

ภาคผนวก ข-26

การตรวจสอบอุปกรณ์และเครื่องจักร

Work Order Shop Paper

Order	83699698	Order type	0C20 0C20 Planned Maintenance
Description	RECIPROCATING COMPRESSOR		
Reported By	IP1020231127		
Start date	07.12.2023		
End date	07.12.2023		
Priority	3	0C-Medium Risk	
Status	REL NMAT PRC SETC		
Funct. location	9149-14-18-10	CO COMPRESSION	
Equipment	TH-HCO1MT-00001777	COMPRESSOR CO C1608	
TechIdentNo.	C1608		
Superord.Equip.			
Main work center	OPER 9149	Operation Group	
Maintenance plan	309208		

Operation	Description	Activity Type	Est Hours/ Qty	Act Hours/ Qty
0010	Reciprocating Compressor 1M	ENGR	0.5	

Close



Maintenance Checklist

Reciprocating Compressor 1 monthly

PM Category:	Tasklist:	PRT Document:	Standard Text:
RECPCOMP	T0118227	GT016526	G016526

	Task Description	OK	Not OK	Not Applicable
10	<p>Review compressor variable data if available. Compare against historical and allowable values.</p> <p>Some compressor operating parameters are captured in the PLC / HMI. Where possible, review parameters such as bearing vibrations and temperatures, suction/discharge pressure and temperature. Compare against historical and allowable values. If the compressor has a local control panel then check all parameters for any deviation from the norm or for any alarms. Raise a notification for corrective measures in the event of significant deviation.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20	<p>Record / trend interstage pressures and temperatures for multiple stage units (if applicable).</p> <p>A change in interstage pressures or rise in temperatures can be an indication of valve malfunction, ring bypassing, or unloader malfunction.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
30	<p>Record and trend suction and discharge valve temperatures (infrared gun or RTDs if equipped).</p> <p>35% of all reciprocating compressor unscheduled shutdowns are due to valves so correct valve maintenance and planning for valve maintenance is essential. Valve bypassing due to failure of springs, plates, poppet's, etc. will cause higher valve temperature due to gas recirculation. High valve temperatures indicate a valve failure. Create a notification for valve replacement.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
40	<p>Check machine train for loose/missing bolts and cracked foundations.</p> <p>Foundation deterioration is very serious and can lead to compressor failure due to increased piping stresses, distortion of casing and loss of internal machine clearances. Minor looseness on reciprocating machine frames or components can quickly deteriorate and result in failures of fasteners, mechanical impact of fixed components and/or fatigue cracking or ultimate failure. Visually inspect holding down bolts and foundation shim/shim packs. Place hands on the lower corners of the frame and feel for any signs of movement. Any deficiencies must have a corrective maintenance notification created. Any oil leaks must be mitigated and then corrected when possible.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
50	<p>Check all pipework, pulsation vessels and coolers for damage, corrosion, and mechanical integrity.</p> <p>Check for excessive vibration, cracking, and looseness of any component. Tightness of compressor cases and compressor distance pieces, cylinders, and pulsation bottles is important as any looseness can lead to stress on bolting and cracking flanges, pipework and large cast components. In addition, pulsation in bottles or pipework can adversely affect the smooth operation of the valves resulting in machine inefficiencies.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



