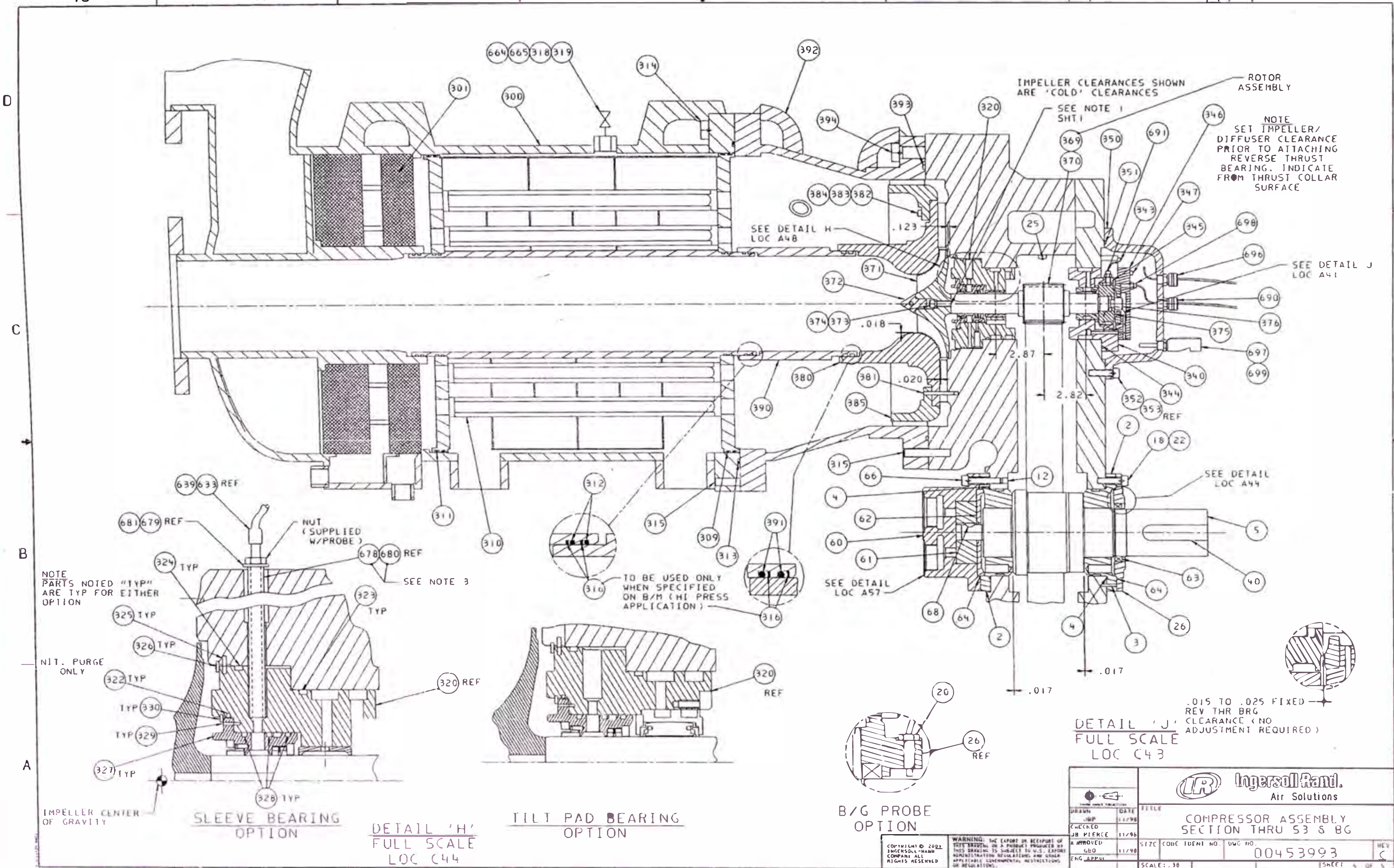
Ingersoll Rand. Air Solutions
TITLE COMPRESSOR ASSEMBLY SECTION THRU S2
DRAWN JUP
CHECKED JB PIERCE
APPROVED GBO
SIZE C
DWG NO. 00453993
REV C
SCALE: .38
SHEET 3 OF 5



Ingersoll Rand. Air Solutions

COMPRESSOR ASSEMBLY SECTION THRU 53 & BG

DWG NO. 00453993 REV C

DRAWN JWP 11/98 · CHECKED JB PIERCE 11/98 · APPROVED GBO 11/98

SCALE: .30 · SHEET 4 OF 5

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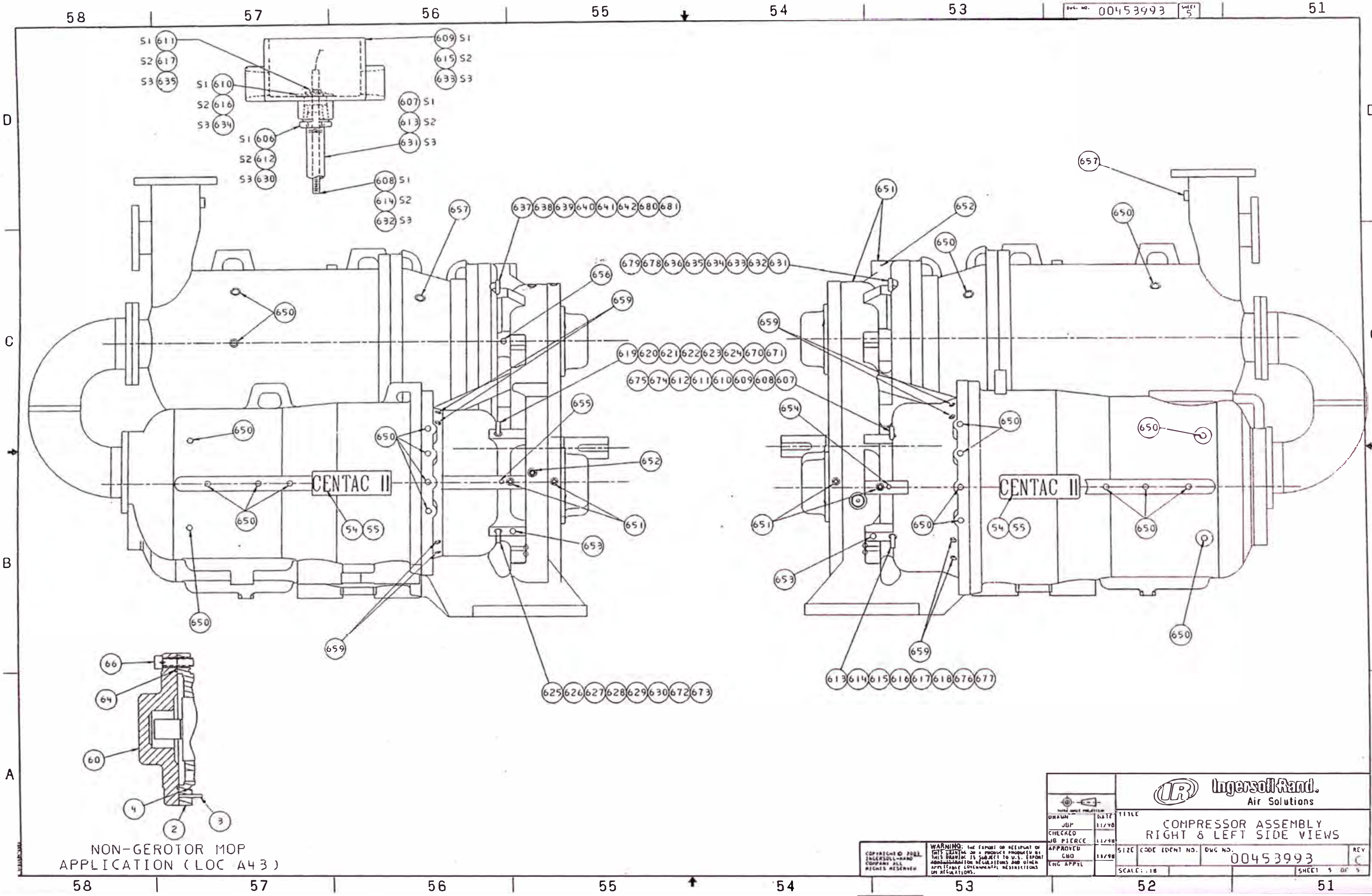


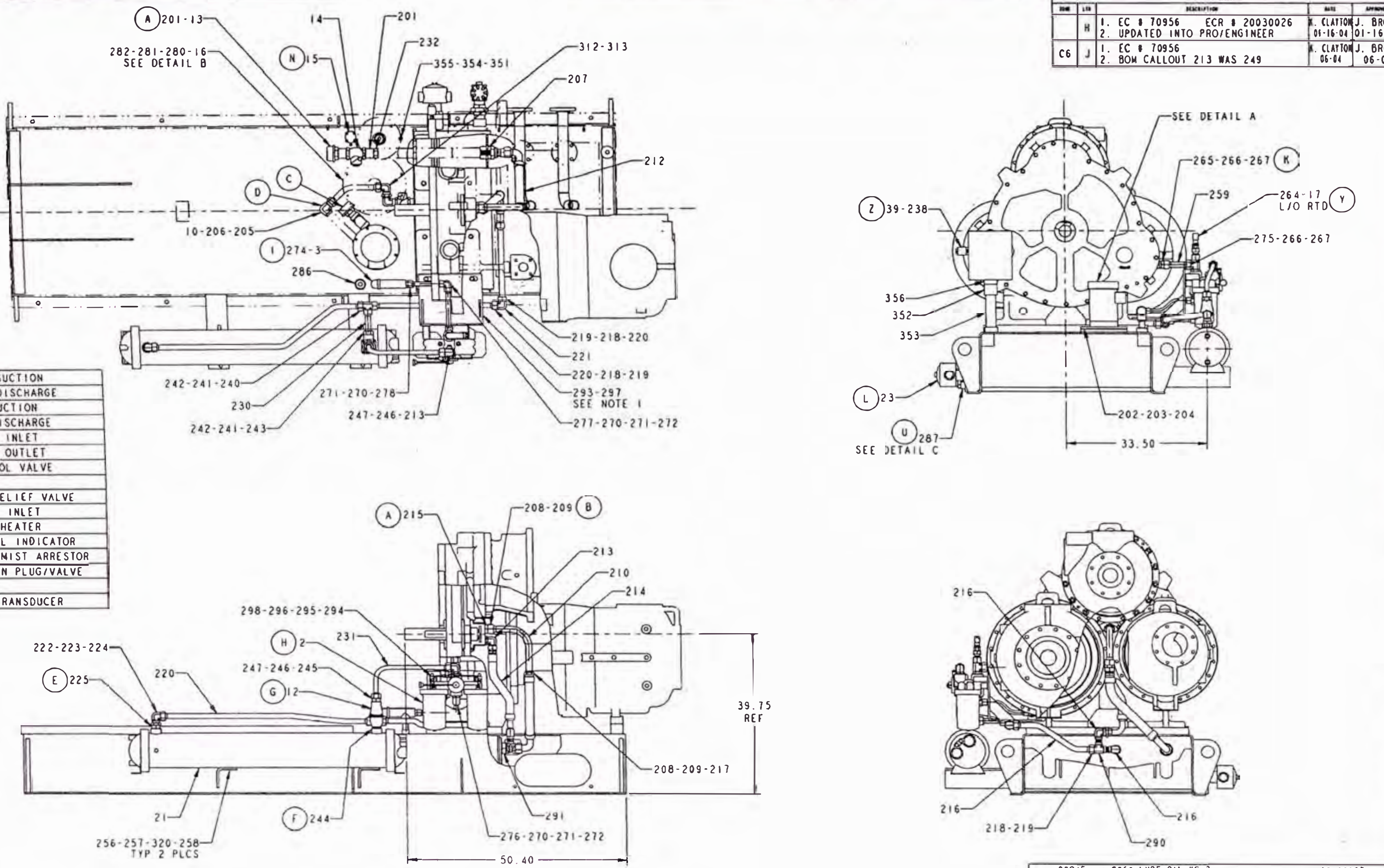
Ingersoll Rand. Air Solutions

COMPRESSOR ASSEMBLY
RIGHT & LEFT SIDE VIEWS

DWG NO. 00453993 REV C

SHEET 5 OF 5

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	H	1. EC # 70956 ECR # 20030026 2. UPDATED INTO PRO/ENGINEER	K. CLAYTON 01-16-04	J. BROWN 01-16-04
C6	J	1. EC # 70956 2. BOM CALLOUT 213 WAS 249	K. CLAYTON 06-04	J. BROWN 06-04



A	MAIN OIL PUMP SUCTION
B	MAIN OIL PUMP DISCHARGE
C	PRELUBE PUMP SUCTION
D	PRELUBE PUMP DISCHARGE
E	OIL COOLER OIL INLET
F	OIL COOLER OIL OUTLET
G	OIL TEMP CONTROL VALVE
H	OIL FILTER
I	OIL PRESSURE RELIEF VALVE
K	COMPRESSOR OIL INLET
L	RESERVOIR OIL HEATER
N	RESERVOIR LEVEL INDICATOR
O	OIL RESERVOIR MIST ARRESTOR
U	RESERVOIR DRAIN PLUG/VALVE
Y	OIL RTD
Z	OIL PRESSURE TRANSDUCER

NOTES:

1. MOUNT FILTER SUPPORT (ITEM #293) TO THE TOP OF THE COMPRESSOR FOOT BY REPLACING THE EXISTING CAPSCREWS WITH ITEM #297.
2. REFER TO DRAWING 5X4565 FOR TORQUE VALUES OF SAE THREADED FITTINGS.
3. THIS IS THE MAX. ALLOWABLE DIMENSION FOR THIS SIDE OF THE COMPRESSOR PIPING PACKAGE.

UNSPECIFIED TOLERANCES

USE REFERENCE: C950

PRO/E PART: C950_LUBE_OIL_KC_2 DRW: 00466037

DRAWN: K. CLAYTON 01-16-04
APPROVED: J. BROWN 01-16-04

TITLE: ASSEMBLY, LUBE OIL PIPING

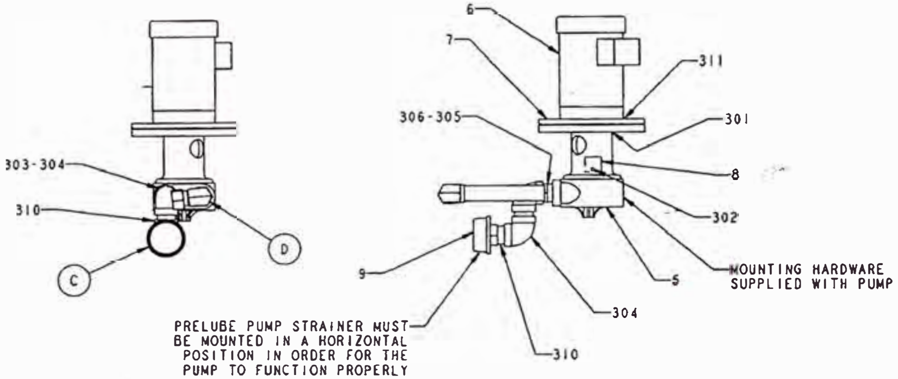
SIZE	CODE IDENT NO.	DWG NO.	REV
D		00466037	J

SCALE: 0.085 SHEET 1 OF 2

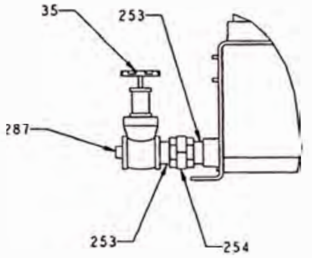
00466037 SHEET 2

REVISION

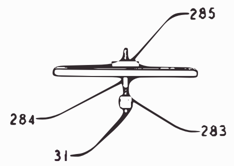
ZONE	LTR	DESCRIPTION	DATE	APPROVED



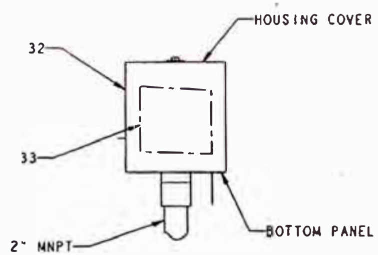
DETAIL A



DETAIL C
W/OIL RESERVOIR DRAIN VALVE



DETAIL B
W/OIL RESERVOIR SWITCH



MONSANTO MIST ELIMINATOR

NOTES:
1. TAKE HOUSING APART AND INSTALL ELEMENT INTO COUPLING IN BOTTOM PAN.
2. REATTACH HOUSING COVER TO PAN.
3. INSTALL ON MACHINE.