60	<p>If the machine is fitted with valve unloaders or cylinder clearance unloaders then ensure that no leaks exist and that they are functioning correctly.</p> <p>Valve unloaders function by forcing open the valve seat such that compressed gas is passed back into the suction as well as the discharge. As indicated they unload the machine reducing power consumption and production. Cylinder unloaders function by changing the volume clearance in the cylinder. Cylinder unloaders do something similar but have greater volume control. Unloaders can be manually actuated or use actuators. Ensure that the valves move / function and that no leaks exist. Ensure that the loader is in the position required. When the machine is loaded, no air pressure is placed on the unloader and no air should exist in the tubing. If possible, remove a dead-end tubing connection to the unloader and check for gas. If an unloader solenoid valve or diaphragm is leaking, then air, CO2 or ammonia will be detected in the tubing.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
70	<p>Check for loose/missing covers and guards. Rectify as required.</p> <p>Guards and covers for personnel protection must remain securely in place. Any deficiencies can result in increased risk to safety.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
80	<p>Check for unusual noise or vibrations on the complete machine train. If possible, place hands on machine to detect any unusual vibrations or pulsations.</p> <p>It is possible to have noise and vibration around the compressor that is not detected by the machinery protection system. Investigate any abnormal noises or vibrations for the source. Serious compressor problems have been detected by technicians with a good ear or feel for audible changes in the machine.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
90	<p>Listen for any sign of noise / knocking from the cylinder heads.</p> <p>There can be tight clearances between the pistons and the cylinder head, especially if the machine is fitted with unloaders. Listen for any unusual signs of knocking which might indicate a loose piston, a foreign object inside the cylinder (ie damaged valve parts) or the pistons are hitting the cylinder heads</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
100	<p>Inspect distance piece for evidence of oil leakage past oil scrapers, excessive gas packing leaks, and piston rod surface condition (where possible).</p> <p>The distance piece is a structural member connecting the cylinder to the compressor frame. Any process gas leakage past the seals is typically vented at the distance piece. Gas packing leaks should be small but must be monitored. Any increase in leakage indicates gas wiper seal wear. Oil scrapers are designed to prevent oil migration to the process gas and again, any leak should be negligible. Some compressors have a drain valve located underneath the distance piece. Open and check for presence of any oil. Measure and record any oil drained out. Significant amounts of oil suggest that the oil scrapers may need replacing. Any carryover must be investigated. The piston rod surface should be clean and undamaged. Any damage to the rod will increase oil and gas leakage. Rod damage also may indicate wear on the piston rider bands.</p>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>



110	<p>Visually inspect cross heads if possible (where applicable).</p> <p>This is generally applicable to horizontally opposed compressors. Look for any obvious signs of wear on the cross head or bearing pad. Listen for any clunking noises which may indicate that something is loose.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
120	<p>Check, record, and trend rod drop indication values (if equipped).</p> <p>Rod drop indicators measure the position between the piston rod and the cylinder surface. Any changes in measurement indicate wear in the rings and / or rider bands. Rod drop indicators, if fitted with a trip circuit, may also provide protection against running the piston into the cylinder in the event of a compressor trip.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
130	<p>Check for proper distance piece purge flow (if equipped).</p> <p>Distance piece purges are typical with compression of hydrocarbon gases, oxidizers, toxic gases, or others that may pose risk if vented to atmosphere or mixed with oil in the motion works of the compressor.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
140	<p>Check cooling water system for leaks.</p> <p>Cooling water volume flow and quality is critical to the efficiency of the machine. Visually check to ensure that all cylinders, coolers etc. receive water. Check sight glasses and ensure that they are clean. Ensure water quality is maintained, controlled and monitored. If cooling water is supplied by the customer it is still required to be monitored. If unsure, review with the Plant Manager, RBU Support Team, or water treatment engineer.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
150	<p>Inspect the lube oil system. Check for correct oil levels in the tank and for leaks. Check all oil filter differential pressures (ΔPs).</p> <p>If any leak exists in the lube oil system then first identify the source of the leak. It must be mitigated and then corrected. Ensure the ΔP gauge is functioning correctly. Note that the absence of a ΔP may indicate a bypassing or failed filter which can result in machine failure. Low ΔP situations must be immediately investigated and corrected. If ΔP starts to rise then switch filters immediately because the contamination rate is exponential and they will fail quickly. Change cartridge as necessary. Note that when changing cartridges on either a single system or dual system all air must be purged. Any loss of oil in the system can result in machine damage.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
160	<p>Check lube oil return sight glass for oil colour/flow/excessive gas entrapment (if equipped).</p> <p>Degradation of oil can be an indicator of machine wear or contamination from water, thermal breakdown, etc.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
170	<p>Check oil flow, pressure, and temperature are within limits.</p> <p>Review process data trending where available.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