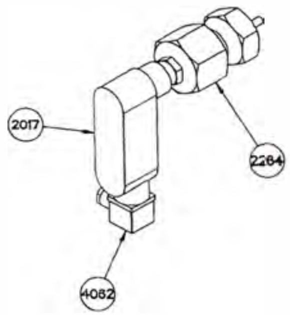
PRO/E PART: C950_LUBE_OIL_KC_2 DRW:00466037

DRAWN: K. CLAYTON DATE: 01-18-04
APPROVED: J. BROWN 01-18-04

TITLE: ASSEMBLY, LUBE OIL PIPING

SIZE: D DWG NO. 00466037 REV: J

SCALE: 0.085 SHEET 2 OF 2



UNSPECIFIED TOLERANCES					
CASTING		MACHINING			
DIMENSION	TOLERANCE		INCH	DEC. PLC	MM
UNDER 2" (UNDER 50mm)	±.062" (±1.5mm)	COUNTERSINK TAPPED HOLES TO BODY SIZE	N/A	0 PLACE	±1.0
2 - 5" (50 - 125mm)	±.125" (±3.0mm)	MACH FIN. 125 RMS	±.04	1 PLACE	±0.3
5 - 8" (125 - 200mm)	±.187" (±5.0mm)		±.01	2 PLACE	±0.15
ABOVE 8" (ABOVE 200mm)	±.250" (±6.0mm)	DIMENSION & TOLERANCE CONVERSION REQUIRES INCH VALUES TO HAVE ONE MORE DECIMAL PLACE THAN METRIC	±.005	3 PLACE	±0.013
FILLETS & RADII TO BE .125" (3mm)			±.0005	4 PLACE	N/A

Ingersoll-Rand Industrial Technologies

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DRAWING CONFORMS TO ASME Y14.5M - 1994

CAD GENERATED DRAWING, NO MANUAL REVISIONS ALLOWED

UNLESS OTHERWISE SPECIFIED:
- REMOVE ALL BURRS AND SHARP CORNERS
- WELD SYMBOLS TO BE IN ACCORDANCE WITH ANSI/AWS A2.4

THIRD ANGLE PROJECTION

DRAWN: M. CURRY	DATE: 03-22-07
CHECKED: JP	DATE: 03-07
APPROVED: J. PARK	DATE: 03-07

Ingersoll Rand

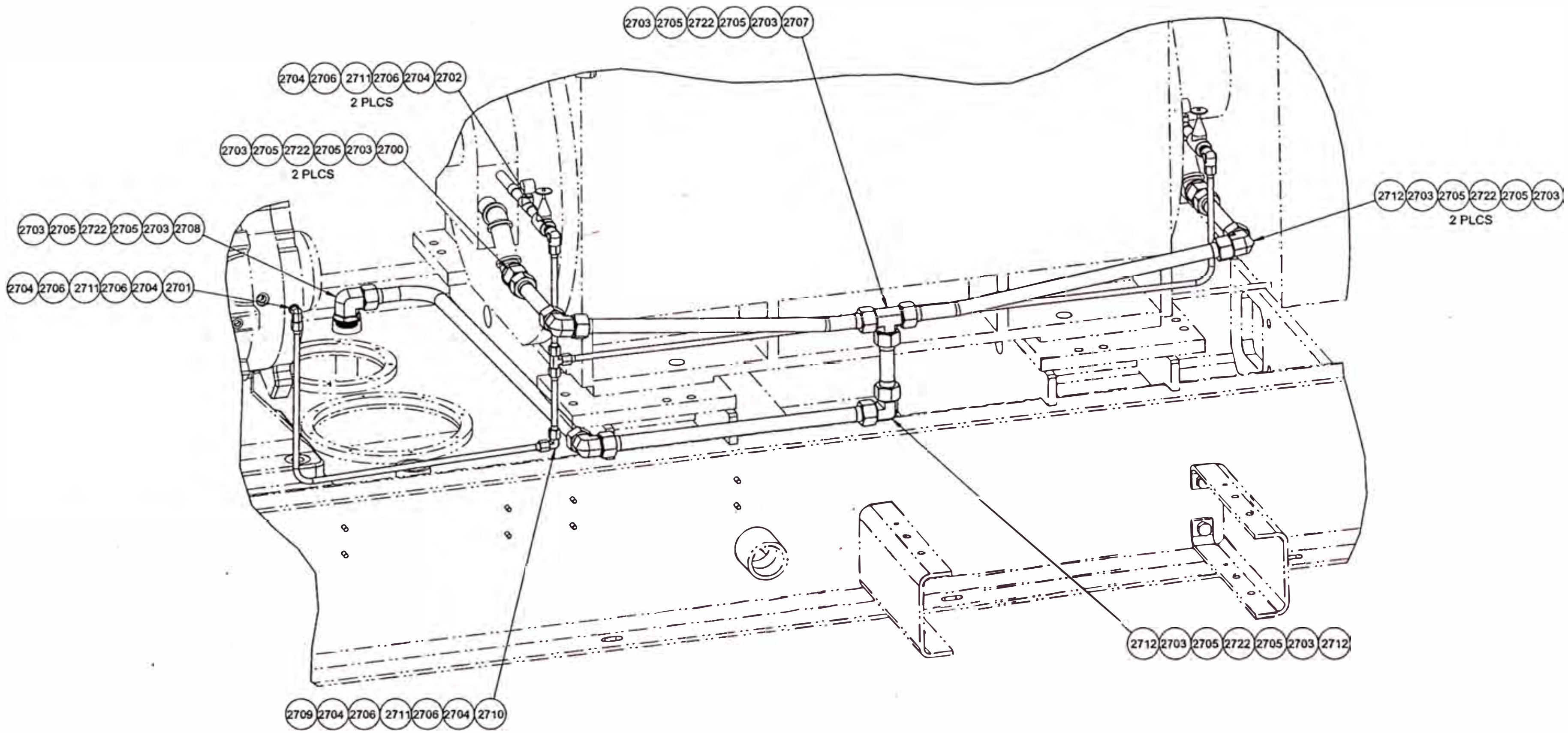
TITLE: ASSEMBLY, OIL RTD W/CABLE

SIZE	ESTIMATED WEIGHT	DWG NO.	REV
A1	0.0	23099112	B
SCALE: 0.50	UNIT: C950	SHEET	1 OF 1

UNLESS OTHERWISE SPECIFIED PRINTED DOCUMENT IS UNCONTROLLED

NOTES :

REVISIONS						
ZONE	REV	ECN	DESCRIPTION	DATE	DRAWN	APPD
	A	77153	ORIGINAL RELEASE	2008JUN26	M.CURRY	R.J.GRISE



UNSPECIFIED TOLERANCES

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DRAWING CONFORMS TO ASME Y14.5M - 1994

CAD GENERATED DRAWING, NO MANUAL REVISIONS ALLOWED

UNLESS OTHERWISE SPECIFIED:
- REMOVE ALL BURRS AND SHARP CORNERS
- WELD SYMBOLS TO BE IN ACCORDANCE WITH ANSI/AWS A2.4

THIRD ANGLE PROJECTION

DRAWN: M.CURRY	DATE: 2008JUN26
CHECKED: RJG	DATE: 2008JUN26
APPROVED: R.J.GRISE	DATE: 2008JUN26

Ingersoll Rand

TITLE: ASSY, FORCED LUBE C950

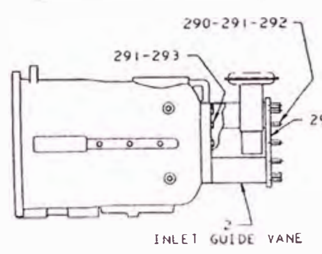
SIZE: A1 | 0.0 | DWG NO: 23332679 | REV: A

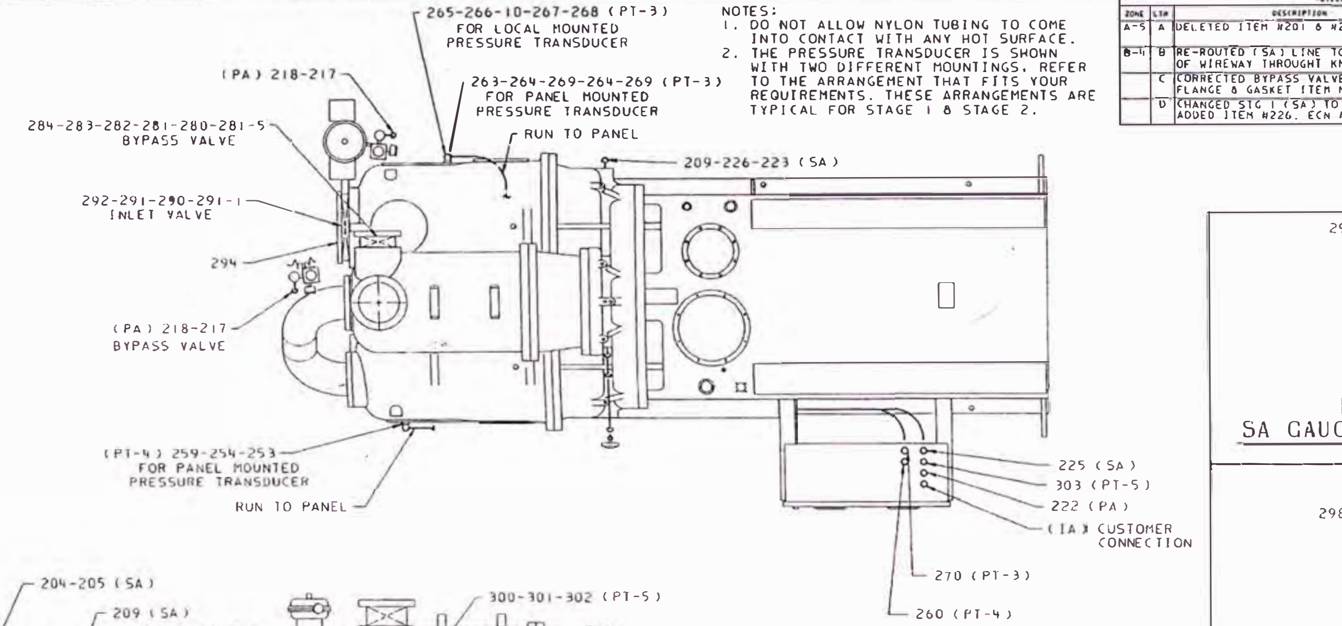
DWG. NO. 00478669 SHEET 1

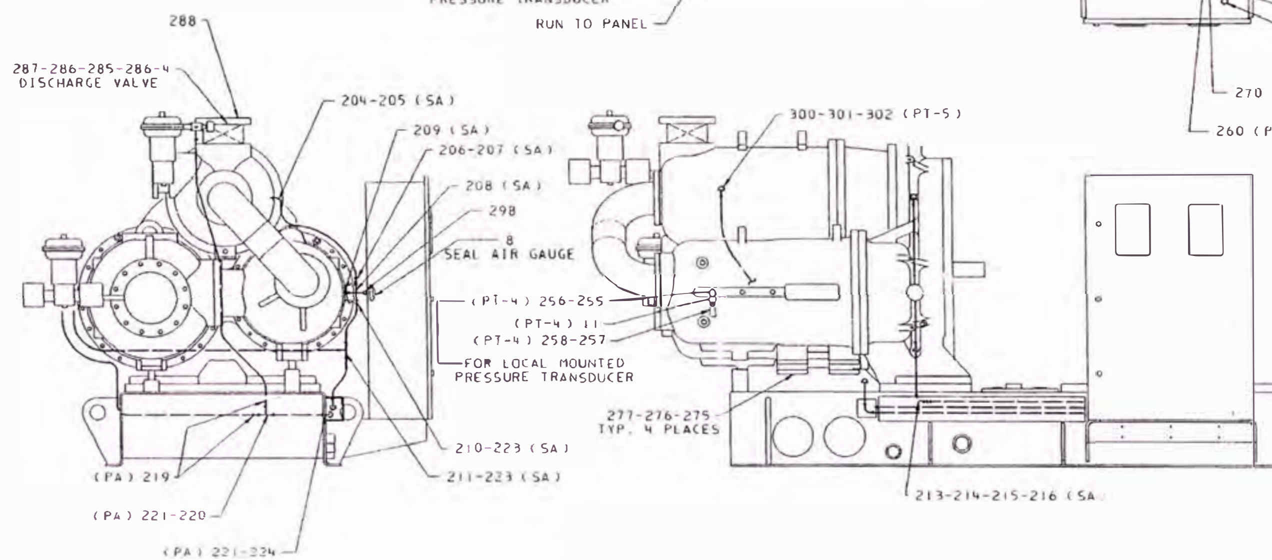
ZONE	LTR	REVISION DESCRIPTION	DATE	APPROVED
A-5	A	DELETED ITEM #201 & #202	MG 11/99	JRB 11/99
B-4	B	RE-ROUTED (SA) LINE TO ENTER TOP OF WIREWAY THROUGHT KNOCKOUT.	NOLES 02/00	CALDWELL 02/00
	C	CORRECTED BYPASS VALVE SHIPPING FLANGE & GASKET ITEM NO. LOCATION	SH 12-00	JRB 12-00
	D	CHANGED STG 1 (SA) TO 1/2" TUBE. ADDED ITEM #226. ECN #71540.	SH 4-04	JRB 4-04

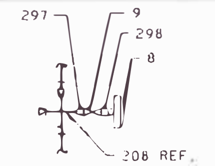
NOTES:
1. DO NOT ALLOW NYLON TUBING TO COME INTO CONTACT WITH ANY HOT SURFACE.
2. THE PRESSURE TRANSDUCER IS SHOWN WITH TWO DIFFERENT MOUNTINGS. REFER TO THE ARRANGEMENT THAT FITS YOUR REQUIREMENTS. THESE ARRANGEMENTS ARE TYPICAL FOR STAGE 1 & STAGE 2.

DETAIL INLET GUIDE VANE

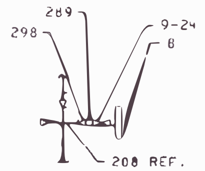








DETAIL SA GAUGE WITH VALVE



DETAIL SA GAUGE WITH BLOCK AND BLEED VALVE

PT-5	PRESSURE TRANSDUCER (STAGE-3) FOR CMC
PT-4	PRESSURE TRANSDUCER (STAGE-2)
PT-3	PRESSURE TRANSDUCER (STAGE-1)
SA	SEAL AIR
PA	POWER AIR
IA	INSTRUMENT AIR (CUST. CONN.)

ITEM	QUAN	DESCRIPTION	PART NUMBER	MATERIAL	WT

LIST OF MATERIAL

MANUAL REVISION TO THIS DOCUMENT IS PROHIBITED

CADDS PART: ENG.DP.00478669 DRA: DWG

UNSPECIFIED TOLERANCES

CASTING DIMENSION	TOLERANCE
UNDER 2" (50 mm)	±.062" (1.5 mm)
2-5" (50-125 mm)	±.125" (3.0 mm)
5-8" (125-200 mm)	±.187" (4.5 mm)
ABOVE 8" (200 mm)	±.250" (6.0 mm)

FILLETS & RADII TO BE .125 (3 mm)

MACHINING

IN.	DEC. PLC.	mm
N/A	0 PLACE	±1.0
±.04	1 PLACE	±0.3
±.01	2 PLACE	±0.15
±.005	3 PLACE	±0.13
±.0005	4 PLACE	N/A

GEOMETRIC TOLERANCES

USE REFERENCE C1250 35/3C STANDARD

REFERENCE DRAWING 7X28133

Ingersoll-Rand Air Solutions

TITLE: ASSEMBLY CONTROL-AIR

DRAWN NOLES 10-99
CHECKED JOHNSON 10-99
APPROVED BROWN 10-99

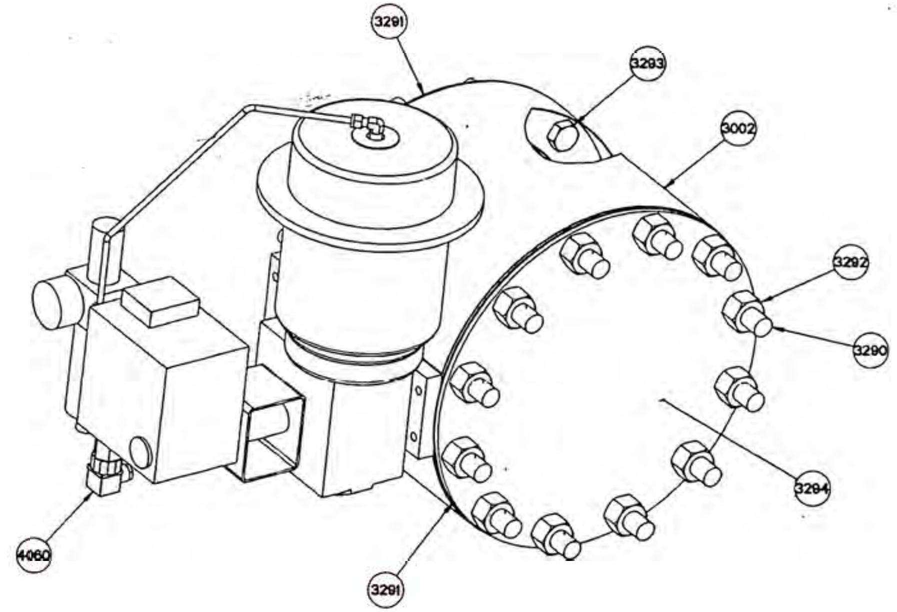
DWG NO. 00478669 REV D

SCALE: NONE SHEET 1 OF 1

FILE DATE: 95-11-02
FILE TIME: 14:53:10

ZONE	REV	ECN	DESCRIPTION	DATE	DRAWN	APP'D
	A	74431	ORIGINAL RELEASE	03-30-2007	MAC	JP

REVISIONS



NOTES :

UNSPECIFIED TOLERANCES

CASTING: DIMENSION	CASTING: TOLERANCE	MACHINING	INCH	DEC. PLC.	MM
UNDER 2" (UNDER 50mm)	±.062" (±1.5mm)	COUNTERSINK TAPPED HOLES TO BODY DIA	N/A	0 PLACE	±1.5
2" - 5" (50 - 125mm)	±.125" (±3.0mm)	MACH FIN. 125 RMS	±.01	1 PLACE	±0.3
5" - 8" (125 - 200mm)	±.187" (±5.0mm)		±.01	2 PLACE	±0.15
ABOVE 8" (ABOVE 200mm)	±.250" (±6.0mm)	DIMENSION & TOLERANCE CONVERSION REQUIRES INCH VALUES TO HAVE ONE MORE DECIMAL PLACE THAN METRIC	±.005	3 PLACE	±0.015
FILLETS & RADII TO BE .125" (3mm)			±.0005	4 PLACE	N/A
			[illegible]		

[illegible] Industrial Technologies

WARNING: THE EXPORT OR REEXPORT OF THIS DRAWING OR A PRODUCT PRODUCED BY THIS DRAWING IS SUBJECT TO U.S. EXPORT ADMINISTRATION REGULATIONS AND OTHER APPLICABLE GOVERNMENT RESTRICTIONS OR REGULATIONS.