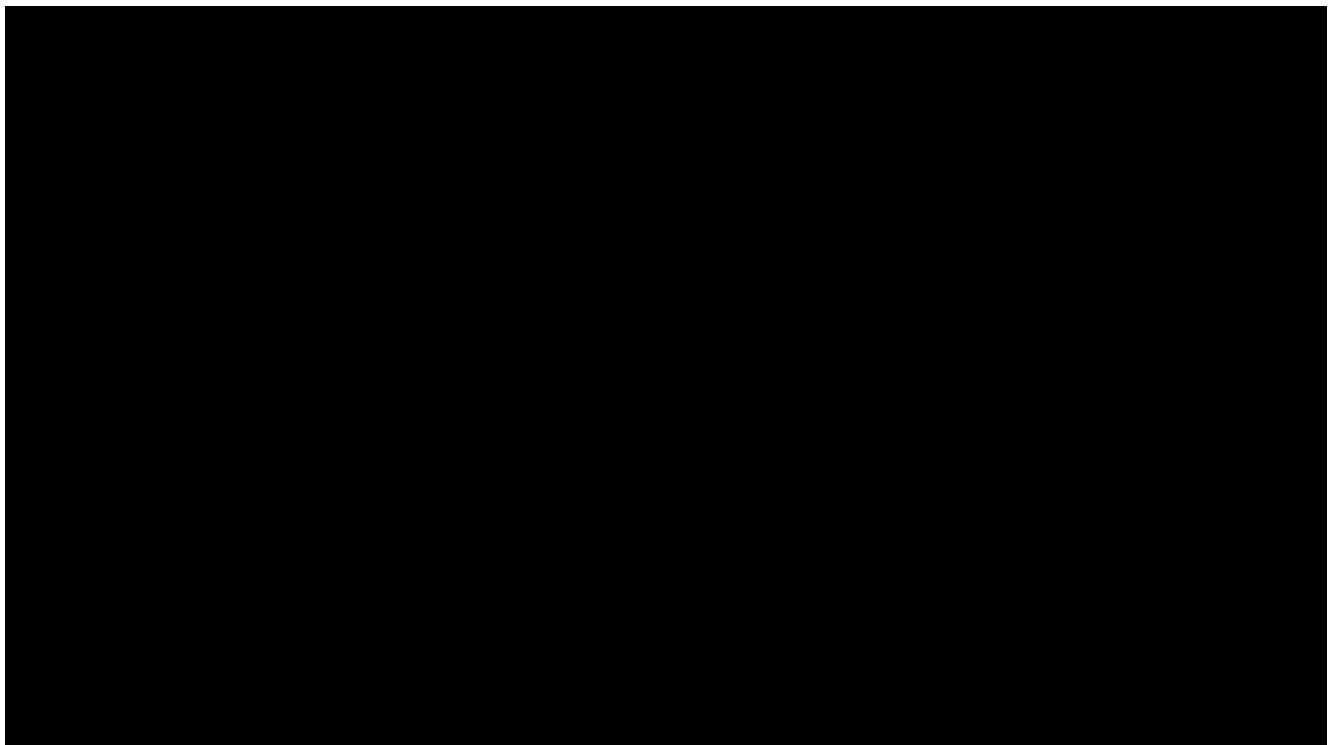
180	<p>Check operation of lubricator system (if applicable).</p> <p>Cylinders with lubrication rely on drip lubricators to regulate oil flow via drip rate for proper lubrication. Insufficient lubrication will lead to greater ring wear. Over lubrication can lead to valve failures and carry over to downstream equipment.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
190	<p>Check water return sight glasses for evidence of gas bubbles.</p> <p>Gas bubbles are an indication of leakage in intercoolers or head gaskets.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
200	<p>Check all bearings (motor and compressor) for abnormal temperature (if equipped).</p> <p>Many machines are fitted with bearing temperature indicators. If not and the plant has a thermographic gun the temperatures should be taken and recorded. Compare to historical values and proximity to alarm setpoints. It is difficult to generalize on bearing temperatures for plain bearings but typically if it is not possible to put a hand on a bearing surface for ten seconds then the temperatures are high and should be investigated. A rule of thumb is that 90C (195F) is acceptable, 100C (212F) a cause for concern, and 115C (240F) a potential problem.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
210	<p>Check all relief devices are free from obstruction and ice, and are not passing.</p> <p>Check that discharge pipes are securely clamped, drain holes are clear and bird meshes are in place (where required).</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
220	<p>Check condition of any filters. Change / clean as necessary.</p> <p>On air cooled motors it is essential that air filters are clean. Any restriction in air flow can lead to high internal temperatures adversely impacting the life of the winding insulation. Check manufacturer's specifications manual for filter status. Typically, filters are steel mesh and can be washed and re-inserted as the machine is running.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
230	<p>Check motor space heater (anti-condensation) switch is on (if equipped).</p> <p>Motor space heater will typically only come on during motor downtime to prevent moisture accumulation in the motor and the potential for winding failure during restart.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
240	<p>Check emergency stops are undamaged and have accidental stopguards fitted.</p> <p>Initiate a corrective maintenance notification as necessary.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
250	<p>Check all cabling is securely attached and undamaged, and all terminal boxes, local starter and control panels, are free from damage and corrosion, closed and intact.</p> <p>Any damage or corrosion to terminal boxes, cable glands or conduit can lead to water/moisture ingress that can cause intermittent trips that are difficult to locate. The integrity of terminal boxes and cable glands must be maintained to ensure that the equipment meets the hazardous zone requirements for electrical safety.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



260	<p>Check all field instruments (pressure, temperature, flow) are functioning correctly and free from corrosion or vibration, and any housings are secure, closed and watertight. Ensure all trace heating and winterization equipment is functioning correctly.</p> <p>Check all field instruments (pressure, temperature, flow) are functioning correctly and free from corrosion or vibration, and any housings are secure, closed and watertight. Ensure all trace heating and winterization equipment is functioning correctly.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Content source:

Additional Comments:



Fault Finding Report

Observation and Action Taken

Failure component

Damage description

Root cause

Work Done

Actual
Duration

Activity
Type

Start date
& Time

End date
& Time

Work

Work Ap

Batch

Acceptance Inspection:

Date:

Safety Opinion:

Date:

Material Planning

Item	Component Reservation/PR	Description Manufacturer Part No.	Reqmt Qty Manufacturer Name	UoM	OpAc
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End of report

ภาคผนวก ข-27

การตรวจสอบอุปกรณ์ที่เกี่ยวข้องกับ CO

Work Order Shop Paper

Order	83699698	Order type	0C20 0C20 Planned Maintenance
Description	RECIPROCATING COMPRESSOR		
Reported By	IP1020231127		
Start date	07.12.2023		
End date	07.12.2023		
Priority	3	0C-Medium Risk	
Status	REL NMAT PRC SETC		
Funct. location	9149-14-18-10	CO COMPRESSION	
Equipment	TH-HCO1MT-00001777	COMPRESSOR CO C1608	
TechIdentNo.	C1608		
Superord.Equip.			
Main work center	OPER 9149	Operation Group	
Maintenance plan	309208		

Operation	Description	Activity Type	Est Hours/ Qty	Act Hours/ Qty
0010	Reciprocating Compressor 1M	ENGR	0.5	

Close



Maintenance Checklist

Reciprocating Compressor 1 monthly

PM Category:	Tasklist:	PRT Document:	Standard Text:
RECPCOMP	T0118227	GT016526	G016526

	Task Description	OK	Not OK	Not Applicable
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20	<p>Record / trend interstage pressures and temperatures for multiple stage units (if applicable).</p> <p>A change in interstage pressures or rise in temperatures can be an indication of valve malfunction, ring bypassing, or unloader malfunction.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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40	<p>Check machine train for loose/missing bolts and cracked foundations.</p> <p>Foundation deterioration is very serious and can lead to compressor failure due to increased piping stresses, distortion of casing and loss of internal machine clearances. Minor looseness on reciprocating machine frames or components can quickly deteriorate and result in failures of fasteners, mechanical impact of fixed components and/or fatigue cracking or ultimate failure. Visually inspect holding down bolts and foundation shim/shim packs. Place hands on the lower corners of the frame and feel for any signs of movement. Any deficiencies must have a corrective maintenance notification created. Any oil leaks must be mitigated and then corrected when possible.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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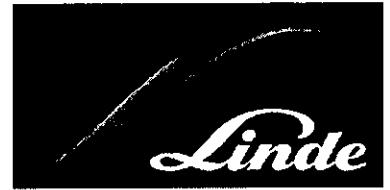
60	<p>If the machine is fitted with valve unloaders or cylinder clearance unloaders then ensure that no leaks exist and that they are functioning correctly.</p> <p>Valve unloaders function by forcing open the valve seat such that compressed gas is passed back into the suction as well as the discharge. As indicated they unload the machine reducing power consumption and production. Cylinder unloaders function by changing the volume clearance in the cylinder. Cylinder unloaders do something similar but have greater volume control. Unloaders can be manually actuated or use actuators. Ensure that the valves move / function and that no leaks exist. Ensure that the loader is in the position required. When the machine is loaded, no air pressure is placed on the unloader and no air should exist in the tubing. If possible, remove a dead-end tubing connection to the unloader and check for gas. If an unloader solenoid valve or diaphragm is leaking, then air, CO2 or ammonia will be detected in the tubing.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
70	<p>Check for loose/missing covers and guards. Rectify as required.</p> <p>Guards and covers for personnel protection must remain securely in place. Any deficiencies can result in increased risk to safety.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
80	<p>Check for unusual noise or vibrations on the complete machine train. If possible, place hands on machine to detect any unusual vibrations or pulsations.</p> <p>It is possible to have noise and vibration around the compressor that is not detected by the machinery protection system. Investigate any abnormal noises or vibrations for the source. Serious compressor problems have been detected by technicians with a good ear or feel for audible changes in the machine.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
90	<p>Listen for any sign of noise / knocking from the cylinder heads.</p> <p>There can be tight clearances between the pistons and the cylinder head, especially if the machine is fitted with unloaders. Listen for any unusual signs of knocking which might indicate a loose piston, a foreign object inside the cylinder (ie damaged valve parts) or the pistons are hitting the cylinder heads</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
100	<p>Inspect distance piece for evidence of oil leakage past oil scrapers, excessive gas packing leaks, and piston rod surface condition (where possible).</p> <p>The distance piece is a structural member connecting the cylinder to the compressor frame. Any process gas leakage past the seals is typically vented at the distance piece. Gas packing leaks should be small but must be monitored. Any increase in leakage indicates gas wiper seal wear. Oil scrapers are designed to prevent oil migration to the process gas and again, any leak should be negligible. Some compressors have a drain valve located underneath the distance piece. Open and check for presence of any oil. Measure and record any oil drained out. Significant amounts of oil suggest that the oil scrapers may need replacing. Any carryover must be investigated. The piston rod surface should be clean and undamaged. Any damage to the rod will increase oil and gas leakage. Rod damage also may indicate wear on the piston rider bands.</p>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>