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DRAWING CONFORMS TO ASME Y14.5M - 1994

CAD GENERATED DRAWING, NO MANUAL REVISIONS ALLOWED

UNLESS OTHERWISE SPECIFIED:
- REMOVE ALL BURRS AND SHARP CORNERS
- WELD SYMBOLS TO BE IN ACCORDANCE WITH ANSI/AWS A2.4

THIRD ANGLE PROJECTION

	DATE
DRAWN: M. CURRY	03-30-07
CHECKED: JP	03-07
APPROVED: J. PARK	03-07

Ingersoll Rand

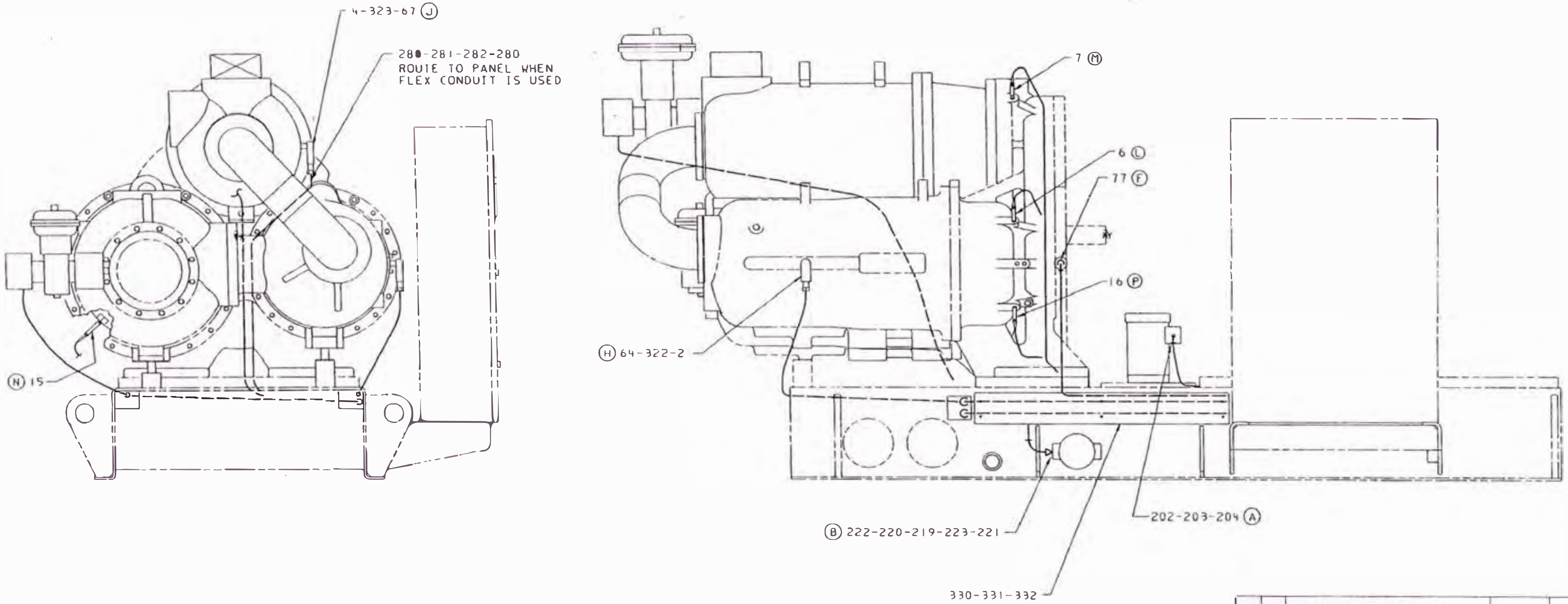
TITLE: OPT, IGV NYLON TUBING

SIZE	ESTIMATED WEIGHT	DWG NO.	REV
A1	0.0	23104060	A
SCALE: 0.38	UNIT:	C950	SHEET 1 OF 1

UNLESS OTHERWISE SPECIFIED PRINTED DOCUMENT IS UNCONTROLLED

DWG. NO. 7X28831

REVISION				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	ITEMS #5 AND #15 WERE REVERSED.	MG 11/99	JRB 11/99
	B	REROUTED VIB. CABLE AND OIL P.T. LINES ENTER TOP OF WIREWAY.	NOLES 02/00	CALDWELL 02/00



ITEM	QUAN	DESCRIPTION	PART NUMBER	MATERIAL	WT

LIST OF MATERIAL

MANUAL REVISION TO THIS DOCUMENT IS PROHIBITED

CADDS PART:ENG.DF.7X28831

INGERSOLL-RAND.
AIR COMPRESSORS
CENTRIFUGAL COMPRESSOR DIVISION
MAYFIELD, KY. 42066

TITLE: ASSEMBLY-WIRING (HARNESS)

DRAWN	DATE
NOLES	10-99
CHECKED JOHNSON	10-99
APPROVED BROWN	10-99
ENG APPVL	

SIZE | CODE IDENT NO. | DWG NO. 7X28831 | REV B

SCALE: .12 | SHEET 1 OF 2

PLOT DATA:

FILE DATE: 95-11-14
FILE TIME: 6:50:14

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UNSPECIFIED TOLERANCES

CASTING	
DIMENSION	TOLERANCE
UNDER 2" (50 mm)	±.062" (±1.5 mm)
2-5" (50-125 mm)	±.125" (±3.0 mm)
5-8" (125-200 mm)	±.187" (±4.5 mm)
ABOVE 8" (200 mm)	±.250" (±6.0 mm)

FILLETS & RADII TO BE .125 (3 mm)

MACHINING

REMOVE BURRS & SHARP CORNERS.

COUNTERSINK TAPPED HOLES TO BODY SIZE.

MACH FIN. 125 RMS

DIMENSION & TOLERANCE CONVERSION REQUIRES INCH VALUES TO HAVE ONE MORE DECIMAL PLACE THAN METRIC VALUES

IN.	DEC. PLC.	mm
N/A	0 PLACE	±1.0
±.04	1 PLACE	±0.5
±.01	2 PLACE	±0.15
±.005	3 PLACE	±0.015
±.0005	4 PLACE	N/A

INT. CORNER .030 (.8 mm) R MAX.
EXT. CORNER .015 (.4 mm) R MAX.
ANGULARITY ±1°
TORCH CUT ±1/16 (1.5 mm)

GEOMETRIC TOLERANCES	SYM
FLATNESS	
CIRCULARITY	
CYLINDRICITY	
PROFILE OF LINE	
PROFILE OF SURFACE	
ANGULARITY	
PERPENDICULARITY	
PARALLELISM	
POSITION	
CONCENTRICITY	
CIRCULAR RUNOUT	
TOTAL RUNOUT	

USE REFERENCE: C1250 STANDARD 35/3C

REFERENCE DRAWING: 7X28134

WEIGHT

PATTERN NO.

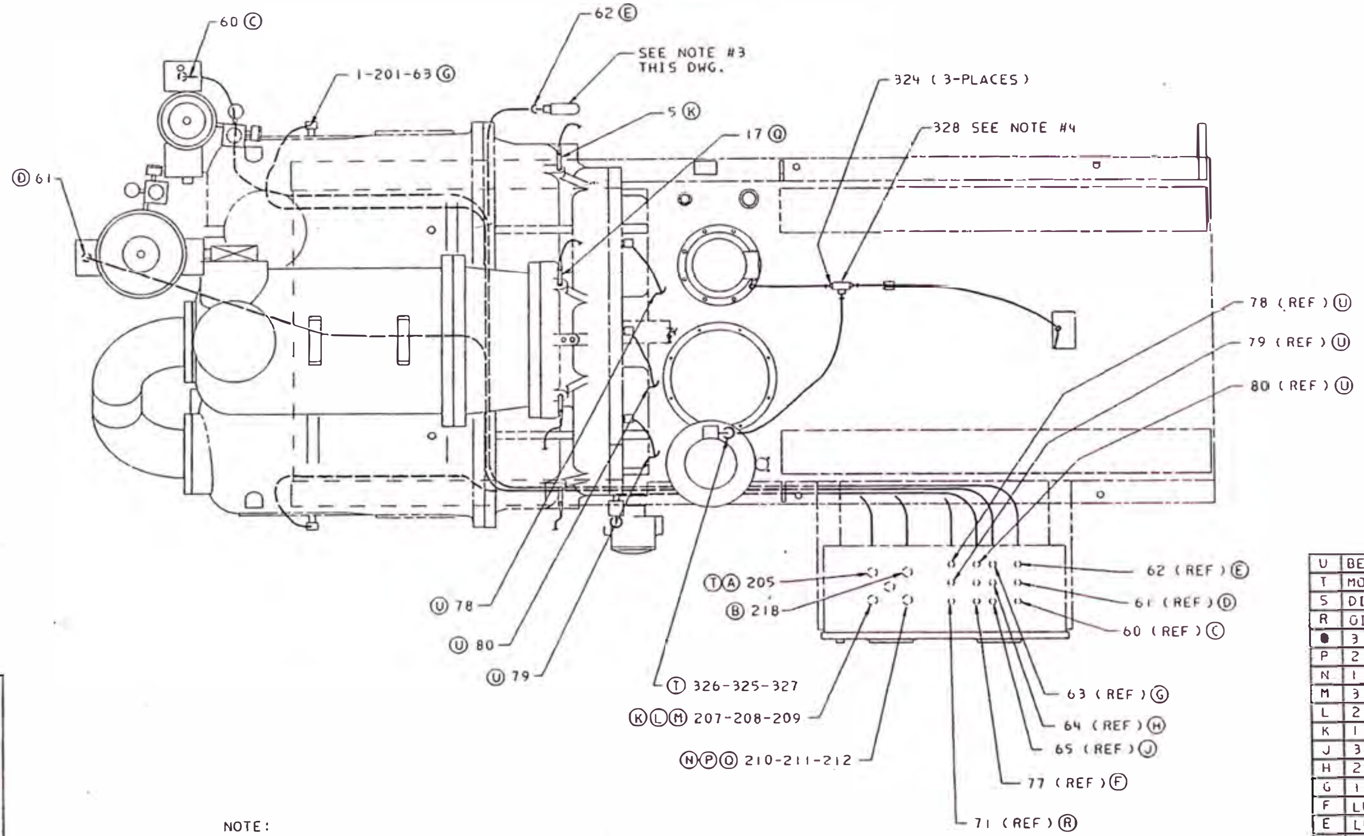
MATERIAL

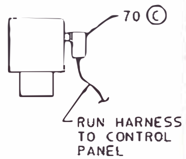
HEAT TREAT

HARDNESS MAX MIN

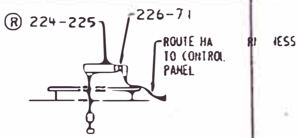
MET APPVL

D C B A





DIRTY OIL FILTER SWITCH



OIL LEVEL SWITCH

NOTE:

1. DO NOT ALLOW NYLON HARNESS TO CONTACT OR MOUNT TO ANY HOT SURFACE.
2. WIRING HARNESS ARE CALLED OUT TWICE ON THE DRAWING, ONCE ON THE ITEM TO BE WIRED AND AGAIN AT THE CONTROL PANEL FOR REFERENCE.
3. LUBE OIL RTD IS SHOWN IN A GENERAL LOCATION. THIS VARIES FROM SINGLE FILTER TO DUAL FILTER LUBE OIL SYSTEMS.
4. IF MOTORIZED DEMISTER IS USED THEN JOIN A UNILET (#328) INTO THE PRELUBE PUMP CONDUIT RUN AND CONNECT BOTH ITEMS TO THE CONTROL PANEL.

U	BEARING RTD	HARNESS
T	MOTORIZED DEMISTER	CONDUIT
S	DIRTY OIL FILTER SWITCH	HARNESS
R	OIL LEVEL SWITCH	HARNESS
●	3 RD STAGE "X" VIBRATION	CABLE
P	2 ND STAGE "X" VIBRATION	CABLE
N	1 ST STAGE "X" VIBRATION	CABLE
M	3 RD STAGE "Y" VIBRATION	CABLE
L	2 ND STAGE "Y" VIBRATION	CABLE
K	1 ST STAGE "Y" VIBRATION	CABLE
J	3 RD STAGE TEMP RTD	HARNESS
H	2 ND STAGE TEMP RTD	HARNESS
G	1 ST STAGE TEMP RTD	HARNESS
F	LUBE OIL PRESS. TRANSDUCER	HARNESS
E	LUBE OIL RTD	HARNESS
D	BYPASS VALVE	HARNESS
C	INLET VALVE	HARNESS
B	LUBE OIL HEATER	CONDUIT
A	PRELUBE PUMP	CONDUIT

LEGEND

INGERSOLL-RAND.
AIR COMPRESSORS
CENTRIFUGAL COMPRESSOR DIVISION
MAYFIELD, KY. 42066

DRAWN	NOLES	10-99
CHECKED	JOHNSON	10-99
APPROVED	BROWN	10-99
CHG APPVL		

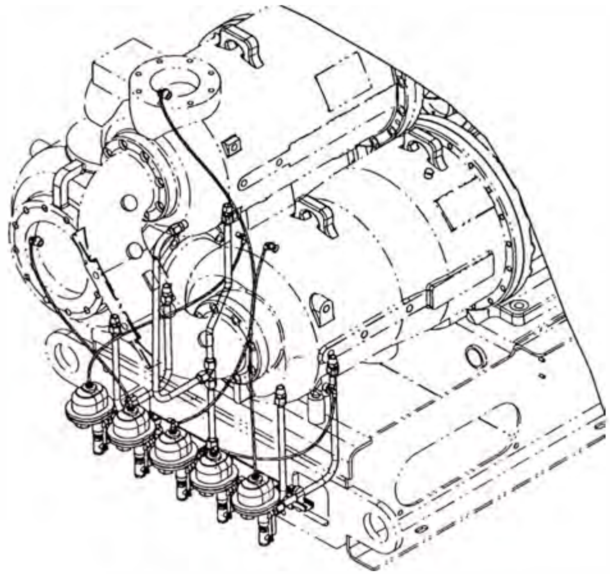
TITLE ASSEMBLY-WIRING (HARNESS)

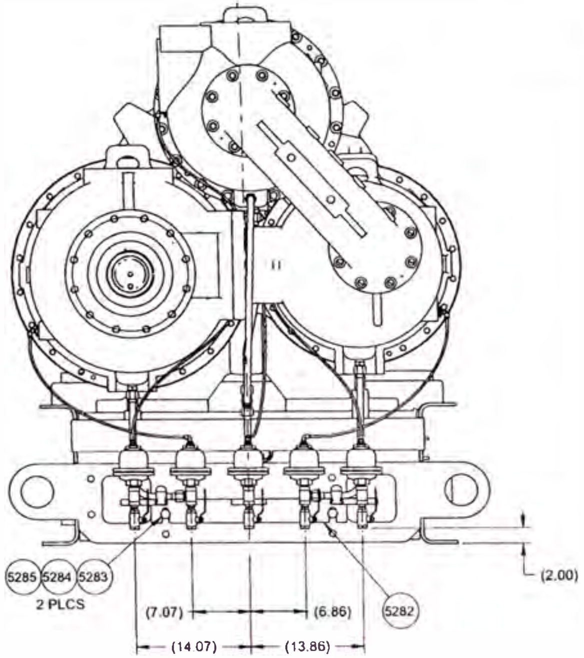
SIZE | CODE IDENT NO. | DWG NO. 7X28831 | REV B

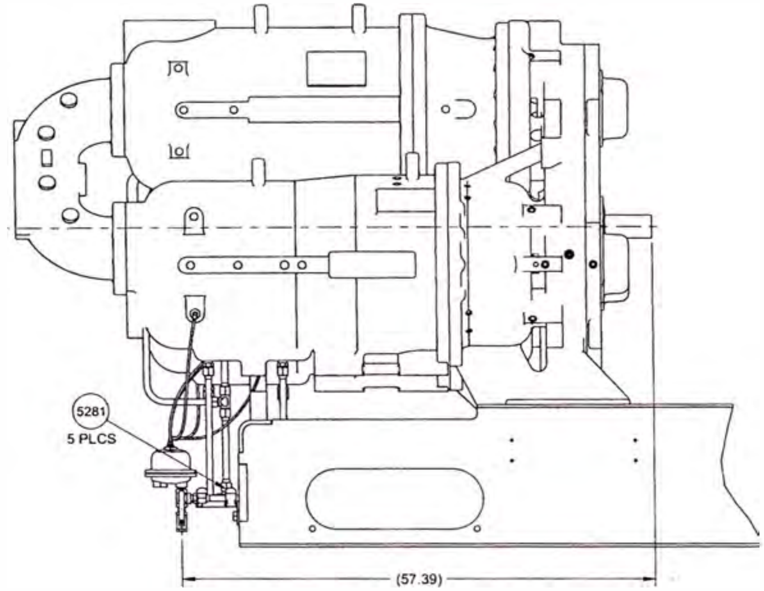
SCALE 1:12 | SHEET 2 OF 2

NOTES:

ITEM 5282 WITH BOLTS. ADJUST AS NEEDED.
USE ITEM 5281 TO SECURE TUBING TO ITEM 5282.







UNSPECIFIED TOLERANCES					
CASTING		MACHINING			
DIMENSION	TOLERANCE	[illegible]	INCH	DEC. PLC	MM
UNDER 2"	[illegible]	[illegible] TO BODY SIZE	N/A	0 PLACE	[illegible]
[illegible]	± .125"	MACHINE 125 Ra	[illegible]	1 PLACE	±0.3
[illegible]	± .187"		[illegible]	2 PLACE	±0.16
ABOVE 8" (ABOVE 200mm)	± .250"	DIMENSION & TOLERANCE CONVERSION REQUIRES EACH VALUE TO HAVE ONE MORE DECIMAL PLACE THAN METRIC	± .005	3 PLACE	±0.016
FILLETS & RADII [illegible]			±.0000	4 PLACE	N/A

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DO NOT SCALE DRAWING

DRAWING CONFORMS TO ASME Y14.5M - 1994

CAD GENERATED DRAWING, NO MANUAL REVISIONS ALLOWED

UNLESS OTHERWISE SPECIFIED
- REMOVE ALL BURRS AND SHARP CORNERS
- WELD SYMBOLS TO BE IN ACCORDANCE WITH ANSI/AWS A2.4

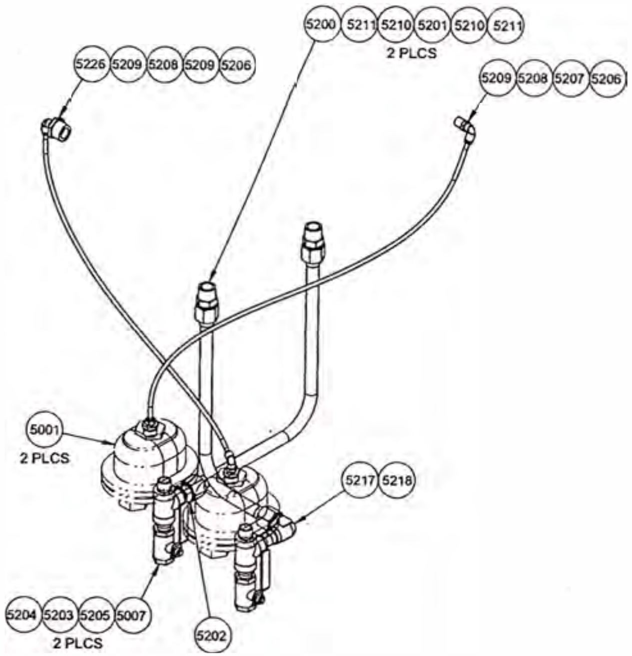
THIRD ANGLE PROJECTION

DRAWN	DATE
M.CURRY	2008MAY12
CHECKED: R.JG	2008MAY12
APPROVED: R.J.GRISE	2008MAY12

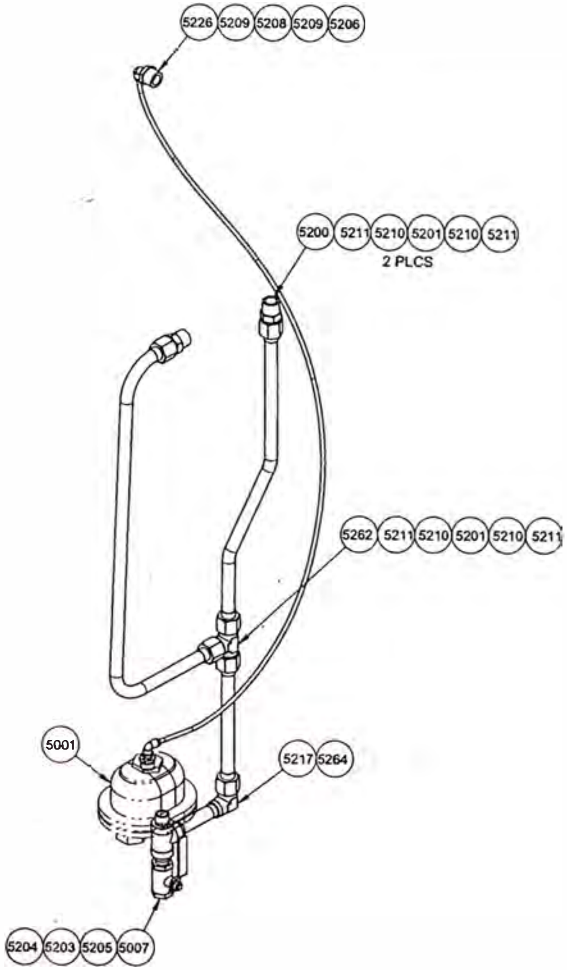
Ingersoll Rand

ASSY, CONDENSATE

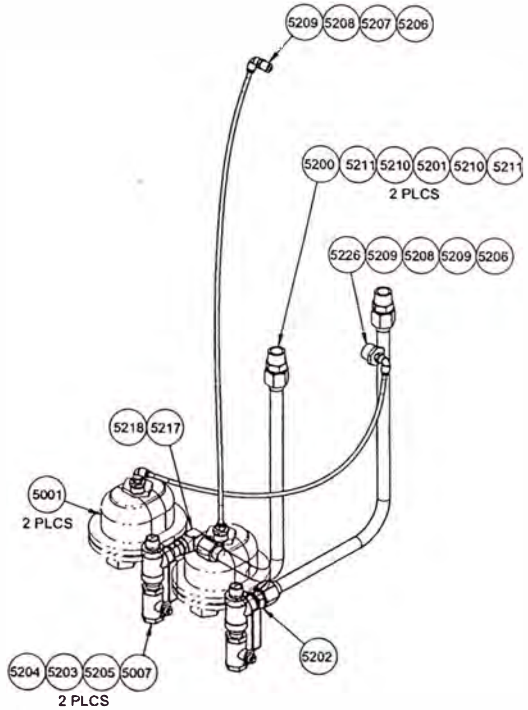
SIZE	ESTIMATED WEIGHT	DWG NO	REV
A1	0.0	23308182	A
SCALE 0.13	UNIT	C950	SHEET 1 OF 2



STAGE 1
SCALE 0.250



STAGE 3
SCALE 0.250



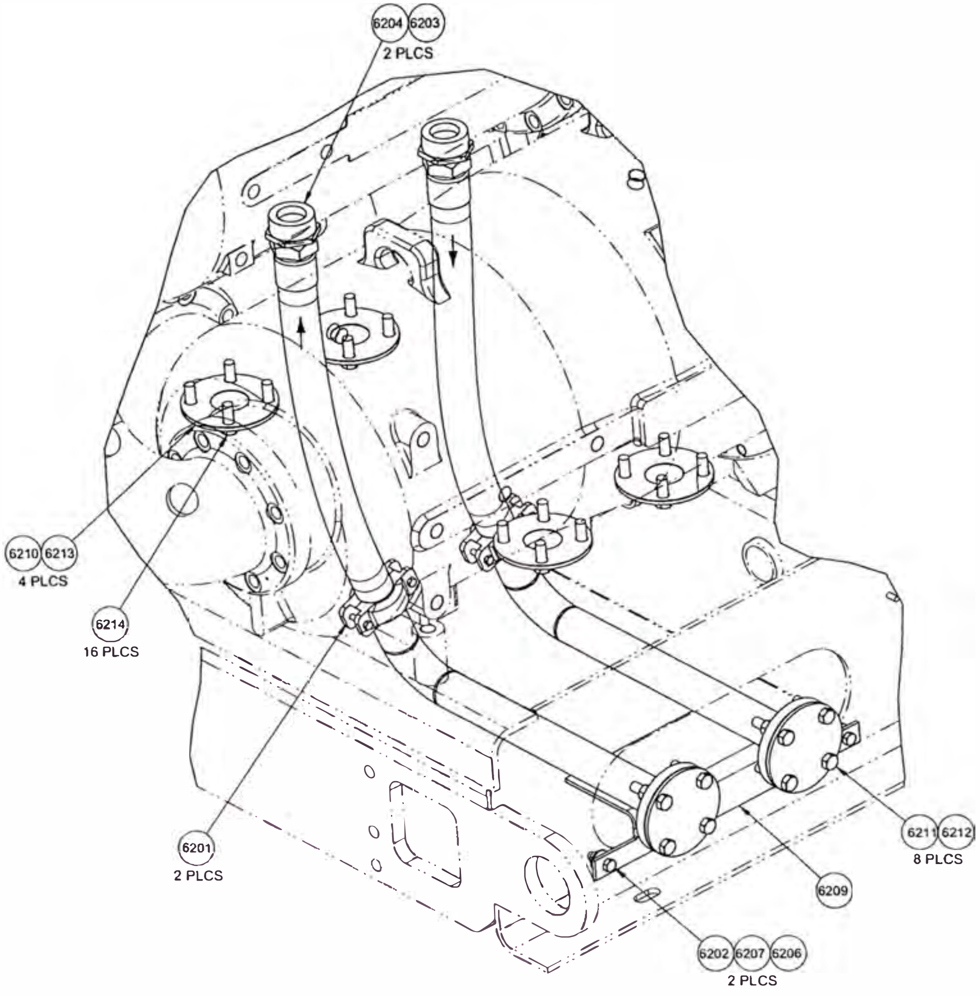
STAGE 2
SCALE 0.250

PROPRIETARY NOTICE

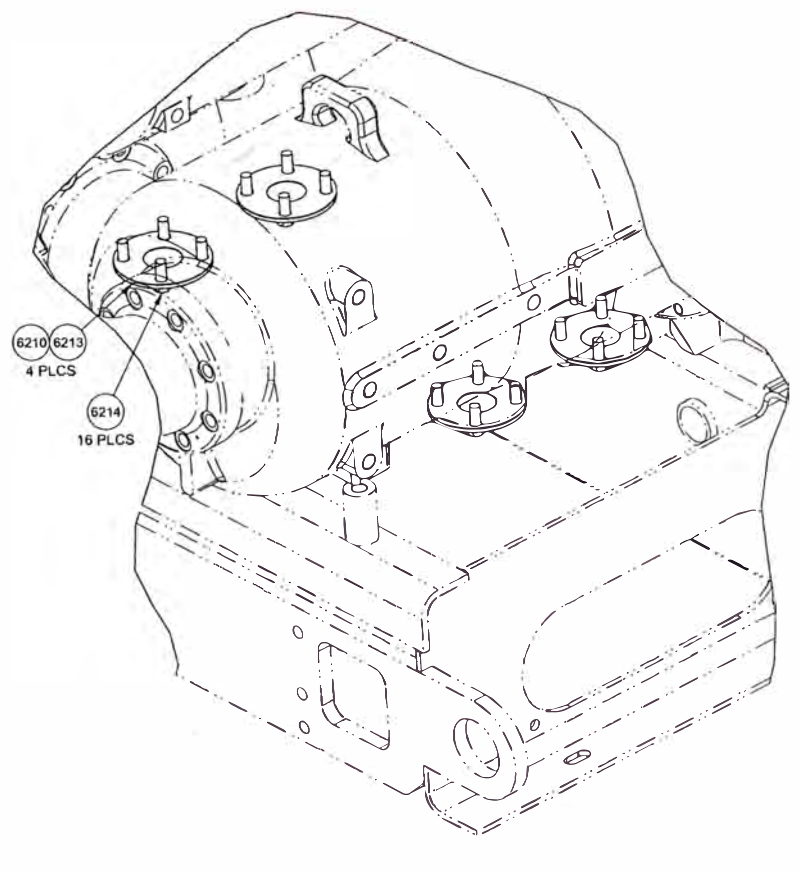
ASSY, CONDENSATE

A1 | 23308182 | A

2 OF 2



3S-3C DETAIL



3S-2C AND 2S-2C DETAIL

NOTES :
1. INSERT PIPE ASSEMBLY (ITEM 6209) AT AN ANGLE THRU LARGE SLOT IN SIDE OF BASEPLATE AND POSITION AS SHOWN.
2. ATTACH ASSEMBLY (ITEM 6209) USING FASTENERS (ITEMS 6202, 6206 & 6207) INSERTED FROM EITHER DIRECTION.
3. ALIGN FLEX HOSES (ITEM 6203 & 6205) TO ASSEMBLY PIPE ENDS AND CONNECT USING VICTAULIC COUPLINGS (ITEM 6201).

UNSPECIFIED TOLERANNES

CASTING		MACHINING			
DIMENSION	TOLERANCE		INCH	DEC. PLC	MM
UNDER 2"	[illegible]	COUNTERSINK TAPPED HOLES TO BODY SIZE	N/A	[illegible] PLACE	[illegible]
2 - 5" (50 - 125mm)	± .125"	MACHINE 125 MAS	±.04	1 PLACE	±0.3
5 - 8"	± .187"		±.01	2 PLACE	[illegible]
ABOVE 8"	± .250"	DIMENSION & TOLERANCE CONVERSION [illegible]	[illegible]	3 PLACE	[illegible]
[illegible]			±.0[illegible]	4 PLACE	N/A

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DRAWING CONFORMS TO ASME Y14.5M - 1994

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THIRD ANGLE PROJECTION

DRAWN	M.CURRY	2008JUN13
CHECKED	RJG	2008JUN13
APPROVED	R J GRISE	2008JUN13

Ingersoll Rand

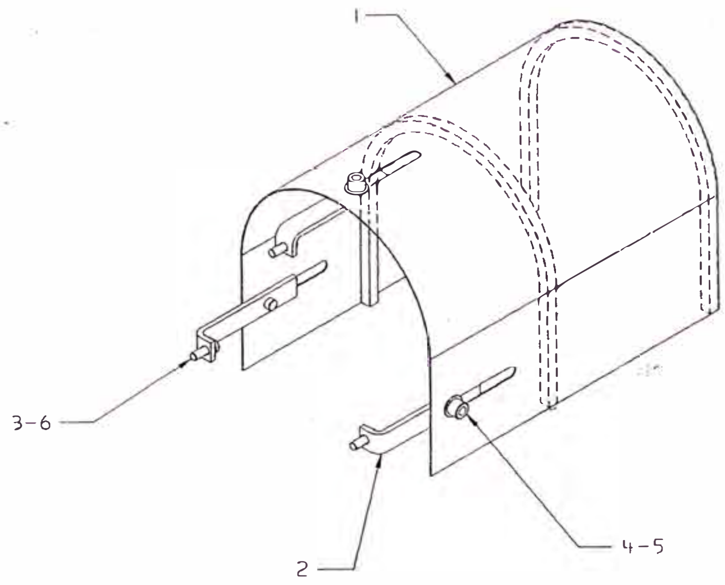
TITLE: **ASSY, WATER MANIFOLD**

SIZE		DWG NO	REV
A1	0 0	23327216	A
SCALE 0.25		C950	SHEET 1 OF 1

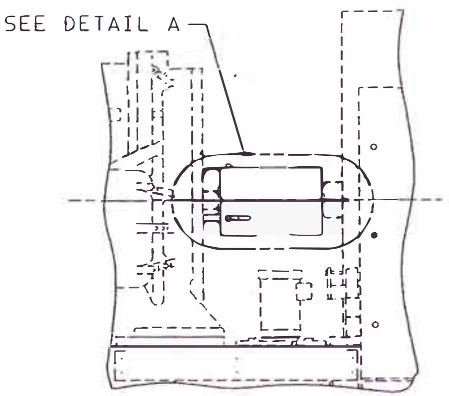
UNLESS OTHERWISE SPECIFIED PRINTED DOCUMENT IS UNCONTROLLED

ZONE	LTR	DESCRIPTION	DATE	APPROVED

REVISION



DETAIL A



NOTE:
ATTACH TO COMPRESSOR AS REQUIRED.

ITEM	QUAN	DESCRIPTION	PART NUMBER	MATERIAL	WT

LIST OF MATERIAL

MANUAL REVISION TO THIS DOCUMENT IS PROHIBITED

CADDS PART: ENG.DP.5X5774 DRA: 1

PROPRIETARY NOTICE

0 5 10 15 20 25 (mm) (INCH)

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UNSPECIFIED TOLERANCES

CASTING		MACHINING			
DIMENSION	TOLERANCE	REMOVE BURRS & SHARP CORNERS.			
UNDER 2" (50 mm)	±.062" (1.5 mm)		N/A	0 PLACE	±1.0
2-5" (50-125 mm)	±.125" (3.0 mm)	COUNTERSINK TAPPED HOLES TO BODY SIZE.	±.04	1 PLACE	±0.3
			±.01	2 PLACE	±0.15
5-8" (125-200 mm)	±.187" (4.5 mm)	MACH FIN. 125 RMS	±.005	3 PLACE	±0.015
ABOVE 8" (200 mm)	±.250" (6.0 mm)	DIMENSION & TOLERANCE CONVERSION REQUIRES INCH VALUES TO HAVE ONE MORE DECIMAL PLACE THAN METRIC VALUES	±.0005	4 PLACE	N/A
FILLETS & RADII TO BE .125 (3 mm)			INT. CORNER .030 (.8 mm) R MAX. EXT. CORNER .015 (.4 mm) R MAX.		

GEOMETRIC TOLERANCES	SYM
FLATNESS	
CYLINDRICITY	
PROFILE OF LINE	
PROFILE OF SURFACE	
ANGULARITY	
PERPENDICULARITY	
PARALLELISM	
POSITION	
CONCENTRICITY	
CIRCULAR RUNOUT	
TOTAL RUNOUT	

USE REFERENCE: 2ACII STANDARD

REFERENCE DRAWING

WEIGHT

PATTERN NO.