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130	<p>Check for proper distance piece purge flow (if equipped).</p> <p>Distance piece purges are typical with compression of hydrocarbon gases, oxidizers, toxic gases, or others that may pose risk if vented to atmosphere or mixed with oil in the motion works of the compressor.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
140	<p>Check cooling water system for leaks.</p> <p>Cooling water volume flow and quality is critical to the efficiency of the machine. Visually check to ensure that all cylinders, coolers etc. receive water. Check sight glasses and ensure that they are clean. Ensure water quality is maintained, controlled and monitored. If cooling water is supplied by the customer it is still required to be monitored. If unsure, review with the Plant Manager, RBU Support Team, or water treatment engineer.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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160	<p>Check lube oil return sight glass for oil colour/flow/excessive gas entrapment (if equipped).</p> <p>Degradation of oil can be an indicator of machine wear or contamination from water, thermal breakdown, etc.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
170	<p>Check oil flow, pressure, and temperature are within limits.</p> <p>Review process data trending where available.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



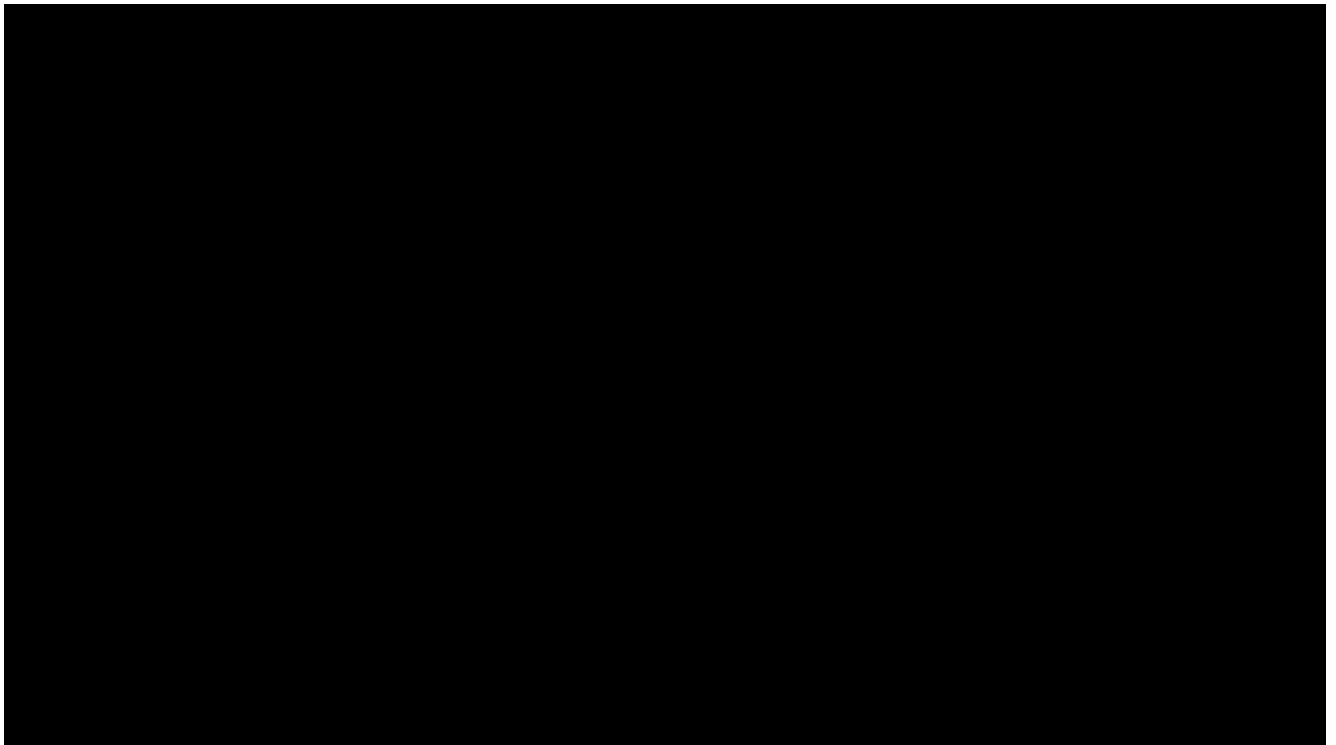
180	<p>Check operation of lubricator system (if applicable).</p> <p>Cylinders with lubrication rely on drip lubricators to regulate oil flow via drip rate for proper lubrication. Insufficient lubrication will lead to greater ring wear. Over lubrication can lead to valve failures and carry over to downstream equipment.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
190	<p>Check water return sight glasses for evidence of gas bubbles.</p> <p>Gas bubbles are an indication of leakage in intercoolers or head gaskets.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
200	<p>Check all bearings (motor and compressor) for abnormal temperature (if equipped).</p> <p>Many machines are fitted with bearing temperature indicators. If not and the plant has a thermographic gun the temperatures should be taken and recorded. Compare to historical values and proximity to alarm setpoints. It is difficult to generalize on bearing temperatures for plain bearings but typically if it is not possible to put a hand on a bearing surface for ten seconds then the temperatures are high and should be investigated. A rule of thumb is that 90C (195F) is acceptable, 100C (212F) a cause for concern, and 115C (240F) a potential problem.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
210	<p>Check all relief devices are free from obstruction and ice, and are not passing.</p> <p>Check that discharge pipes are securely clamped, drain holes are clear and bird meshes are in place (where required).</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
220	<p>Check condition of any filters. Change / clean as necessary.</p> <p>On air cooled motors it is essential that air filters are clean. Any restriction in air flow can lead to high internal temperatures adversely impacting the life of the winding insulation. Check manufacturer's specifications manual for filter status. Typically, filters are steel mesh and can be washed and re-inserted as the machine is running.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
230	<p>Check motor space heater (anti-condensation) switch is on (if equipped).</p> <p>Motor space heater will typically only come on during motor downtime to prevent moisture accumulation in the motor and the potential for winding failure during restart.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
240	<p>Check emergency stops are undamaged and have accidental stopguards fitted.</p> <p>Initiate a corrective maintenance notification as necessary.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
250	<p>Check all cabling is securely attached and undamaged, and all terminal boxes, local starter and control panels, are free from damage and corrosion, closed and intact.</p> <p>Any damage or corrosion to terminal boxes, cable glands or conduit can lead to water/moisture ingress that can cause intermittent trips that are difficult to locate. The integrity of terminal boxes and cable glands must be maintained to ensure that the equipment meets the hazardous zone requirements for electrical safety.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



260	<p>Check all field instruments (pressure, temperature, flow) are functioning correctly and free from corrosion or vibration, and any housings are secure, closed and watertight. Ensure all trace heating and winterization equipment is functioning correctly.</p> <p>Check all field instruments (pressure, temperature, flow) are functioning correctly and free from corrosion or vibration, and any housings are secure, closed and watertight. Ensure all trace heating and winterization equipment is functioning correctly.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Content source:

Additional Comments:



Fault Finding Report

Observation and Action Taken

Failure component

Damage description

Root cause

Work Done	Actual Duration	Activity Type	Start date & Time	End date & Time
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Work