MATERIAL

HEAT TREAT

HARDNESS MAX ____ MIN ____

NET APPVL

INGERSOLL-RAND
AIR COMPRESSORS
CENTRIFUGAL COMPRESSOR DIVISION
MAYFIELD, KY. 42066

		DATE
DRAWN	RJS	1/96
CHECKED	JRB	1/96
APPROVED	JRB	1/96

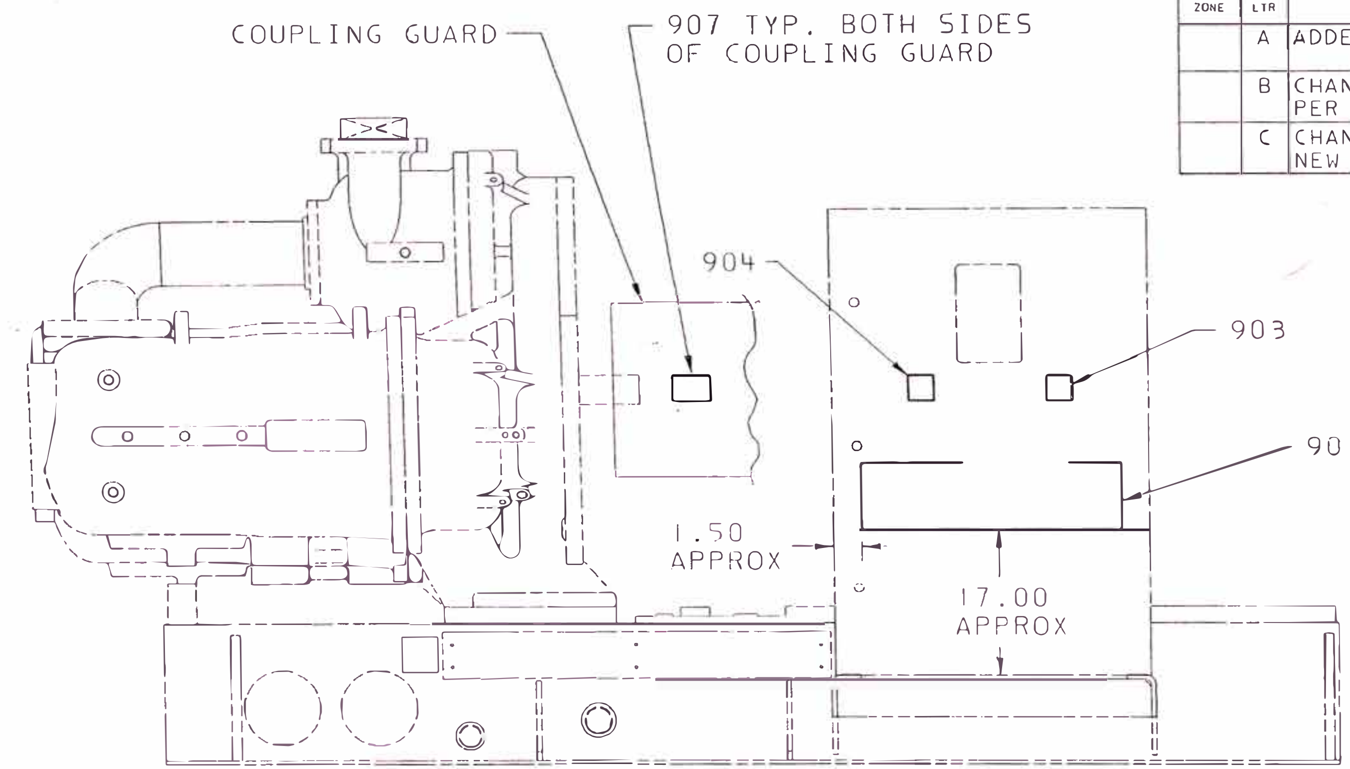
TITLE
ASSEMBLY COUPLING GUARD

SIZE | CODE IDENT NO. | DWG NO. 5X5774 | REV

DWG. NO. 5X5774 SHEET 1

DWG. NO. 3X4538 SHEET 1

REVISION				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	ADDED ITEM 907	MRH 7/97	JRB 7/97
	B	CHANGED LOC ITEM 901 PER ECR 99013	MEH 6-99	JRB 6-99
	C	CHANGED ITEM 901 TO NEW IR LABEL.	SH 8-00	JRB 8-00



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0 5 10 15 20 25 (MM) (INCH)

PROPRIETARY NOTICE

ITEM	QUAN	DESCRIPTION	PART NUMBER	MATERIAL	WT

LIST OF MATERIAL

MANUAL REVISION TO THIS DOCUMENT IS PROHIBITED

CADDS PART:ENG.DP.3X4538 DRA: 1

UNSPECIFIED TOLERANCES

CASTING		MACHINING			
DIMENSION	TOLERANCE	REMOVE BURRS & SHARP CORNERS.	IN.	DEC. PLC.	mm
UNDER 2" (50 mm)	±.062" (1.5 mm)		N/A	0 PLACE	±1.0
2-5" (50-125 mm)	±.125" (3.0 mm)	COUNTERSINK TAPPED HOLES TO BODY SIZE.	±.04	1 PLACE	±0.3
5-8" (125-200 mm)	±.187" (4.5 mm)		±.01	2 PLACE	±0.15
ABOVE 8" (200 mm)	±.250" (6.0 mm)	MACH FIN. 125 RMS	±.005	3 PLACE	±0.015
FILLETS & RADII TO BE .125 (3 mm)		DIMENSION & TOLERANCE CONVERSION REQUIRES INCH VALUES TO HAVE ONE MORE DECIMAL PLACE THAN METRIC VALUES	±.0005	4 PLACE	N/A
			INT. CORNER .030 (.8 mm) R MAX. EXT. CORNER .015 (.4 mm) R MAX. ANGULARITY ±1° TORCH CUT ±1/16 (1.5 mm)		

GEOMETRIC TOLERANCES	SYM
FLATNESS	▱
CIRCULARITY	○
CYLINDRICITY	⌭
PROFILE OF LINE	⌒
PROFILE OF SURFACE	⌓
ANGULARITY	∠
PERPENDICULARITY	⊥
PARALLELISM	//
POSITION	⌖
CONCENTRICITY	◎
CIRCULAR RUNOUT	↗
TOTAL RUNOUT	⌰

REF. ANSI Y14.5M-1982

USE REFERENCE 2ACII STANDARD

REFERENCE DRAWING

WEIGHT

PATTERN NO.

MATERIAL

HEAT TREAT

HARDNESS MAX ____ MIN ____

MET APPVL

THIRD ANGLE PROJECTION

DRAWN	RJS	DATE 10/95
CHECKED	JRB	10/95
APPROVED	JRB	10/95
ENG APPVL		

INGERSOLL-RAND
AIR COMPRESSORS
CENTRIFUGAL COMPRESSOR DIVISION
MAYFIELD, KY. 42066

TITLE
ASSEMBLY LABELS & TAGS

SIZE	CODE IDENT NO.	DWG NO.	REV
		3X4538	C

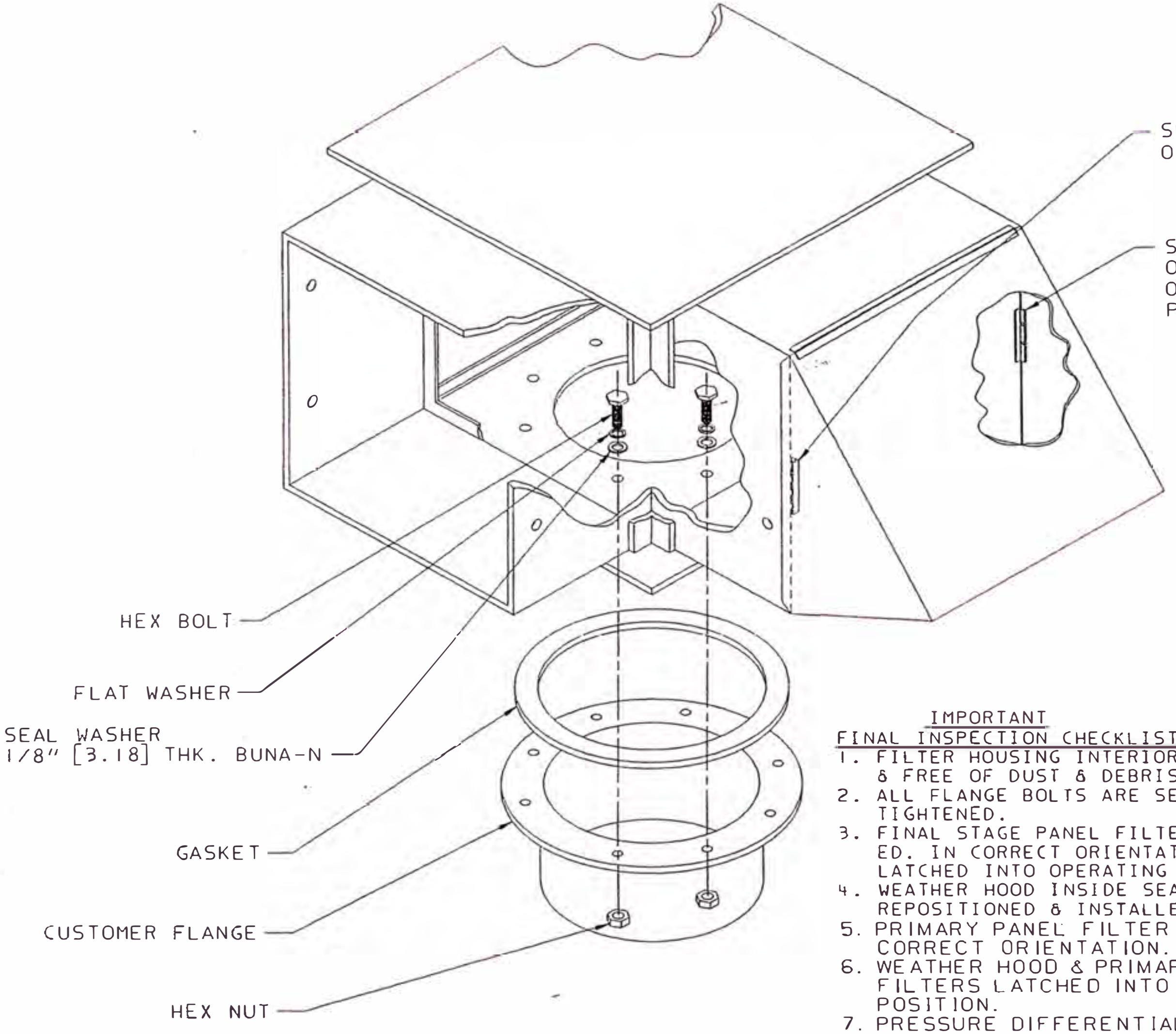
SCALE: .078 SHEET 1 OF 1

PLOT DATA:

FILE DATE: 95-10-13
FILE TIME: 10:22:36

FORM SE4403

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	REDRAWN TO CADDS.	S.R. 12/97	WJ 12/97
	B	DELETE "G-3999" FROM TITLE BLOCK.	NOLES 7/98	JOHNSON 7/98
	C	ADDED METRIC DIMENSIONS	NOLES 9/98	JOHNSON 9/98



NOTES:
1. SHOWN CONNECTION METHOD MUST BE USED TO PREVENT LEAKAGE.
2. ALL HARDWARE SHOWN MUST BE INSTALLED AT EACH HOUSING FLOOR BOLT HOLE.
3. HARDWARE MUST BE OF CORROSION RESISTANT MATERIAL OR COATED TO PREVENT RUST.
4. FILTER HOUSING FLANGE PLATE: HOLE DIA. & BOLT CIRCLE PER ANSI STANDARD. NUMBER OF BOLT HOLES IS ONE HALF THE NUMBER NORMALLY CALLED FOR ON THE SPECIFIED ANSI FLANGE SIZE.
5. CUSTOMER TO SUPPLY:
   A) HEX BOLTS
   B) HEX NUTS
   C) FLAT WASHERS
   D) 1/8" [3.18] THK. BUNA-N SEAL WASHERS
   E) GASKET: 1/8" [3.18] THK. BUNA-N (DUR. 70)
6. [ ] INDICATES METRIC DIMS.

IMPORTANT
FINAL INSPECTION CHECKLIST:
1. FILTER HOUSING INTERIOR IS CLEAN & FREE OF DUST & DEBRIS.
2. ALL FLANGE BOLTS ARE SECURELY TIGHTENED.
3. FINAL STAGE PANEL FILTERS INSTALLED. IN CORRECT ORIENTATION AND LATCHED INTO OPERATING POSITION.
4. WEATHER HOOD INSIDE SEAL BRACKETS REPOSITIONED & INSTALLED AS SHOWN.
5. PRIMARY PANEL FILTER INSTALLED IN CORRECT ORIENTATION.
6. WEATHER HOOD & PRIMARY PANEL FILTERS LATCHED INTO OPERATING POSITION.
7. PRESSURE DIFFERENTIAL GAGE (IF SUPPLIED) INSTALLED & OPERATIONAL.

ITEM	QUAN	DESCRIPTION	PART NUMBER	MATERIAL	WT

LIST OF MATERIAL

MANUAL REVISION TO THIS DOCUMENT IS PROHIBITED
CADDS PART: ENG.DP.5X2941 DRA: 1

UNSPECIFIED TOLERANCES

CASTING DIMENSION	CASTING TOLERANCE	MACHINING	IN.	DEC. PLC.	mm
UNDER 2" (50 mm)	±.062" (1.5 mm)	REMOVE BURRS & SHARP CORNERS.	N/A	0 PLACE	±1.0
2-5" (50-125 mm)	±.125" (3.0 mm)	COUNTERSINK TAPPED HOLES TO BODY SIZE.	±.04	1 PLACE	[illegible]
			±.01	2 PLACE	±0.15
5-8" (125-200 mm)	±.187" (4.5 mm)	MACH FIN. 125 RMS	±.005	3 PLACE	±0.015
ABOVE 8" (200 mm)	±.250" (6.0 mm)	DIMENSION & TOLERANCE CONVERSION REQUIRES INCH VALUES TO HAVE ONE MORE DECIMAL PLACE THAN METRIC VALUES	±.0005	4 PLACE	N/A
FILLETS & RADII	25 (3 mm)		INT. CORNER .030 (.8 mm) R MAX. EXT. CORNER .015 (.4 mm) R MAX. ANGULARITY ±1° TORCH CUT ±1/16 (1.5 mm)		

GEOMETRIC TOLERANCES	SYM
FLATNESS	
CIRCULARITY	
CYLINDRICITY	
PROFILE OF LINE	
PROFILE OF SURFACE	
ANGULARITY	∠
PERPENDICULARITY	⊥
PARALLELISM	//
POSITION	
CONCENTRICITY	
CIRCULAR RUNOUT	
TOTAL RUNOUT	

USE REFERENCE
REFERENCE DRAWING
WEIGHT
PATTERN NO.
MATERIAL
HEAT TREAT
HARDNESS
MAX
MIN
MET APPVL

THIRD ANGLE PROJECTION

DRAWN | DATE
CHECKED
APPROVED
ENG APP

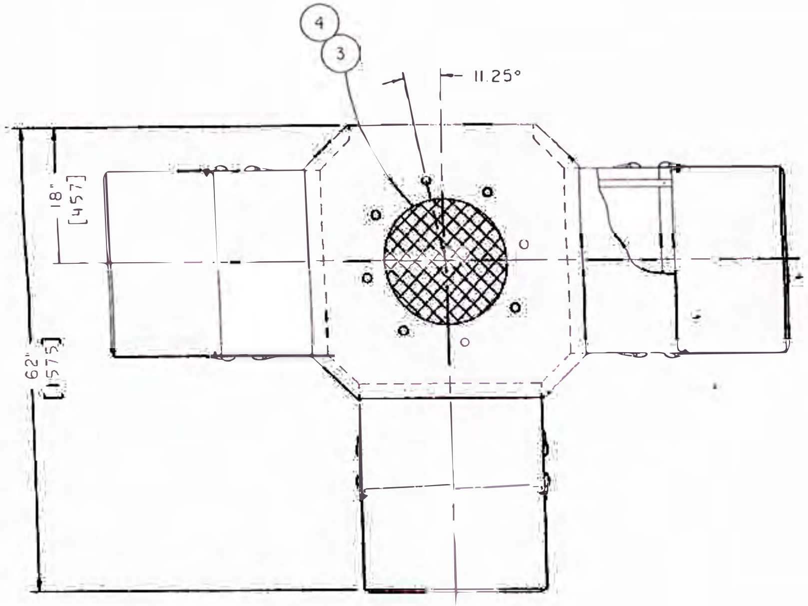
INGERSOLL-RAND
AIR COMPRESSORS
CENTRIFUGAL COMPRESSOR DIVISION
MAYFIELD, KY. 42066

TITLE
INLET AIR FILTER
FIELD CONNECTION
INSTRUCTION

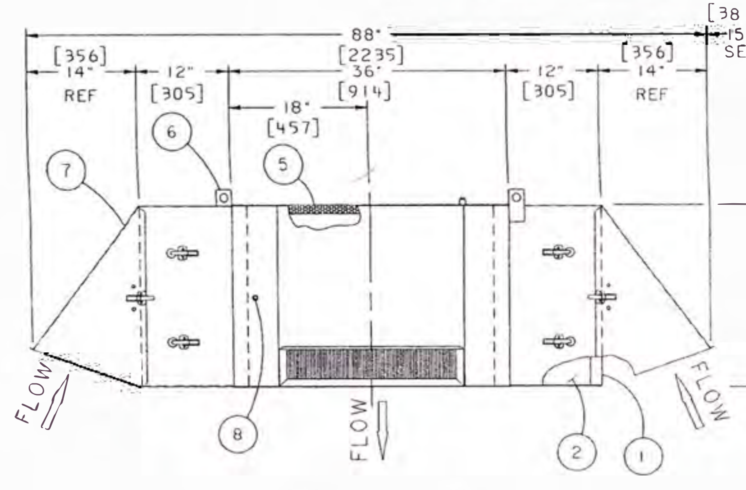
SIZE | CODE IDENT NO. | DWG NO. 5X2941 | REV C

DWG. NO. 5X2941
SHEET 1

C	UPDATED I-R FORMAT & CHGD. OUTLINE DIMS.	RAH 12/19/94	JKP 2/8/95
D	ADDED FILTER DIFFERENTIAL PRESSURE DROP TO DWG.: NOTE 2 WAS DURAD BLUE CHANGED TO IR 1X1984	KH/RLP 12/97/97	MG/JRB 11/97
E	ADDED METRIC DIMENSIONS	NOLES 9/29/98	JOHNSON 9/29/98



BOTTOM VIEW



ELEVATION VIEW

ITEM		ITEM DESCRIPTION
1	1ST STAGE PANEL	(3) REQUIRED INGERSOLL RAND P/N 1X8258
2	2ND STAGE PANEL	(3) REQUIRED INGERSOLL RAND P/N 1X8259
3	OUTLET	16" [406] DIA. W/ (8) 1 1/8" [29] DIA. HOLES EQUALLY SPACED ON A 21 1/4" [540] CIRCLE
4	SAFETY SCREEN	1/2" [13] EXPANDED METAL
5	SILENCING FOAM	POLYESTER URETHANE FOAM 2.0 LB. [1 KGS.] /CU. FT. DENSITY
6	LIFTING LUG	12 GA. [3] X 2" [51] WIDE W/ 1" [25] DIA. HOLE
7	WEATHER HOOD	HINGED TYPE WITH DRIP EDGE
8	PRESSURE TAP	1/4" [6] FEMALE NPT WITH PLUG

REMARKS:
1. GALVANNEAL AND CARBON STEEL CONSTRUCTION.
2. FINISH: PAINT PER IR SPEC 1X1984.
3. APPROXIMATE DRY WEIGHT: 415 LBS.[188 KGS.]
4. CLEAN FILTER DIFFERENTIAL PRESSURE DROP.
   4500 CFM-1.79" [45] H_2O (.06 PSI)
   5000 CFM-2.11" [54] H_2O (.08 PSI)
   5500 CFM-2.65" [67] H_2O (.10 PSI)
5. [ ] INDICATES METRIC DIMENSION.