Work Ap

Batch

Acceptance Inspection:	Date:	Safety Opinion:	Date:
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Material Planning

Item	Component Reservation/PR	Description Manufacturer Part No.	Reqmt Qty Manufacturer Name	UoM	OpAc
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End of report

ภาคผนวก ข-28

เอกสารรองรับความปลอดภัยของไฟฟ้า

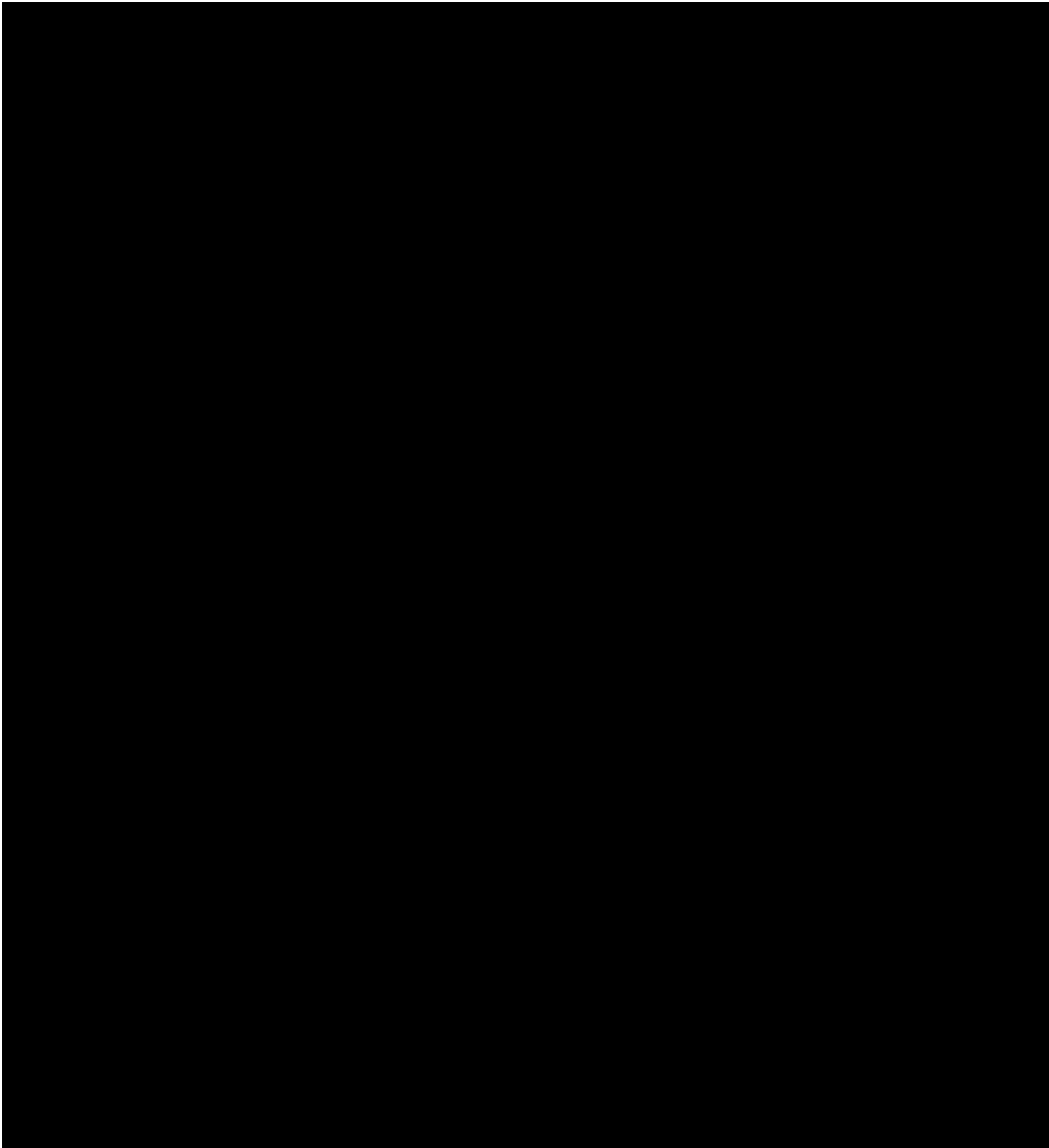
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กรมโรงงานอุตสาหกรรม

สำหรับเจ้าหน้าที่รับเรื่อง

รหัส.....