ITEM	QUAN	DESCRIPTION	PART NUMBER	MATERIAL	WT

LIST OF MATERIAL

MANUAL REVISION TO THIS DOCUMENT IS PROHIBITED

CADDS PART: ENG.SP.5X2900 DRA: 1

UNSPECIFIED TOLERANCES

CASTING		MACHINING			
DIMENSION	TOLERANCE	REMOVE BURRS & SHARP CORNERS	DEC. PLC.		mm
UNDER 2" (50 mm)	±.062" (1.5 mm)	COUNTERSINK TAPPED HOLES TO BODY SIZE.	N/A	0 PLACE	±1.0
2-5" (50-125 mm)	±.125" (3.0 mm)		±.04	1 PLACE	±0.3
5-8" (125-200 mm)	±.187" (4.5 mm)	MACH FIN. 125 RMS	±.01	2 PLACE	±0.15
ABOVE 8" (200 mm)	±.250" (6.0 mm)	DIMENSION & TOLERANCE CONVERSION REQUIRES INCH VALUES TO HAVE ONE MORE DECIMAL PLACE THAN METRIC VALUES	±.005	3 PLACE	±0.015
			±.0005	4 PLACE	N/A

FILLETS & RADII TO BE .125 (3 mm)

INT. CORNER .030 (.8 mm) R MAX.
EXT. CORNER .015 (.4 mm) R MAX.
ANGULARITY ±1°
TORCH CUT ±1/16 (1.5 mm)

GEOMETRIC TOLERANCES | SYM
FLATNESS
CIRCULARITY

USE REFERENCE: NAFCO 22160-0750

PATTERN NO.
MATERIAL
HEAT TREAT
HARDNESS

THIRD ANGLE PROJECTION

		DATE
DRAWN	REH	6-92
CHECKED	JPH	11-94
APPROVED	DHC	11-94
ENG APPVL		

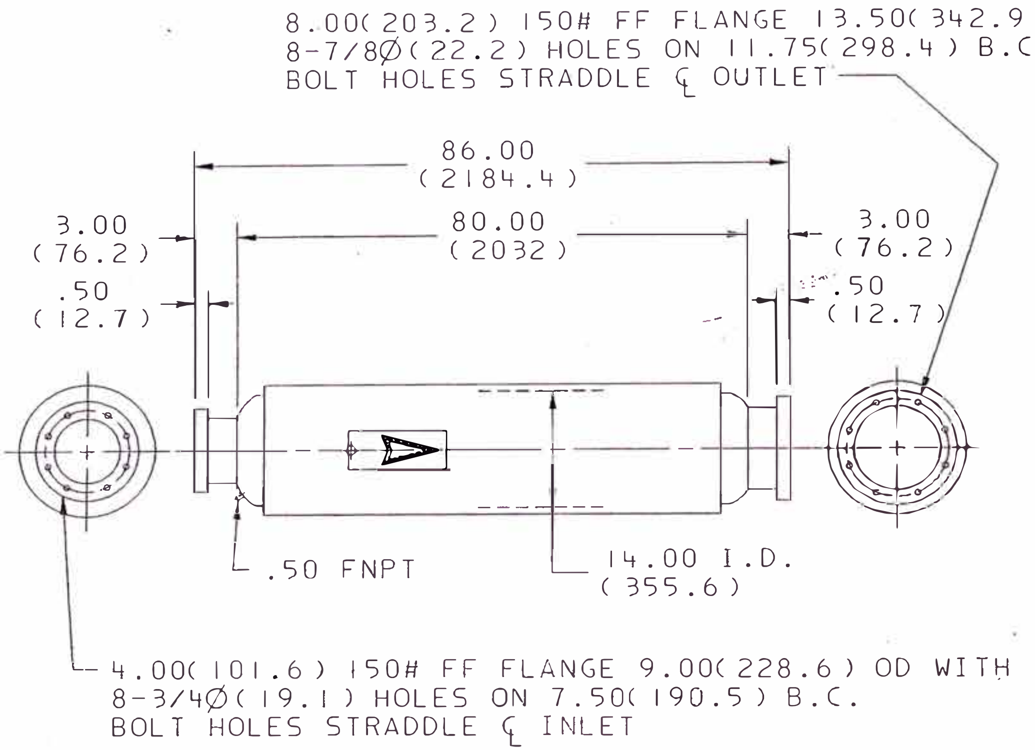
INGERSOLL-RAND
AIR COMPRESSORS
CENTRIFUGAL COMPRESSOR DIVISION
MAYFIELD, KY. 42066

TITLE
AIR INTAKE FILTER/SILENCER

SIZE | CODE IDENT NO. | DWG NO. 5X2900 | REV E

DWG. NO. 67693812 SHEET 1

REVISION				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	14.00 ID WAS 14.00 OD ADDED .50 FNPT DRAIN COUPLING.	TK 10-90	TH 10-90
	B	ADDED NOTE #10.	MEH 1-91	TH 1-91
	C	REDRAWN TO CADDS.	SH 6-99	WJ 6-99
	D	CONVERTED DWG #3X2144 TO CORRESPONDING CCN#. REMOVED NOTE 9. ECN #69863.	SH 8-02	JRB 8-02



NOTES:

1. UNIT MAY BE INSTALLED IN HORIZONTAL OR VERTICAL POSITION.
2. UNLESS OTHERWISE SPECIFIED ON SALES ORDER-FINISH TO BE EXTERNAL SHOP COAT PRIMER.
3. EST. WEIGHT 152 LBS. (68.9 KG).
4. ACOUSTICAL PACK MATERIAL TO BE FIBER-GLASS.
5. FOR HORIZONTAL MOUNTING-BOTH FLANGES TO BE SUPPORTED.
6. UNIT TO BE SUITABLE FOR INTERNAL DESIGN PRESSURE OF 10 PSIG (69KPA) BACK PRESSURE.
7. BODY MATERIAL 14 GA. CARBON STEEL DOUBLE WRAPPED.
8. DIMENSIONS IN ( ) ARE IN MILLIMETERS.
9. DIMENSIONAL TOLERANCE IS ±.25 ON OVERALL LENGTH, AND ±.12 ON ALL OTHER DIMENSIONS.

0 5 10 15 20 25 (MM) (INCH)

ITEM	QUAN	DESCRIPTION	PART NUMBER	MATERIAL	WT

LIST OF MATERIAL

MANUAL REVISION TO THIS DOCUMENT IS PROHIBITED

CADDS PART: ENG.SD.67693812 DRA: 1

UNSPECIFIED TOLERANCES

CASTING		MACHINING			
DIMENSION	TOLERANCE	REMOVE BURRS & SHARP CORNERS.	IN.	DEC. PLC.	mm
UNDER 2" (50 mm)	±.062" (1.5 mm)		N/A	0 PLACE	±1.0
2-5" (50-125 mm)	±.125" (3.0 mm)	COUNTERSINK TAPPED HOLES TO BODY SIZE.	±.04	1 PLACE	±0.3
5-8" (125-200 mm)	±.187" (4.5 mm)		±.01	2 PLACE	±0.15
ABOVE 8" (200 mm)	±.250" (6.0 mm)	MACH FIN. 125 RMS	±.005	3 PLACE	±0.015
		DIMENSION & TOLERANCE CONVERSION REQUIRES INCH VALUES TO HAVE ONE MORE DECIMAL PLACE THAN METRIC VALUES	±.0005	4 PLACE	N/A
FILLETS & RADII TO BE .125 (3 mm)			INT. CORNER .030 (.8 mm) R MAX. EXT. CORNER .015 (.4 mm) R MAX. ANGULARITY ±1° TORCH CUT ±1/16 (1.5 mm)		

GEOMETRIC TOLERANCES	SYM
FLATNESS	⏥
CIRCULARITY	○
CYLINDRICITY	⌭
PROFILE OF LINE	⌒
PROFILE OF SURFACE	⌓
ANGULARITY	∠
PERPENDICULARITY	⊥
PARALLELISM	//
POSITION	⌖
CONCENTRICITY	◎
CIRCULAR RUNOUT	↗
TOTAL RUNOUT	⌰

REF. ANSI Y14.5M-1982

USE REFERENCE

REFERENCE DRAWING

WEIGHT

PATTERN NO.

MATERIAL

HEAT TREAT

HARDNESS MAX ____ MIN ____

MET APPVL

THIRD ANGLE PROJECTION

DRAWN	DATE
PAM	2-84
CHECKED DL	2-84
APPROVED DK	2-84
ENG APPVL	

Ingersoll Rand. Air Solutions

TITLE

SILENCER 8" VENT WITH 4" INLET

SIZE	CODE IDENT NO.	DWG NO.	REV
		67693812	D

SCALE: SHEET 1 OF 1

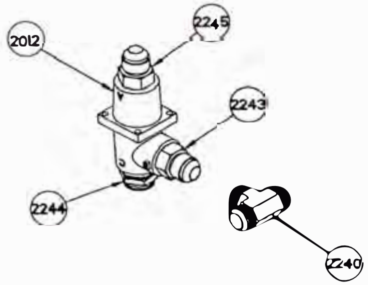
PLOT DATA:

FILE DATE: 99-06-24

D

C

B



A

NOTES :

UNSPECIFIED TOLERANCES

CASTING		MACHINING			
DIMENSION	TOLERANCE		INCH	DEC. PLC.	mm
UNDER 2" (UNDER 50mm)	± .06[illegible]" (±1.5mm)	COUNTERSINK TAPPED HOLES TO BODY SIZE	N/A	0 PLACE	±1.0
2 - 5" (51 - 125mm)	± .12[illegible]" (±3.0mm)	MACH FIN 125 RMS	±.04	1 PLACE	±0.5
5 - 8" (125 - 200mm)	± .18[illegible]" (±[illegible])		±.01	2 PLACE	±0.15
ABOVE 8" (ABOVE 200mm)	± .250" (±6.0mm)	DIMENSION & TOLERANCE CONVERSION REQUIRES INCH VALUES TO HAVE ONE MORE DECIMAL PLACE THAN METRIC	±.005	3 PLACE	±0.015
FILLETS & RADII TO BE .125" (3mm)			±.0005	4 PLACE	N/A
			[illegible]		

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- WELD SYMBOLS TO BE IN ACCORDANCE WITH ANSI/AWS A2.4

THIRD ANGLE PROJECTION

DRAWN: M. CURRY	DATE: 04-16-07
CHECKED: JP	DATE: 04-07
APPROVED: J. PARK	DATE: 04-07

Ingersoll Rand

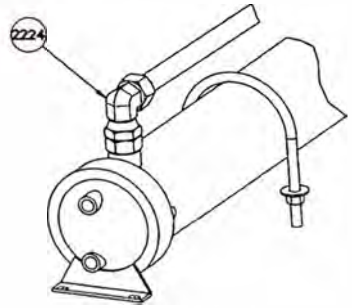
TITLE: VALVE, AMOT 1C-2F

SIZE	ESTIMATED WEIGHT	DWG NO.	REV
A1	0.0	23108327	A
SCALE: 0.25	UNIT:	C950	SHEET: 1 OF 1

8 7 6 5 4 3 2 1

UNLESS OTHERWISE SPECIFIED PRINTED DOCUMENT IS UNCONTROLLED

ZONE	REV	ECN	REVISIONS DESCRIPTION	DATE	DRAWN	APP'D
	A	74431	ORIGINAL RELEASE	04-06-2007	MSC	JP



NOTES :

UNSPECIFIED TOLERANCES

CASTING		MACHINING			
DIMENSION	TOLERANCE		INCH	DEC. PLC.	MM
UNDER 2" (UNDER 50mm)	±.062" (±1.5mm)	COUNTERSINK TAPPED HOLES TO BODY SIZE	N/A	0 PLACE	±1.0
2" - 5" (50 - 125mm)	±.125" (±3.0mm)	MACH FIN. 125 RMS	±.04	1 PLACE	±0.3
5" - 8" (125 - 200mm)	±.187" (±3.0mm)		±.01	2 PLACE	±0.15
ABOVE 8" (ABOVE 200mm)	±.250" (±6.0mm)	DIMENSION & TOLERANCE CONVERSION REQUIRES INCH VALUES TO HAVE ONE MORE DECIMAL PLACE THAN METRIC	±.005	3 PLACE	±0.015
FILLETS & RADII TO BE .125" (3mm)			±.0005	4 PLACE	N/A

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UNLESS OTHERWISE SPECIFIED:
- REMOVE ALL BURRS AND SHARP CORNERS
- WELD SYMBOLS TO BE IN ACCORDANCE WITH ANSI/AWS A2.4

THIRD ANGLE PROJECTION

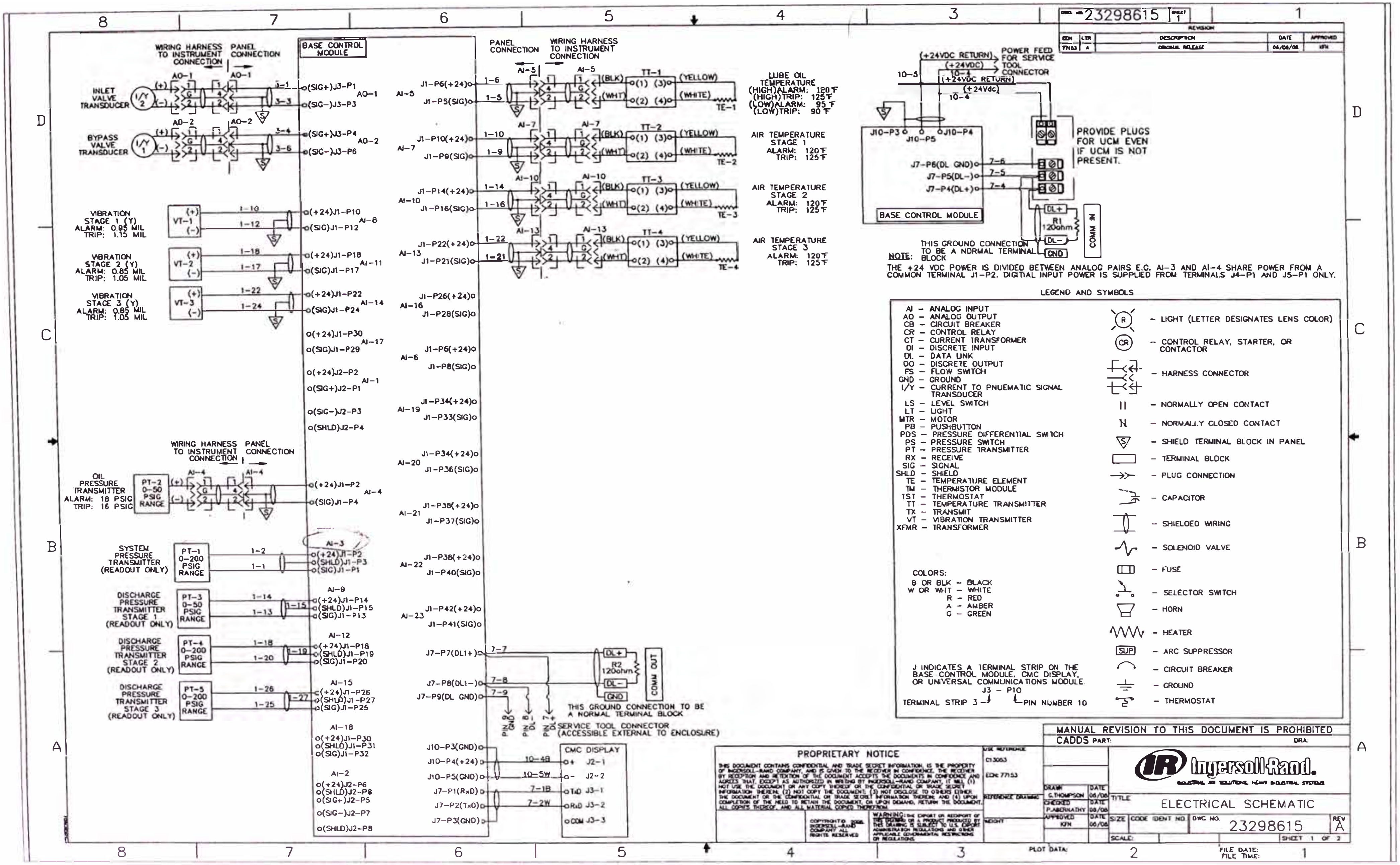
DRAWN	DATE
M.CURRY	04-06-07
CHECKED JP	04-07
APPROVED J.PARK	04-07

Ingersoll Rand

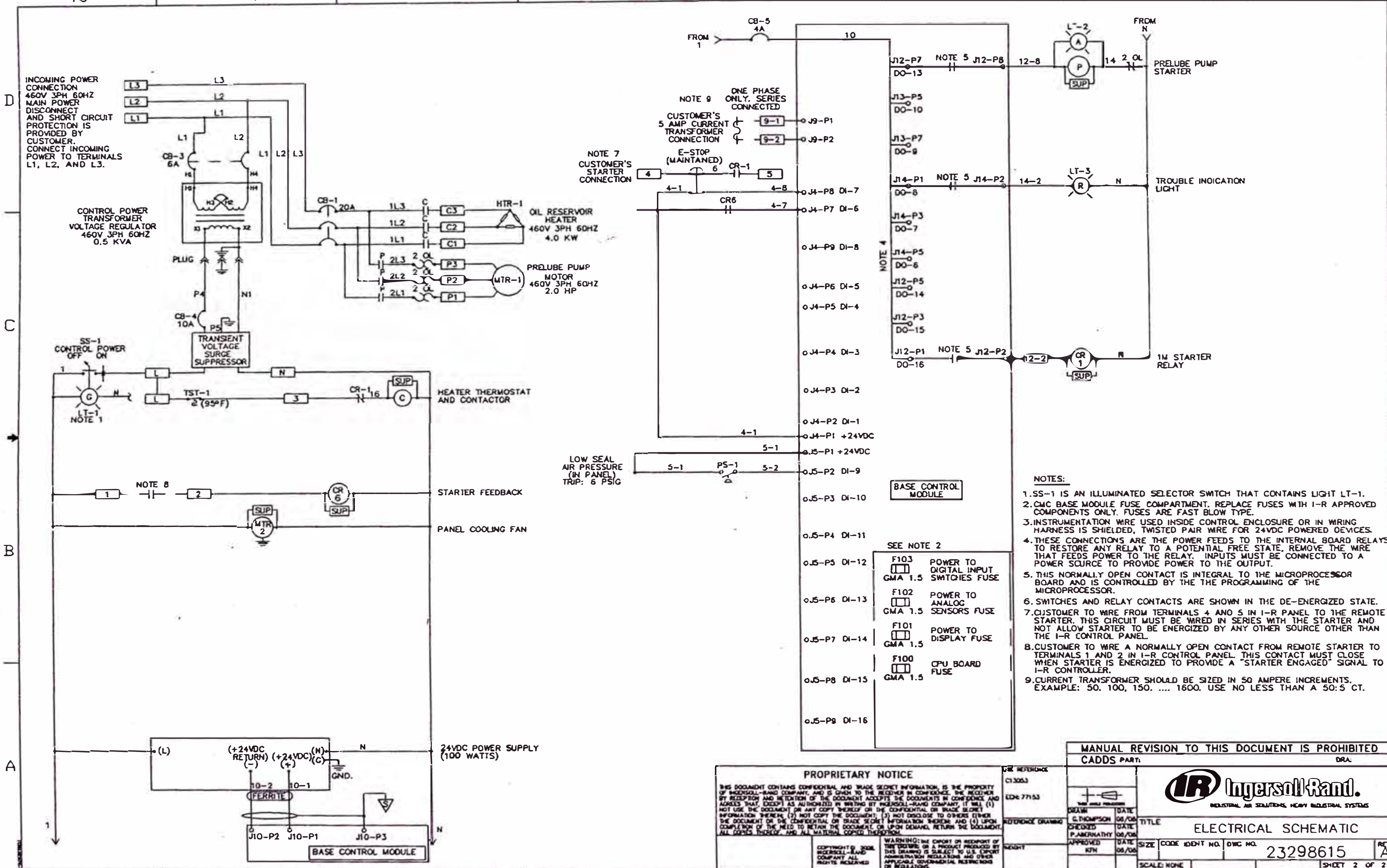
TITLE: GAUGE, TEMP
NONE

SIZE	ESTIMATED WEIGHT	DWG NO.	REV
A1	0.0	23107386	A
SCALE: 0.25	UNIT:	C950	SHEET 1 OF 1

ED PR TE NT



23298615 SHEET 1
REVISION
ECN 77153 LTR A DESCRIPTION ORIGINAL RELEASE DATE 04/06/08 APPROVED KFN
BASE CONTROL MODULE
WIRING HARNESS TO INSTRUMENT CONNECTION
PANEL CONNECTION
INLET VALVE TRANSDUCER
BYPASS VALVE TRANSDUCER
(SIG+)J3-P1 AO-1
(SIG-)J3-P3
(SIG+)J3-P4 AO-2
(SIG-)J3-P6
VIBRATION STAGE 1 (Y) ALARM: 0.85 MIL TRIP: 1.15 MIL
VIBRATION STAGE 2 (Y) ALARM: 0.85 MIL TRIP: 1.05 MIL
VIBRATION STAGE 3 (Y) ALARM: 0.85 MIL TRIP: 1.05 MIL
(+24)J1-P10 AI-8 (SIG)J1-P12
(+24)J1-P18 AI-11 (SIG)J1-P17
(+24)J1-P22 AI-14 (SIG)J1-P24
(+24)J1-P30 AI-17 (SIG)J1-P29
(+24)J2-P2 AI-1 (SIG+)J2-P1 (SIG-)J2-P3 (SHLD)J2-P4
OIL PRESSURE TRANSMITTER ALARM: 18 PSIG TRIP: 16 PSIG
PT-2 0-50 PSIG RANGE
(+24)J1-P2 AI-4 (SIG)J1-P4
SYSTEM PRESSURE TRANSMITTER (READOUT ONLY)
PT-1 0-200 PSIG RANGE
AI-3 (+24)J1-P2 (SHLD)J1-P3 (SIG)J1-P1
DISCHARGE PRESSURE TRANSMITTER STAGE 1 (READOUT ONLY)
PT-3 0-50 PSIG RANGE
AI-9 (+24)J1-P14 (SHLD)J1-P15 (SIG)J1-P13
DISCHARGE PRESSURE TRANSMITTER STAGE 2 (READOUT ONLY)
PT-4 0-200 PSIG RANGE
AI-12 (+24)J1-P18 (SHLD)J1-P19 (SIG)J1-P20
DISCHARGE PRESSURE TRANSMITTER STAGE 3 (READOUT ONLY)
PT-5 0-200 PSIG RANGE
AI-15 (+24)J1-P26 (SHLD)J1-P27 (SIG)J1-P25
AI-18 (+24)J1-P30 (SHLD)J1-P31 (SIG)J1-P32
AI-2 (+24)J2-P6 (SHLD)J2-P8 (SIG+)J2-P5 (SIG-)J2-P7 (SHLD)J2-P8
AI-5 J1-P6(+24) J1-P5(SIG)
AI-7 J1-P10(+24) J1-P9(SIG)
AI-10 J1-P14(+24) J1-P16(SIG)
AI-13 J1-P22(+24) J1-P21(SIG)
AI-16 J1-P26(+24) J1-P28(SIG)
AI-6 J1-P6(+24) J1-P8(SIG)
AI-19 J1-P34(+24) J1-P33(SIG)
AI-20 J1-P34(+24) J1-P36(SIG)
AI-21 J1-P38(+24) J1-P37(SIG)
AI-22 J1-P38(+24) J1-P40(SIG)
AI-23 J1-P42(+24) J1-P41(SIG)
J7-P7(DL1+) J7-P8(DL1-) J7-P9(DL GND)
R2 120ohm COMM OUT
THIS GROUND CONNECTION TO BE A NORMAL TERMINAL BLOCK
PIN 9 GND PIN 8 DL- PIN 7 DL+ SERVICE TOOL CONNECTOR (ACCESSIBLE EXTERNAL TO ENCLOSURE)
J10-P3(GND) J10-P4(+24) J10-P5(GND) J7-P1(RxD) J7-P2(TxD) J7-P3(GND)
CMC DISPLAY +J2-1 -J2-2 TxD J3-1 RxD J3-2 COM J3-3
TT-1 TT-2 TT-3 TT-4 (BLK) (WHT) (YELLOW) (WHITE) TE-1 TE-2 TE-3 TE-4
LUBE OIL TEMPERATURE (HIGH)ALARM: 120°F (HIGH)TRIP: 125°F (LOW)ALARM: 95°F (LOW)TRIP: 90°F
AIR TEMPERATURE STAGE 1 ALARM: 120°F TRIP: 125°F
AIR TEMPERATURE STAGE 2 ALARM: 120°F TRIP: 125°F
AIR TEMPERATURE STAGE 3 ALARM: 120°F TRIP: 125°F
POWER FEED FOR SERVICE TOOL CONNECTOR
(+24VDC RETURN) (+24VDC) (+24VDC RETURN) (+24Vdc)
J10-P3 J10-P5 J10-P4
J7-P8(DL GND) J7-P5(DL-) J7-P4(DL+)
PROVIDE PLUGS FOR UCM EVEN IF UCM IS NOT PRESENT.
R1 120ohm COMM IN
THIS GROUND CONNECTION TO BE A NORMAL TERMINAL BLOCK
NOTE: THE +24 VDC POWER IS DIVIDED BETWEEN ANALOG PAIRS E.G. AI-3 AND AI-4 SHARE POWER FROM A COMMON TERMINAL J1-P2. DIGITIAL INPUT POWER IS SUPPLIED FROM TERMINALS J4-P1 AND J5-P1 ONLY.
LEGEND AND SYMBOLS
AI - ANALOG INPUT
AO - ANALOG OUTPUT
CB - CIRCUIT BREAKER
CR - CONTROL RELAY
CT - CURRENT TRANSFORMER
DI - DISCRETE INPUT
DL - DATA LINK
DO - DISCRETE OUTPUT
FS - FLOW SWITCH
GND - GROUND
I/Y - CURRENT TO PNUEMATIC SIGNAL TRANSDUCER
LS - LEVEL SWITCH
LT - LIGHT
MTR - MOTOR
PB - PUSHBUTTON
PDS - PRESSURE DIFFERENTIAL SWITCH
PS - PRESSURE SWITCH
PT - PRESSURE TRANSMITTER
RX - RECEIVE
SIG - SIGNAL
SHLD - SHIELD
TE - TEMPERATURE ELEMENT
TM - THERMISTOR MODULE
TST - THERMOSTAT
TT - TEMPERATURE TRANSMITTER
TX - TRANSMIT
VT - VIBRATION TRANSMITTER
XFMR - TRANSFORMER
- LIGHT (LETTER DESIGNATES LENS COLOR)
- CONTROL RELAY, STARTER, OR CONTACTOR
- HARNESS CONNECTOR
- NORMALLY OPEN CONTACT
- NORMALLY CLOSED CONTACT
- SHIELD TERMINAL BLOCK IN PANEL
- TERMINAL BLOCK
- PLUG CONNECTION
- CAPACITOR
- SHIELDED WIRING
- SOLENOID VALVE
- FUSE
- SELECTOR SWITCH
- HORN
- HEATER
- ARC SUPPRESSOR
- CIRCUIT BREAKER
- GROUND
- THERMOSTAT
COLORS:
B OR BLK - BLACK
W OR WHT - WHITE
R - RED
A - AMBER
G - GREEN
J INDICATES A TERMINAL STRIP ON THE BASE CONTROL MODULE, CMC DISPLAY, OR UNIVERSAL COMMUNICATIONS MODULE.
J3 - P10
TERMINAL STRIP 3 PIN NUMBER 10
MANUAL REVISION TO THIS DOCUMENT IS PROHIBITED
CADDS PART:
PROPRIETARY NOTICE
Ingersoll Rand
ELECTRICAL SCHEMATIC
DRAWN G.THOMPSON CHECKED P.ABERNATHY APPROVED KFN
DWG NO. 23298615 REV A
SHEET 1 OF 2
PLOT DATA: FILE DATE: FILE TIME:



NOTES:

1. SS-1 IS AN ILLUMINATED SELECTOR SWITCH THAT CONTAINS LIGHT LT-1.
2. CMC BASE MODULE FUSE COMPARTMENT. REPLACE FUSES WITH I-R APPROVED COMPONENTS ONLY. FUSES ARE FAST BLOW TYPE.
3. INSTRUMENTATION WIRE USED INSIDE CONTROL ENCLOSURE OR IN WIRING HARNESS IS SHIELDED, TWISTED PAIR WIRE FOR 24VDC POWERED DEVICES.
4. THESE CONNECTIONS ARE THE POWER FEEDS TO THE INTERNAL BOARD RELAYS. TO RESTORE ANY RELAY TO A POTENTIAL FREE STATE, REMOVE THE WIRE THAT FEEDS POWER TO THE RELAY. INPUTS MUST BE CONNECTED TO A POWER SOURCE TO PROVIDE POWER TO THE OUTPUT.
5. THIS NORMALLY OPEN CONTACT IS INTEGRAL TO THE MICROPROCESSOR BOARD AND IS CONTROLLED BY THE THE PROGRAMMING OF THE MICROPROCESSOR.
6. SWITCHES AND RELAY CONTACTS ARE SHOWN IN THE DE-ENERGIZED STATE.
7. CUSTOMER TO WIRE FROM TERMINALS 4 AND 5 IN I-R PANEL TO THE REMOTE STARTER. THIS CIRCUIT MUST BE WIRED IN SERIES WITH THE STARTER AND NOT ALLOW STARTER TO BE ENERGIZED BY ANY OTHER SOURCE OTHER THAN THE I-R CONTROL PANEL.
8. CUSTOMER TO WIRE A NORMALLY OPEN CONTACT FROM REMOTE STARTER TO TERMINALS 1 AND 2 IN I-R CONTROL PANEL. THIS CONTACT MUST CLOSE WHEN STARTER IS ENERGIZED TO PROVIDE A "STARTER ENGAGED" SIGNAL TO I-R CONTROLLER.
9. CURRENT TRANSFORMER SHOULD BE SIZED IN 50 AMPERE INCREMENTS. EXAMPLE: 50, 100, 150, ... 1600. USE NO LESS THAN A 50:5 CT.

MANUAL REVISION TO THIS DOCUMENT IS PROHIBITED

CADDS PART:

Ingersoll Rand. INDUSTRIAL AIR SOLUTIONS, HEAVY INDUSTRIAL SYSTEMS

DRAWN	G.THOMPSON	DATE	06/06
CHECKED	P.ABERNATHY	DATE	06/06
APPROVED	KFH	DATE	06/06

TITLE: ELECTRICAL SCHEMATIC

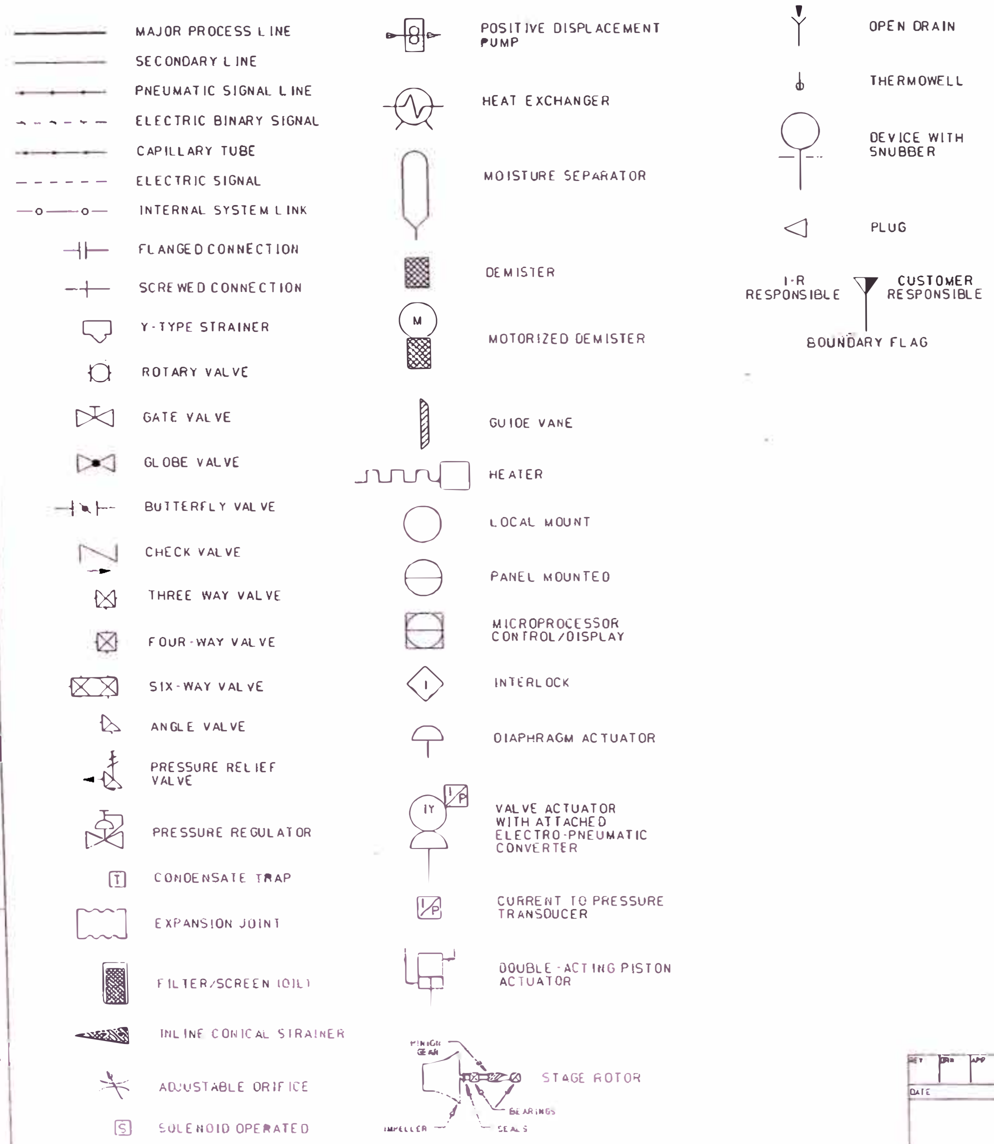
SIZE A | DWG NO. 23298615 | REV A

SCALE: NONE | SHEET 2 OF 2

ECN 77153

PLOT DATA:

FILE DATE:
FILE TIME:



AL	LOW ALARM
ALL	LOW SHUTDOWN
AH	HIGH ALARM
AHH	HIGH SHUTDOWN
ES	ELECTRIC SUPPLY
FCV	FLOW CONTROL VALVE
FE	FLOW SENSOR
FG	FLOW SIGHT GLASS
FI	FLOW INDICATOR
FO	FLOW ORIFICE
FQ	FLOW TOTALIZER
FIQ	FLOW INDICATING TOTALIZER
FR	FLOW RECORDER
FS	FLOW SWITCH
FT	FLOW TRANSMITTER
FIT	FLOW INDICATING TRANSMITTER
HV	HAND CONTROL VALVE
IY	CURRENT CONVERTER
JT	POWER TRANSMITTER
LG	LEVEL GAUGE GLASS
LI	LEVEL INDICATOR
LS	LEVEL SWITCH
LT	LEVEL TRANSMITTER
PC	PRESSURE CONTROLLER
PIC	PRESSURE INDICATING CONTROLLER
PCV	PRESSURE CONTROL VALVE
PDI	PRESSURE DIFFERENTIAL INDICATOR
PDS	PRESSURE DIFFERENTIAL SWITCH
PDT	PRESSURE DIFFERENTIAL TRANSMITTER
PI	PRESSURE INDICATOR
PR	PRESSURE RECORDER
PS	PRESSURE SWITCH
PSV	PRESSURE SAFETY VALVE
PT	PRESSURE TRANSMITTER
PIT	PRESSURE INDICATING TRANSMITTER
SC	SPEED CONTROL
SE	SPEED SENSOR
SI	SPEED INDICATOR
ST	SPEED TRANSMITTER
TC	TEMPERATURE CONTROLLER
TCV	TEMPERATURE CONTROL VALVE
TE	TEMPERATURE SENSOR
TI	TEMPERATURE INDICATOR
TS	TEMPERATURE SWITCH
TT	TEMPERATURE TRANSMITTER
VE	VIBRATION SENSOR
VI	VIBRATION INDICATOR
VS	VIBRATION SWITCH
VT	VIBRATION TRANSMITTER
XV	SOLENOID VALVE
ZI	POSITION INDICATOR
ZS	POSITION SWITCH
ZT	POSITION TRANSMITTER