เลขรับเลขที่..... วันที่.....

เอกสารรับรองความปลอดภัยของระบบไฟฟ้า



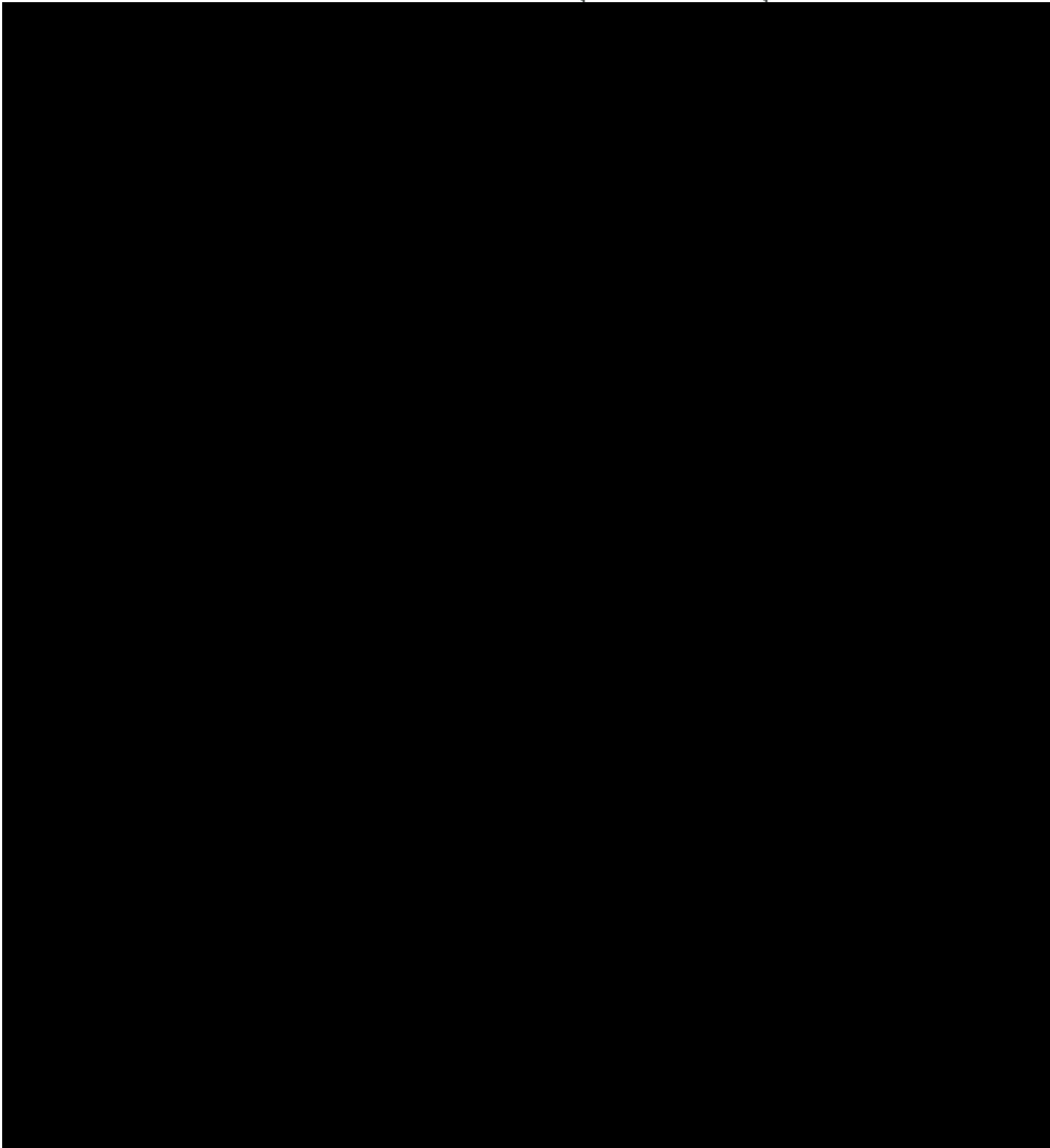
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กรมโรงงานอุตสาหกรรม

สำหรับเจ้าหน้าที่รับเรื่อง

รหัส.....

เลขรับเลขที่..... วันที่.....

รายงานการตรวจสอบระบบและอุปกรณ์ไฟฟ้าในโรงงานอุตสาหกรรม



- ระบบสายดิน