REV | DRN | APP
DATE

PROPRIETARY NOTICE

USE REFERENCE
REFERENCE DRAWING
WEIGHT

MANUAL REVISION TO THIS DOCUMENT IS PROHIBITED
CADDS PART: DRA:

INGERSOLL-RAND
AIR COMPRESSORS
CENTRIFUGAL COMPRESSOR DIVISION
MAYFIELD, KY 42066

DRAWN	DATE
BG	2/94
CHECKED	
TH	3/94
APPROVED	
DS	3/94
ENG APPVL	

TITLE
PROCESS AND INSTRUMENTATION DIAGRAM SYMBOLS

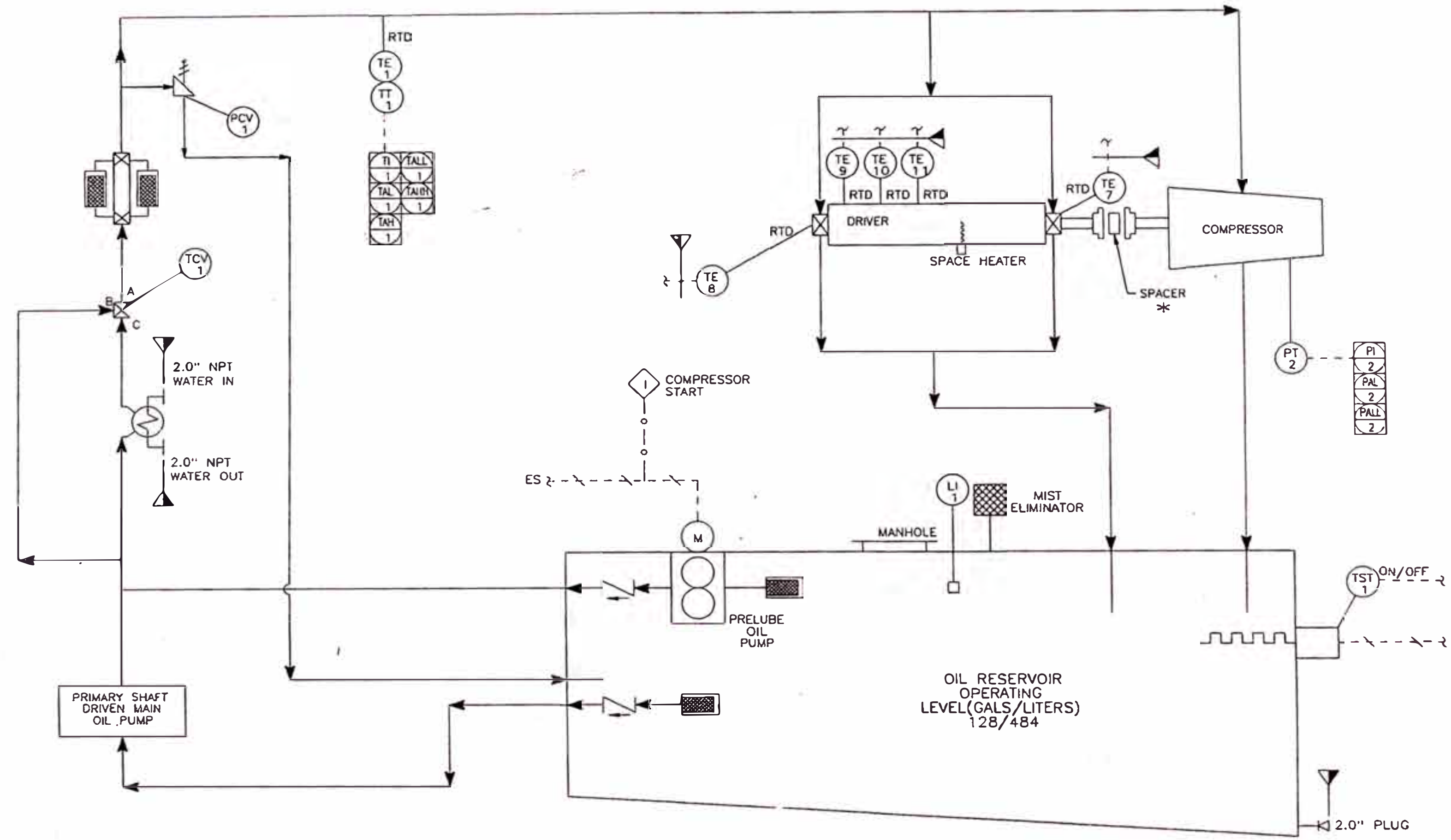
SIZE | CODE IDENT NO. | DWG NO. 7X23560 | REV
SCALE: | SHEET 1 OF 1

PLOT DATA:
FILE DATE:
FILE TIME:

AutoCAD® Drawing File
No Manual Revisions

REVISIONS

REV	ECN	DESCRIPTION	DWN	APV	DATE
A	77153	ORIGINAL RELEASE	RJG	RJG	06/23/08



NOTES

1. SEE 7X23560 FOR PROCESS AND INSTRUMENTATION SYMBOLS.
2. ITEMS MARKED * ARE SUPPLIED BY INGERSOLL-RAND COMPANY BUT ARE SHIPPED LOOSE FOR MOUNTING BY OTHERS.

USE REFERENCE
STANDARD C950 PID
W/ DUAL FILTER
W/ MTR RTDS
W/ FORCE LUBE

REFERENCE DRAWING

WEIGHT --

DRAWN RJG 06/23/08
CHECKED RJG 06/23/08
APPROVED RJG 06/23/08
DWG AREA 42, 99
SCALE NA
FSCM 6R484

Ingersoll Rand

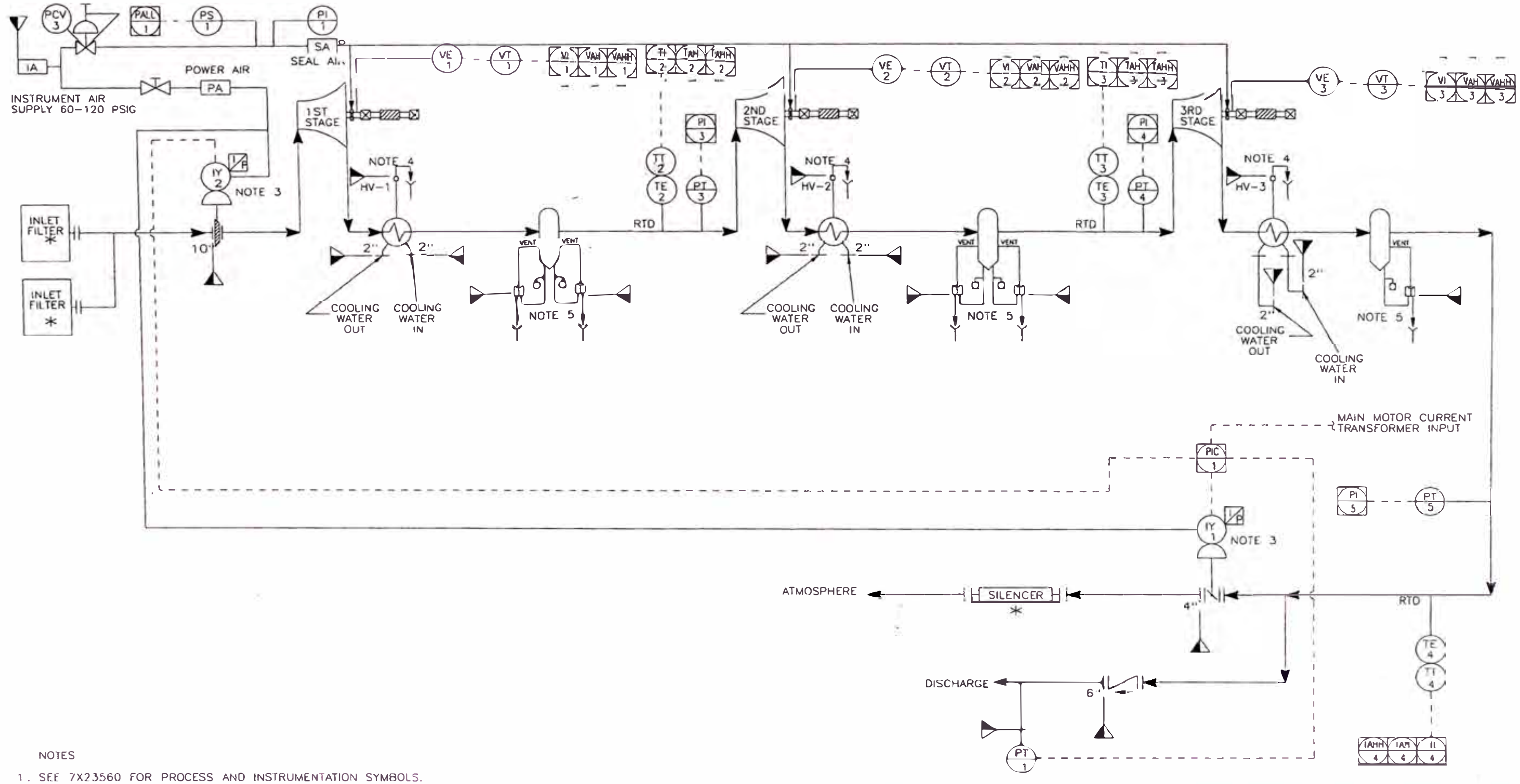
TITLE DIAGRAM, P&I (LUBRICATION)

SIZE D | DWG NO. 23325483 | REV A

UNIT C950 | SHEET 1 OF 1

AutoCAD® Drawing File
No Manual Revisions

REVISIONS					
REV	ECN	DESCRIPTION	DWN	APV	DATE
A	77153	ORIGINAL RELEASE	RJG	RJG	06/23/08



NOTES

1. SEE 7X23560 FOR PROCESS AND INSTRUMENTATION SYMBOLS.
2. ITEMS MARKED * ARE SUPPLIED BY INGERSOLL-RAND COMPANY BUT ARE SHIPPED LOOSE FOR MOUNTING BY OTHERS.
3. VALVE INCLUDES INTEGRAL FILTER/REGULATOR.
4. CUSTOMER TO PROVIDE VISUAL INDICATION OF WATER FLOW FROM EACH AIR COOLER VENT.
5. CONDENSATE CONNECTIONS REQUIRE SEPARATE DRAINS.

USE REFERENCE C950 35-3C 80
W/STD TRAPS
W/IGV
W/ 2 INL FILT

REFERENCE DRAWING

WEIGHT —

THIRD ANGLE PROJECTION

DRAWN RJ	DATE 06/23/08
CHECKED RJG	06/23/08
APPROVED RJG	06/23/08
CHG NOTE	42. 99
SCALE	NA
FSCM 6R484	

Ingersoll Rand

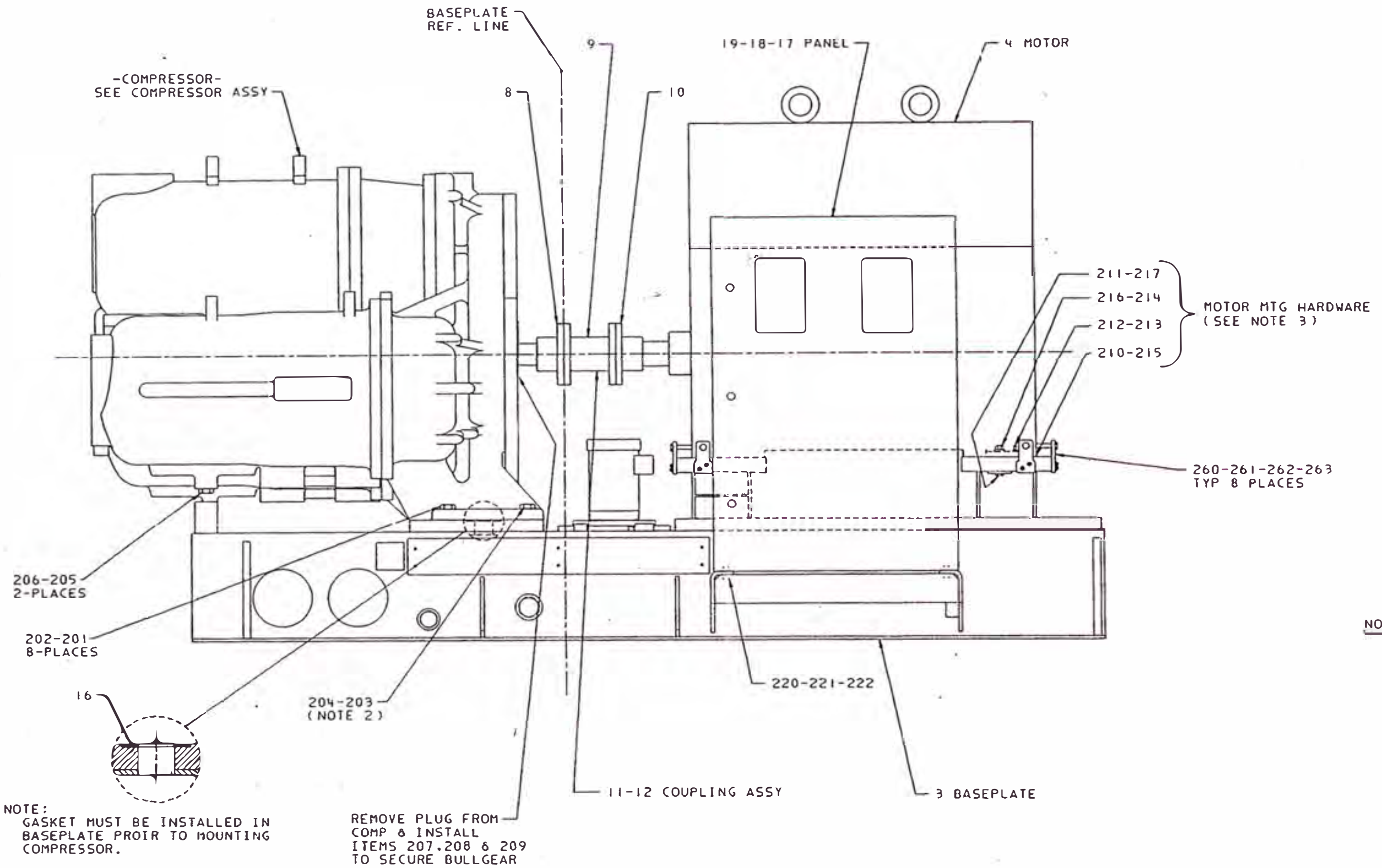
TITLE DIAGRAM, P&I (AIR/WATER)

SIZE	DWG NO.	REV
D	23325475	A
	UNIT C950	SHEET 1 OF 1

DWG. NO. 7X28834	SHEET 1

REVISION

ZONE	LTR	DESCRIPTION	DATE	APPROVED



NOTE:
GASKET MUST BE INSTALLED IN BASEPLATE PROIR TO MOUNTING COMPRESSOR.

NOTES:

1. THIS IS A STANDARD COMPOSITE DRAWING. REFER TO ACTUAL BILL OF MATERIALS FOR APPLICABLE ITEMS.
2. TAPER PIN MOUNTING - .640 (41/64) DRILL 2.75 DEEP IN BASEPLATE (DO NOT DRILL THRU). USE HOLE IN COMPRESSOR FOOT AS GUIDE. #10 TAPER REAM COMPRESSOR FOOT AND BASEPLATE TYPICAL 2 PLACES.
3. TAPER PINS TO BE LOCATED AFTER FINAL ALIGNMENT.
4. WHEN SPECIAL TAGGING IS REQUIRED. SEE BILL OF MATERIAL SEQUENCE NUMBER 7999.

ITEM	QUAN	DESCRIPTION	PART NUMBER	MATERIAL	WT

LIST OF MATERIAL

MANUAL REVISION TO THIS DOCUMENT IS PROHIBITED

CADDS PART: ENG.DF.7X28834 DRA: 1

PROPRIETARY NOTICE

UNSPECIFIED TOLERANCES

CASTING

DIMENSION	TOLERANCE
UNDER 2" (50 mm)	±.062" (1.5 mm)
2-5" (50-125 mm)	±.125" (3.0 mm)
5-8" (125-200 mm)	±.187" (4.5 mm)
ABOVE 8" (200 mm)	±.250" (6.0 mm)

FILLETS & RADII TO BE .125 (3 mm)

MACHINING

REMOVE BURRS & SHARP CORNERS.

COUNTERSINK TAPPED HOLES TO BODY SIZE.

MACH FIN. 125 RMS

DIMENSION & TOLERANCE CONVERSION REQUIRES INCH VALUES TO HAVE ONE MORE DECIMAL PLACE THAN METRIC VALUES

IN.	DEC. PLC.	mm
N/A	0 PLACE	±1.0
±.04	1 PLACE	±0.3
±.01	2 PLACE	±0.15
±.005	3 PLACE	±0.015
±.0005	4 PLACE	N/A

INT. CORNER .030 (.8 mm) R MAX.
EXT. CORNER .015 (.4 mm) R MAX.
ANGULARITY ±1°
TORCH CUT ±1/16 (1.5 mm)

GEOMETRIC TOLERANCES
FLATNESS
CIRCULARITY
CYLINDRICITY
PROFILE OF LINE
PROFILE OF SURFACE
ANGULARITY
PERPENDICULARITY
PARALLELISM
POSITION
CONCENTRICITY
CIRCULAR RUNOUT
TOTAL RUNOUT

USE REFERENCE: C1250 STANDARD

REFERENCE DRAWING

WEIGHT

PATTERN NO.

MATERIAL

HEAT TREAT

HARDNESS MAX — MIN —

MET APPVL

INGERSOLL-RAND AIR COMPRESSORS

CENTRIFUGAL COMPRESSOR DIVISION
MAYFIELD, KY. 42066

DRAWN	NOLES	10-99
CHECKED	JOHNSON	10-99
APPROVED	BROWN	10-99
ENG APPVL		

TITLE
ASSEMBLY - EXTERIOR

SIZE	CODE IDENT NO.	DWG NO.	REV
		7X28834	

SCALE: .125 SHEET 1 OF 1

PLOT DATA:

FILE DATE: 96-01-05
FILE TIME: 10:43:07